QUALITY ASSURANCE PROJECT PLAN
Upper Columbia River Residential Soil Study
Washington State

Prepared for:

U.S. Environmental Protection Agency Region 10
Seattle, Washington

Environmental Response Team
Edison, New Jersey

Prepared by:

SRC, Inc. for Lockheed Martin
Scientific Engineering Response & Analytical Services Program
Syracuse, New York

August 13, 2014

Based on the Intergovernmental Data Quality Task Force Uniform
Federal Policy for Quality Assurance Project Plans
(Final Version 1.1, June 2006)

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ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
APE	Area of potential effects
ARPA	Archeological Resources Protection Act of 1979
As	Arsenic
BC	British Columbia
CCT	Confederated Tribes of the Colville Reservation
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeter
COC	Chain of custody
CRCP	Cultural resources coordination plan
DAHP	Washington State Department of Archaeology & Historic Preservation
DOI	United States Department of Interior
DOJ	United States Department of Justice
DQO	Data quality objective
DU	Decision unit
ECY	Washington Department of Ecology
EDD	Electronic data deliverable
EPC	Exposure point concentration
ERT	Environmental Response Team
FOIA	Freedom of Information Act
FSP	Field Sampling Plan
FE	Fundamental Error
GIS	Geographic information system
GPS	Global positioning system
H_a	Alternative hypothesis
Hg	Mercury
HHRA	Human health risk assessment
HI	Hazard index
H_0	Null hypothesis
H&S	Health and Safety
IC	Incremental composite (sample)
IEUBK	Integrated Exposure Uptake Biokinetic Model
IMS	Information management system
ITRC	Interstate Technology and Regulatory Council
IVBA	*In vitro* bioaccessibility assay
kg	kilogram(s)
Lake Roosevelt	Franklin D. Roosevelt Lake
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
LOE	Level of effort
MEL	Manchester Environmental Laboratory
mg/dl	milligrams per deciliter
mg/kg	milligrams per kilogram
mm	millimeter(s)
MOA	Memorandum of Agreement
MS/MSD	Matrix spike/matrix spike duplicate
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
OSRTI	Office of Superfund Remediation and Technology Innovation

OSWER	Office of Solid Waste and Emergency Response
Pb	Lead
ppm	parts per million
QA	Quality assurance
QAPP	Quality assurance project plan
QA/QC	Quality assurance/quality control
RBA	Relative bioavailability
RBC	Risk-based concentration
RCW	Revised Code of Washington
RI/FS	Remedial Investigation and Feasibility Study
RM	River mile
RPD	Relative percent difference
RPM	Remedial Project Manager
RQAM	Regional Quality Assurance Manager
RSCC	Regional Sample Control Coordinator
RSL	Residential screening level
RV	Recreational vehicle
SERAS	Scientific Engineering Response & Analytical Services
SHPO	State Historic Preservation Officer
SHSP	Site health and safety plan
Site	Upper Columbia River site
SOP	Standard operating procedure
sq ft	Square feet
SSL	Soil screening level
STI	Spokane Tribe of Indians
SU	Sampling unit
TAI	Teck American, Incorporated
TAL	Target analyte list
Teck	Teck Metals, Ltd.
THPO	Tribal Historic Preservation Officer
TL	Task leader
TR	Total risk
UCR	Upper Columbia River
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
µg/dL	micrograms per deciliter
µm	micrometers
U.S.	United States
USBR	United States Bureau of Reclamation
U.S. EPA	United States Environmental Protection Agency
VSP	Visual sampling plan (software supported by EPA to determine the number of samples or increments)
WA	Washington
WAC	Washington Administrative Code
WAM	Work assignment manager
95UCL	95 percent upper confidence limit
“	Inch

INTRODUCTION

This document presents the Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) for the Upper Columbia River (UCR) Residential Soil Study within the northernmost reaches of the UCR Study Area (north of the town of Northport to the United States [U.S.] – Canada border). The properties to be sampled were identified through voluntary participation. The UCR Residential Soil Study represents one of the tasks that will be completed as part of the remedial investigation and feasibility study (RI/FS). The RI/FS is being conducted under a Settlement Agreement between Teck American, Incorporated (TAI) and the U.S. Environmental Protection Agency (U.S. EPA). This QAPP was prepared by SRC, Inc. under Scientific, Engineering, Response & Analytical Services (SERAS) work assignment SERAS 0-079 to the U.S. EPA Environmental Response Team (ERT).

The objective of this study is to collect data that will refine exposure estimates for residents in the northernmost reaches of the Columbia River Study Area to support the human health risk assessment (HHRA). Specifically, surface soils will be collected from rural residential properties in the Columbia River valley north of Northport, Washington (WA) and extending to the U.S. – Canada border (UCR Study Area, see Figure 1); surface soil concentrations for target analyte list (TAL) metals[1] (no mercury [Hg]) will be determined; and the *in vitro* bioaccessibility (IVBA) of lead (Pb) and arsenic (As) in soil will be measured.[2]

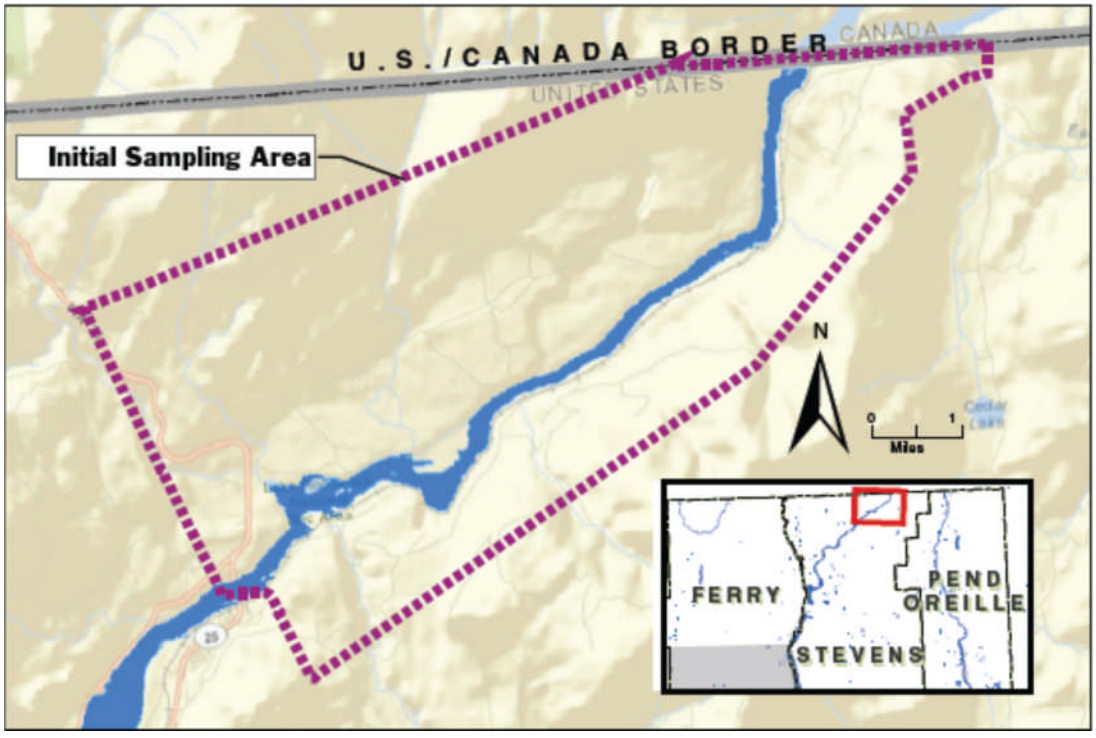

Figure 1. Residential Property Owners within the Initial UCR Study Area

[1]TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Risk-based concentrations for each TAL metal are available in Attachment E.

[2] "Bioaccessibility testing will only be run for increment composite samples that have a Pb or As concentration greater than or equal to 100 or 20 parts per million (ppm), respectively.

This QAPP describes the UCR Study Area history, data quality objectives (DQOs), study design, analytical procedures, and quality assurance and quality control (QA/QC) procedures for the UCR Residential Soil Study. The DQOs for the UCR Residential Soil Study are included as Attachment A. Property-specific sampling maps are presented in Attachment B. The field sampling plan (FSP) is presented in Attachment C.

QAPP Worksheet #1: Title and Approval Page

Site Name/Project Name: UCR Residential Soil Study

Site Location: WA State

Document Title: QAPP for the UCR Residential Soil Study

Lead Organization: EPA/ERT

Preparer's Name and Organizational Affiliation: Karen Kracko, Nick Flavin, and Julie Rothrock, SRC/SERAS

Preparer's Address, Telephone Number, and Email Address: 2890 Woodbridge Avenue, Edison, New Jersey 08837, 732-494-4047, kkracko@srcinc.com

Preparation Date (Day/Month/Year): 08/15/2014

Investigative Organization's Project Manager/Date: _____ 8/15/14
Signature

Printed Name/Organization: David Charters/ERT Work Assignment Manager (WAM)

Investigative Organization's Project Quality Assurance (QA) Officer/Date: _____ 8/15/14
Signature

Printed Name/Organization: Stephen Blaze/ERT Quality Coordinator

Lead Organization's Project Manager/Date: _____ 8.14.14
Signature

Printed Name/Organization: Laura Buelow/EPA Region 10

Approval Signatures/Date: _____ 08/14/2014
Signature

Printed Name/Organization: Gina Grepo-Grove/EPA Region 10 QA Manager

Approval Signatures/Date: _____ 8/15/2014
Signature

Printed Name/Title: Deborah Killeen/SERAS QA/QC Officer

Document Control Numbering System: SERAS-079-DQAPP-0081514-UCR-R10

QAPP Worksheet #2: QAPP Identifying Information

Site Name/Project Name:	UCR Residential Soil Study
Site Location:	WA State
Site Number/Code:	10EM
Operable Unit:	N/A
Contractor Name:	SRC/Lockheed Martin
Contractor Number:	EP-W-09-031
Contract Title:	SERAS
Work Assignment Number:	SERAS-079

1. Identify regulatory program: Comprehensive Environmental Response and Compensation Liability Act (CERCLA); RIFS Settlement Agreement (Department of Justice [DOJ], 2006)
2. Identify approval entity: Region 10 (Remedial Project Managers [RPM] and Regional QA Manager); EPA/ERT
3. The QAPP is (select one): ☐Generic ☒Project Specific
4. List dates of scoping sessions that were held: 14 conference calls between July 2013 and February 2014
5. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
Quality Assurance Project Plan Upper Columbia River Human Health Risk Assessment Washington State SERAS-079-DQAPP-011311	01/13/11

6. List organizational partners (stakeholders) and connection with lead organization: EPA, Region 10, TAI, the Department of the Interior (DOI), Washington Department of Ecology (ECY), Confederated Tribes of the Colville Reservation (CCT), and the Spokane Tribe of Indians (STI)
7. List data users: David Charters, EPA/ERT; Laura Buelow, Matt Wilkening, Monica Tonel, EPA, Region 10; HHRA personnel, Marc Stifelman, EPA, Region 10; Human Health Risk Assessors, SRC
8. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusions below:

   Standard operating procedures (SOPs) for incremental composite (IC) sampling, IVBA for Pb and As, and TAL metals analysis are attached.

QAPP Worksheet #2: QAPP Identifying Information *(continued)*

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QAPP Worksheet #3: Distribution List

☐ Worksheet Not Applicable (State Reason)

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	Email Address	Document Control Number
David Charters	Work Assignment Manager (WAM)	ERT	732-906-6825	732-321-6724	Charters.DavidW@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Stephen Blaze	Quality Coordinator	ERT	732-906-6921	732-321-6724	Blaze.Stephen@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Laura Buelow	Remedial Project Manager (RPM)	EPA R10	509-376-5466	N/A	Buelow.Laura@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Gina Grepo-Grove	Regional QA Manager (RQAM)	EPA R10	206-553-1632	N/A	Grepo-grove.gina@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Matt Wilkening	RPM	EPA R10	208-378-5760	N/A	Wilkening.Matt@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Monica Tonel	Project Team	EPA R10	206-553-0323	N/A	Tonel.Monica@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Marc Stifelman	Human Health Risk Assessor	EPA R10	206-553-6979	N/A	Stifelman.Marc@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Jennifer Crawford	Regional Sample Control Coordinator (RSCC) / QA Chemist	EPA R10	206-553-6261	N/A	Crawford.jennifer@epa.gov	SERAS-079-DQAPP-081314-UCR-R10
Kevin Taylor	Program Manager	SERAS	732-321-4202	732-494-4021	Kevin .C.Taylor@lmco.com	SERAS-079-DQAPP-081314-UCR-R10
Richard Leuser	Deputy Program Manager	SERAS	732-494-4060	732-494-4021	Richard.M.Leuser@lmco.com	SERAS-079-DQAPP-081314-UCR-R10
Deborah Killeen	Quality Assurance/Quality Control (QA/QC) Officer	SERAS	732-321-4245	732-494-4021	Deborah.A.Killeen@lmco.com	SERAS-079-DQAPP-081314-UCR-R10
David Hohreiter	Program Manager	SRC	315-452-8892	315-452-8440	DHohreiter@srcinc.com	SERAS-079-DQAPP-081314-UCR-R10
Bill Thayer	Task Leader (TL)/Quality Control (QC) Coordinator	SRC	315-452-8424	315-452-8440	Thayer@srcinc.com	SERAS-079-DQAPP-081314-UCR-R10
Marilyn Gauthier	Technical Team Coordinator	CH2MHill	503-872-4800	503-736-2000	Marilyn.Gauthier@ch2m.com	SERAS-079-DQAPP-081314-UCR-R10

QAPP Worksheet #4: Project Personnel Sign-Off Sheet

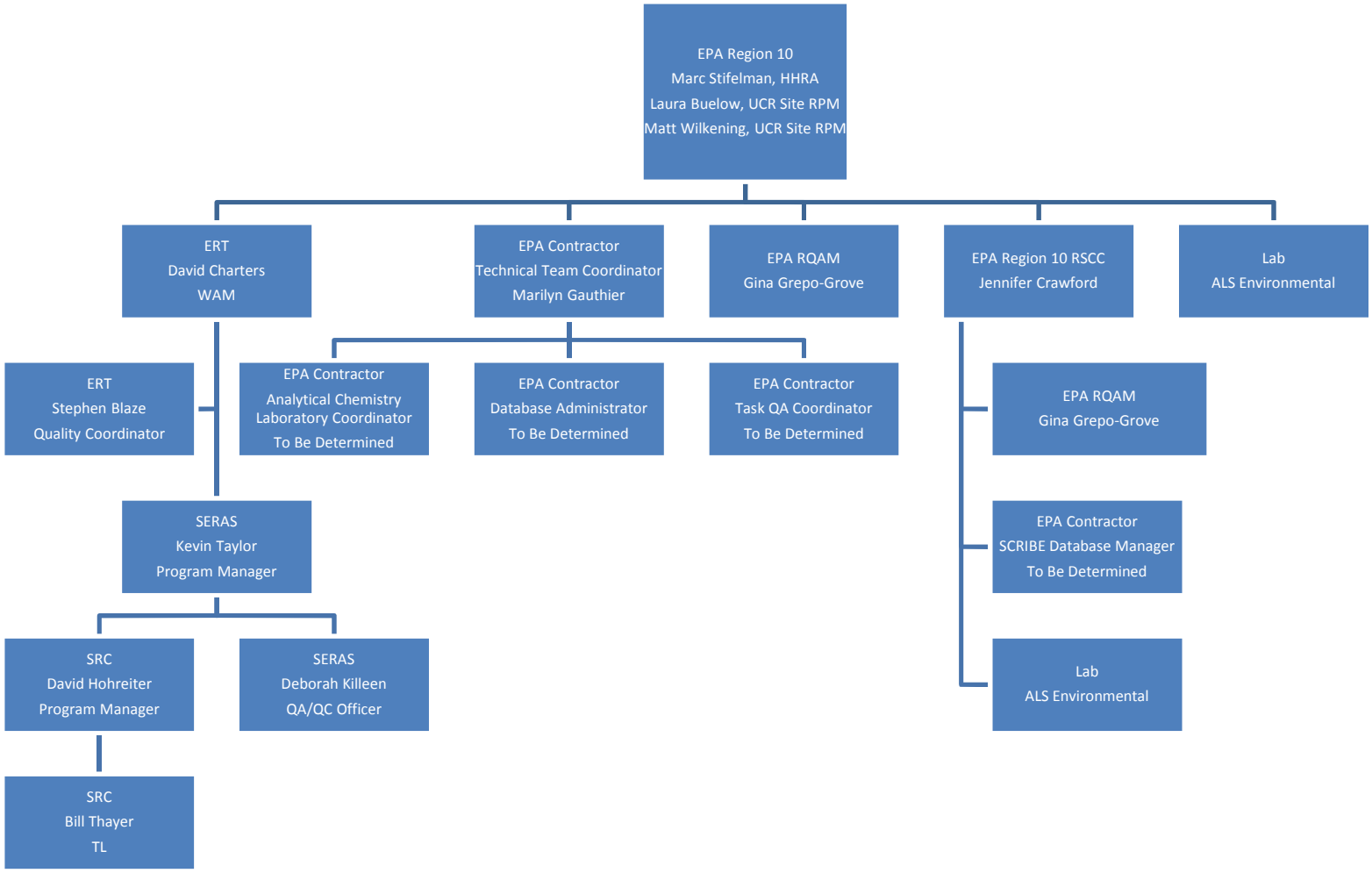
☐ Worksheet Not Applicable (State Reason)

Organization: ERT/SERAS

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
David Charters	ERT WAM	732-906-6825		
Laura Buelow	EPA Region 10 RPM	509-376-5466		
Matt Wilkening	EPA Region 10 RPM	208-378-5760		
Monica Tonel	EPA Region 10	206-553-0323		
Marc Stifelman	EPA Region 10 Human Health Risk Assessor	206-553-6979		
David Hohreiter	SRC Aquatic Ecological Risk Assessor and Program Manager	315-452-8892		
Bill Thayer	SRC TL	315-452-8424		
Marilyn Gauthier	Technical Team Coordinator	503-872-4800		
To Be Determined, EPA Contractor	Analytical Chemistry Laboratory Coordinator			
To Be Determined, EPA Contractor	Database Administrator			
To Be Determined, EPA Contractor	Task QA Coordinator			

QAPP Worksheet #5: Project Organizational Chart

☐ Worksheet Not Applicable (State Reason)



QAPP Worksheet #6: Communication Pathways

☐ Worksheet Not Applicable (State Reason)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Task Direction	ERT WAM EPA Region 10 EPA Region 10 RPM EPA Region 10 RPM	David Charters Marc Stifelman Laura Buelow Matt Wilkening	732-906-6825 206-553-6979 509-376-5466 208-378-5760	EPA Region 10 will contact ERT WAM with specific requests; ERT WAM will contact SERAS TL with specific requests.
Approval of QAPP and Any Amendments	ERT WAM EPA Region 10 RPM ERT Quality Coordinator SERAS QA/QC Officer SERAS TL EPA RQAM	David Charters Laura Buelow Stephen Blaze Deborah Killeen Bill Thayer Gina Grepo-Grove	732-906-6825 509-376-5466 732-906-6921 732-321-4245 303-452-8424 206-553-1632	SERAS initial peer review, followed by R10 review approval and ERT approval, implementation of changes effective only with approved QAPP or QAPP change form.
Field Sampling, Shipping or SCRIBE documentation issues	EPA RSCC Coordinator EPA Contractor Technical Team Coordinator EPA Contractor SCRIBE Database Manager	Jennifer Crawford Marilyn Gauthier To Be Determined	206-553-6261 503-872-4800	Field team will contact RSCC with any sampling, shipping, laboratory or SCRIBE documentation issues. The RSCC will contact field team and /or RPMs with issue resolutions.
Nonconformance and Corrective Action	SERAS TL ERT WAM EPA RQAM EPA Contractor QA Officer	Bill Thayer David Charters Gina Grepo-Grove To Be Determined	303-452-8424 732-906-6825 206-553-1632	Notification to the WAM and RQAM QA/QC Officer. Documentation in logbook.
Transmittal of Deliverables to ERT WAM	SERAS TL	Bill Thayer	303-452-4245	Email of deliverables and posting of deliverables to ERT-Information Management System (IMS) website constitutes delivery to the ERT WAM.
Work Assignment	SERAS Program Manager SRC Program Manager	Kevin Taylor David Hohreiter	732-321-4202 315-452-8892	Describes scope of work to SERAS personnel from the ERT WAM.
Health and Safety On-Site Meeting	Regional Contractor	Rueben Greer	509-847-8819	Explains site hazards, personal protective equipment, local hospital

QAPP Worksheet #7: Personnel Responsibilities and Qualification Table

☐ Worksheet Not Applicable (State Reason)

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
David Hohreiter	Aquatic Ecological Risk Assessor	SRC	SRC Program Manager	PhD in Aquatic Toxicology with 25 years' experience/SRC Employee Files
Laura Buelow	RPM	EPA Region 10	Technical Direction	EPA job-related qualifications/EPA Files
Matt Wilkening	RPM	EPA Region 10	Technical Direction	EPA job-related qualifications/EPA Files
Gina Grepo-Grove	RQAM	EPA Region 10	R10 QA Review and Approval	EPA job-related qualifications/EPA Files
Jennifer Crawford	RSCC/QA Chemist	EPA Region 10	EPA lab scheduling; coordination with field team; SCRIBE file oversight	EPA job-related qualifications/EPA Files
Marc Stifelman	Human Health Risk Assessor	EPA Region 10	Technical Direction	EPA job-related qualifications/EPA Files
David Charters	WAM	EPA/ERT	Technical Direction	EPA job-related qualifications/EPA Files
Bill Thayer	Senior Scientist	SRC	TL/Data Management, Develop QAPP and Risk Assessment Support	PhD in Environmental Engineering with 23 years of related experience/SRC Employee Files
Stephen Blaze	Quality Coordinator	EPA/ERT	QA Oversight	EPA job-related qualifications/EPA Files
Deborah Killeen	QA/QC Officer	SERAS	QA	BS degree plus 14 years of related experience/Lockheed Martin Employee Files
Marilyn Gauthier	Technical Team Coordinator	EPA Contractor	Oversee field sampling activities, oversee all technical aspects of task, coordinate with EPA Region 10, and manage task schedule	As per contractual requirements with EPA R10
To Be Determined	Analytical Chemistry Laboratory Coordinator	EPA Contractor	Coordinate with subcontract laboratory and track lab progress, address QA issues related to laboratory analyses, and address scheduling issues	As per contractual requirements with EPA R10
To Be Determined	SCRIBE Project Manager	EPA Contractor	Responsible for sample management in the field; SCRIBE database management	As per contractual requirements with EPA R10

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Rueben Greer	Site Health and Safety (H&S) Officer	EPA Contractor	Responsible for communicating potential hazards, H&S issues, compliance with the H&S	As per contractual requirements with EPA R10
To Be Determined	Database Administrator	EPA Contractor	Responsible for SCRIBE data management and database maintenance and development	As per contractual requirements with EPA R10
To Be Determined	Task QA Coordinator	EPA Contractor	Provide overall QA support for study	As per contractual requirements with EPA R10

QAPP Worksheet #8: Special Personnel Training Requirements Table

☐ Worksheet Not Applicable (State Reason)

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
QA Oversight	UFP-QAPP	Advanced Systems	January 2006	Deborah Killeen	QA/QC Officer/SERAS	Quality Files
Project Oversight	OSHA Health and Safety Training (HAZWOPER)	Refer to Contractor HASP	Refer to Contractor HASP	To Be Determined	EPA Contractor/ Technical Team Coordinator	Attachment C, Field Sampling Plan (in Attachment 4 Health and Safety Plan)

QAPP Worksheet #9: Project Scoping Session Participants Sheet

☐ Worksheet Not Applicable (State Reason)

Project Name: UCR Residential Soil Sampling
Projected Date(s) of Sampling: Summer/Fall 2014
RPMs: Laura Buelow and Matt Wilkening
Date of Session: July 2013 through February 2014
Scoping Session Purpose: To discuss project scope and schedule

Site Name: UCR
Site Location: WA

Name	Title	Affiliation	Phone Number	Email Address	Project Role
Laura Buelow	RPM	EPA Region 10	509-376-5466	Buelow.Laura@epa.gov	Project Manager
Matt Wilkening	RPM	EPA Region 10	208-378-5760	Wilkening.Matt@epa.gov	Project Manager
Marc Stifelman	Human Health Risk Assessor	EPA Region 10	206-553-6979	Stifelman.Marc@epa.gov	Human Health Risk Assessor
Monica Tonel		EPA Region 10	206-553-0323	Tonel.Monica@epa.gov	
Bill Thayer	Senior Scientist	SRC	315-452-8424	Thayer@srcinc.com	SRC TL
Gary Diamond	Senior Toxicologist	SRC	716-542-7140	Diamond@srcinc.com	Toxicology/Risk Assessment

QAPP Worksheet #10: Problem Definition

☐ Worksheet Not Applicable (State Reason)

Problem to be addressed by the project:

The Upper Columbia River Site Study Area consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake ("Lake Roosevelt"), from the border between the United States and Canada downstream to the Grand Coulee Dam and all suitable areas in proximity to such contamination necessary for implementation of the RI/FS. The RI/FS is currently underway to investigate the nature and extent of contamination that has resulted from historical and continuing discharges of hazardous substances into the Columbia River, including, but not limited to, releases from smelting processes and facility operations by Teck Metals, Ltd. (Teck) at the Trail facility located in Trail, British Columbia (BC). This QAPP concerns soil sampling in a study area located along the Upper Columbia River between Northport, Washington, and the U.S. – Canada border, depicted in Figure 1.

As stated in the DQOs for this study (see Attachment A), historic emissions from the Trail smelting facility in Trail, BC have included metal-enriched particulates and aerosols. These airborne contaminants were deposited at varying distances from the smelter and became incorporated into the soil horizon. Various studies and soil sampling activities conducted in the Columbia River valley corridor south of the U.S. – Canada border (Shannon & Wilson, Inc., 2011; Hart Crowser, 2013) have demonstrated the presence of elevated heavy metal concentrations in the upper horizons of minimally disturbed soils. Sampling activities were focused in an area of northeast WA State where severe vegetation damage and impairment was documented in the 1920s and 1930s, which were attributed to smelter sulfur dioxide (SO2) emissions (Scheffer and Hedgcock, 1955). Elevated metal concentrations also have been mapped in surface soils collected by Canadian investigators between Trail, BC and the U.S. – Canada border (Goodarzi et al., 2002, 2006).

Stack emissions from the Le Roi smelter, which operated in Northport, WA approximately seven river miles south of the U.S. – Canada border, are an additional source of metals in the study area. In 2004, U.S. EPA conducted a soil removal action on the Le Roi property and in the town of Northport (U.S. EPA 2009b; Weston, 2005; see http://yosemite.epa.gov/R10/cleanup.nsf for more information).

The areal extent of contamination for the UCR Study Area has not been fully delineated; exposure point concentrations (EPCs) for WA State residents living within the UCR Study Area, including gardeners and Tribal members, need to be refined. EPA is planning a focused rural residential investigation of the northernmost reaches of the Columbia River valley (north of the town of Northport, WA to the U.S. – Canada border; Figure 1) to assess potential risks to existing residents from exposure to metals- in soils.

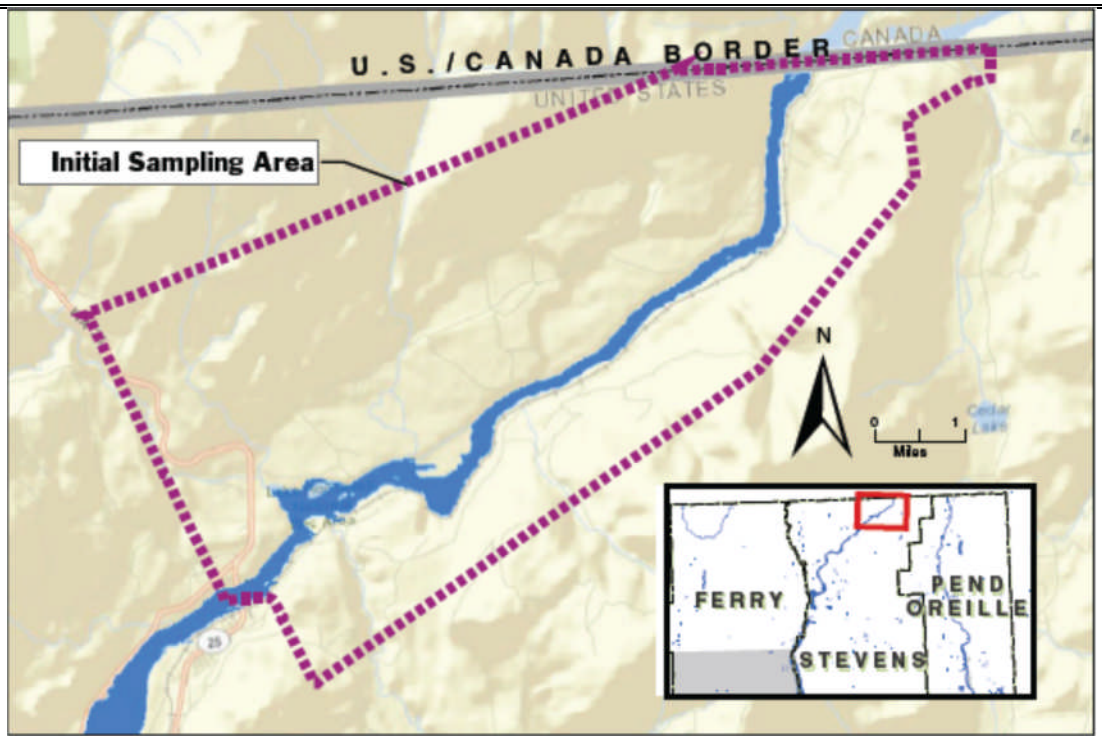


Figure 1. Residential Property Owners within the Initial UCR Study Area

This residential soil investigation will be coordinated with and complement other upland soil sampling planned for the Upper Columbia RI/FS Soil Investigation (Exponent et al., 2013; U.S. EPA, 2012b). The purpose of the upland soil sampling effort is to evaluate if there are unacceptable risks to ecological receptors and people from exposure to metals in upland soils; the boundaries of the upland soil study have not been finalized at this time. The upland soil study will not assess residential properties or estimate EPCs for WA State residents living within the UCR Residential Soil Study Area as indicated in Figure 1. To address these data gaps, site-specific exposure data for residents in the study area will be collected as part of this UCR Residential Soil Study. These sampling efforts are intended to produce data representative of potential exposure, based on activities of residents, associated with metal-enriched soil particles and to support risk management decision making.

In a subset of the residential soil sampling areas, additional samples will be collected at depth to provide information on the vertical nature and extent of contamination near houses or where exposure is expected to be highest based on interviews and site visits.

Data collection activities presented in this QAPP are designed to satisfy DQOs presented in Worksheet 11 and Attachment A.

The environmental questions being asked:

Do Pb and As concentrations (and possibly other TAL metals) in the fine-grained fraction of soils (for soils, <150 microns [µm] representative of dry conditions [Ruby and Lowney, 2012]; for beach sand < 250 µm because it is representative of dermal adherence under wet conditions, consistent with previous beach sampling efforts [Kissel et al. 1996]) from rural residential parcels located within the initial sampling area boundary pose an unacceptable risk to human health, particularly to children who live within the UCR Study Area?

What is the vertical nature and extent of contamination near houses or where potential for exposure is highest based on interviews and site visits?

Observations from any site reconnaissance reports:

Soil sampling activities conducted in the northern portion of the Columbia River valley corridor south of the U.S. – Canada border (Hart Crowser, 2013; Shannon & Wilson, Inc., 2011) have demonstrated the presence of elevated lead and arsenic concentrations in the upper horizons of minimally disturbed soils. Sampling activities were focused in an area of northeast WA State where severe vegetation damage and impairment was documented in the 1920s and 1930s, which were attributed to smelter sulfur dioxide emissions (Scheffer and Hedgcock, 1955). Elevated metal concentrations also have been mapped in surface soils collected by Canadian investigators between Trail, BC and the U.S. – Canada border (Goodarzi et al., 2002, 2006). A 2007 Cantox Environmental Inc. memorandum to Teck Metals, Ltd titled *Potential Chemicals of Concern for Terrestrial Wildlife in the Trail Wide-area Site ERA* states that "metal concentrations of antimony, arsenic, cadmium, copper, lead, mercury, and zinc in soil are related to past smelter activities." The highest metal concentrations within soils at the UCR Study Area in areas close to the U.S. – Canada border appear to occur primarily along the side slopes of the Columbia River valley and its associated tributaries (Hart Crowser, 2013).

A synopsis of existing data or information from site reports:

Elevated heavy metal concentrations have been found in surface soils collected in the Columbia River valley corridor south of the U.S. – Canada border and north of Northport, WA. The Teck smelter is located on the Columbia River approximately 10 miles north of the U.S. – Canada border. Historic emissions from the Trail smelting facility in Trail, BC have included metal-enriched particulates and aerosols. Various studies conducted in the Columbia River valley corridor immediately south of the U.S.-Canada border (Hart Crowser 2013; Shannon & Wilson, Inc. 2011) have demonstrated the presence of elevated lead and arsenic concentrations in the upper horizons of minimally disturbed soils. Stack emissions from the Le Roi smelter, which operated in Northport, WA approximately seven river miles south of the U.S. – Canada border, represent an additional source of metals. The facility smelted copper, gold, lead, and silver ores intermittently from 1896 to 1922 (U.S. EPA, 2003). In 2004, U.S. EPA conducted a soil removal action on the Le Roi property and in the town of Northport (U.S. EPA 2009b; Weston, 2005; see http://yosemite.epa.gov/R10/cleanup.nsf for more information).

Existing surface soil data were reviewed to determine whether and how data previously collected could be used to guide assessment planning for residential soil. A review of the available data did not reveal existing soil data for any of the residential properties to be included in this sampling effort.

The possible classes of contaminants and affected matrices:

Chemicals of interest:

- TAL metals (particularly Pb and As)

Media of interest:

- The exposure pathway of concern is contact with soil. The sampling depth will be based on the soil depth interval that people are most likely to come into contact with and will vary by decision unit (DU). "With respect to risk assessment, the top inch of soil best represents current exposure to contaminants (EPA, 1989, 1996) and is the source of data used in the Integrated Exposure Uptake Biokinetic (IEUBK) model to represent exposure from soil" (U.S. EPA, 2003). Surface soil will be collected from the entire 0-1 inch (") depth interval (top 2 centimeters [cm]) below the organic litter or sod (U.S. EPA, 2003) in house, dripline, agriculture, and other-not specified DUs. Driplines are being sampled as they may represent a combination of aerial deposition and lead-based paint contribution; driplines were included on all houses where precipitation on the roof could run off onto soil below. The sampling depth for gardens, inclusive of produce and ornamental plants, will be the tilled depth because it is reasonable to expect that people routinely come into contact with soil throughout the tilled depth (typically 0-12"; may change based on property-specific interviews). Sampling depth for play areas will generally be 0-1". Areas where soil disturbance is deeper than 1" (based on observations made during the site visit) will generally be sampled at a depth of 0-3" (e.g.,

animal activity areas). Sampling areas and depths were based on interviews with residents and observations from site visits.
The rationale for inclusion of chemical and nonchemical analyses:
Available soil data indicate that transport of metals from the Trail smelter into the UCR Study Area via historic emissions from the smelting facility is likely to have occurred. Various studies and soil sampling activities conducted in the Columbia River valley corridor south of the U.S. – Canada border have demonstrated the presence of elevated metal concentrations in the upper soil horizon (Hart Crowser, 2013; Shannon & Wilson, Inc., 2011). Bioavailability analysis (Pb and As) will be used to refine the exposure estimates for DU areas where sample concentrations are greater than or equal to 100 mg/kg for Pb or 20 mg/kg for As.
Information concerning various environmental indicators: N/A
Project decision conditions ("If..., then..." statements):
If the exposure of human receptors to surface soil under current UCR Study Area conditions results in unacceptable health risks, then EPA will take action to address such exposures.

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

☐ Worksheet Not Applicable (State Reason)

Who will use the data?

ERT environmental scientists and EPA Region 10 RPMs with support from Regional Risk Assessors and SRC HHRA personnel, as well as TAI.

What will the data be used for?

The areal extent of contamination for the UCR Study Area has not been fully delineated; EPCs for WA State residents living within the UCR Study Area, including Tribal members, need to be refined. A focused rural residential soil investigation will be conducted to assess risks to existing residents from exposure to metals in soils. Surface soil samples will be collected from residential properties in locations where there is a high potential for exposure by residents, especially young children, based on activities determined from interviews and site visits. Young children and gardeners are most likely to be exposed to metals via ingestion of fine soil particles that adhere to skin.

The principle risk question that will be addressed by the data to be collected in this study is whether Pb and As concentrations (and possibly other TAL metals) in the fine-grained fraction of soils (<150 µm for soil [Ruby and Lowney 2012], < 250 µm for beach sand [Kissel et al. 1996]) from rural residential pose an unacceptable risk to human health, particularly to children who live within the current area of study.

Land use data from county tax assessor maps, property owners, and residents have been used to identify residential parcels within the UCR Study Area. Access agreements were sent to all property owners within the UCR Study Area; one of the questions was whether there is any residential use of the property. The initial focus of this study is on residential properties located north of Northport and extending to the U.S. Canada border, within the Columbia River valley (see Figure 1). Study boundaries will be re-evaluated as results are available, including locations, frequency, and magnitude above risk-based concentrations (RBCs). Soil samples will be collected during a limited seasonal period when climatic conditions would likely exclude the presence of snow on the ground or frozen ground (typically April through October).

The following human health RBCs have been identified for Pb and As (see Worksheet 15):

- 400 milligrams per kilogram (milligram per kilogram [mg/kg]) Pb
- 20 mg/kg As

Soil data that will be collected will incorporate the following objectives and considerations:

- Inferred exposure areas based on communications with residents, accessibility of soil, the presence of gardens, play areas, pastures, animal pens/riding areas, or other property-specific visual information.
- Estimates of bioavailability based on in-vitro bioaccessibility measurements.
- The target particle size for soil is <150 µm representative of dermal adherence as a proxy for inadvertent soil ingestion (Ruby and Lowney 2012) and for beach sand is <250 µm (Kissel et al. 1996).

Samples will be collected following an IC sampling design from DUs whose areal extents were defined by property-specific estimated exposure categories (e.g., gardens, play areas, animal activity areas). Each incremental sample will consist of 30 increments. Three incremental composite samples will be collected from most of the DUs; however, when a particular exposure category is represented by more than one DU on a property, three samples are collected from one of the DUs while the other DUs of the same category each have 1 IC sample. In addition, only one IC sample is collected from DUs <1000 sq. ft. in size. The increments for each sample will be collected using a systematic grid to provide uniform spatial coverage (ITRC, 2012). Except for drip line DUs, care will be taken to locate increments outside the drip line of the residence, and away from influences of any other painted surfaces. Areas near roadways and railways (represented by a 50 foot buffer from the center line of these features in either direction) will also be avoided to prevent sampling soil that may be contaminated by non-air sources of TAL metals. Lead and As bioaccessibility will be measured in samples where concentrations exceed 100 and 20 parts per million (ppm), respectively.

The purpose of the study is to determine whether concentrations of metals present in surface soil pose an unacceptable risk to residents.

For a subset of DUs, samples will be collected from the entire 1-6" depth interval to provide information on the vertical nature and extent of contamination.

What types of data are needed?

- Site-specific data are needed to determine the level of risk to humans exposed to soils in residential areas. These data should be reliable and representative measurements of the concentration of metals that are present in the soils to which residents, especially children, may be exposed..

Surface soil data collected as part of this investigation will inform the first data need listed above. These data will be used to calculate EPCs for a HHRA of rural residents and to determine whether concentrations of metals present in surface soils pose an unacceptable risk to residents. Surface soil will be sampled in locations where there is a high potential for exposure by residents, especially young children. Metals will be measured in the fine particle fraction (<150 µm for soil, <250 µm for beach sand), which is the fraction expected to adhere to skin. The exposure pathway to be assessed is incidental ingestion of surface soil resulting from contact with surface soils. This could occur as a result of direct skin contract with soil (e.g., during play or gardening), or as a result of inhaling surface dusts entrained to the breathing zone that are ultimately swallowed (e.g., during dirt biking and all-terrain vehicle use). Estimates of the amount and duration of these exposures will follow methods described in the HHRA (EPA 2010). Data will be used to support risk management decisions based on human health risk at the UCR Study Area.

TAL metals (no Hg) will be measured on each IC sample, and up to one IC sample from each DU (except driplines) will be analyzed for Pb and As bioaccessibility. Bioaccessibility testing will only be run for IC samples that have a Pb or As concentration greater than or equal to 100 or 20 ppm, respectively. The 100 ppm level for Pb is based on soil Pb concentrations associated with the Centers for Disease Control (CDC) "reference value" for blood Pb in children (CDC recommends intervention for individual children and communities with blood Pb levels at and above 5 micrograms per deciliter [µg/dL]) (CDC, 2012). U.S. EPA is still considering appropriate policy related to the 2012 CDC recommendation, so a value of 100 ppm is likely the best estimate that can be made at this time. For example, assuming a relative bioavailability (RBA) of 80%, a soil lead concentration associated with a 10% probability of exceeding 5 µg/dL for the 12 to 71 month age range is 117 ppm. A soil lead concentration based on a 5% probability of exceeding 5 µg/dL for the 12 to 71 month age range is 83 ppm. The CDC recommendation is consistent with U.S. EPA's position that there is no safe blood Pb level in children. U.S. EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) is in the process of evaluating the CDC recommendations and implications for site risk assessments. Because there is uncertainty in whether OSRTI will adopt 5 µg/dL as a level of concern for Pb, this value was used as the basis for establishing the target concentration so that sampling results can support site decisions if 5 µg/dL is adopted while the residential soil study is ongoing.

Five grab samples will be collected at depth (1-6") from one DU per property (assumed to be the highest use area based on interviews and the site visit) and submitted for TAL metal analysis. Metals will be measured in the fine particle fraction (<150 µm for soil, <250 µm for beach sand).

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

Data must provide a representative estimate of the mean concentration of TAL metals (no Hg) and bioaccessibility of As and Pb for each DU.

Worksheets #12 and #28 show the measurement performance criteria that are needed for the quality indicators. Worksheet #20 shows the field quality control (QC) samples required. These worksheets will be completed once a laboratory is selected.

Data should allow for reliable risk management decision making within the specified tolerance limits as identified by EPA RPMs for the UCR Study Area (see Worksheet #15).

How much data are needed? (number of samples for each analytical group, matrix, and concentration):

Residential parcels were identified within the UCR Study Area (see Figure 1); however, a number of residents opted not to have their property sampled. Sampling will occur on 86 residential properties in the UCR Study Area. The number of DUs sampled on each property was determined based on the size, features, and layout of each property, which were identified following an initial site visit in the Spring of 2014. IC samples will be collected from each identified DU and submitted for TAL metals (no Hg) analysis. One IC sample from each DU will also be submitted for analysis of Pb and As bioaccessibility. Bioaccessibility testing will be run for IC samples that have a Pb or As concentration greater than or equal to 100 or 20 ppm, respectively. Five grab samples will be collected from the 1-6" depth interval from one DU per property where the IC sampling depth is 0-1":

- 3 IC samples per (most) DU – TAL metals (no Hg)
- 1 IC sample per DU (except driplines) – Pb and As bioaccessibility (if concentration criteria are met)
- 5 grab samples from one DU per property – TAL metals (no Hg)

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

Surface soil will be collected from each DU within each property during the 2014 field sampling season (April to October) using the IC approach. Each of the surface soil IC samples will be analyzed for TAL metals (no Hg). Lead and As bioaccessibility testing will only be performed for IC samples with Pb concentrations ≥100 ppm or As concentration ≥20 ppm. If one of the concentration criteria (Pb ≥100 ppm, As ≥20 ppm) is met, both Pb and As IVBA assays will be done. If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. On a property basis, if more than one IC sample for a given DU category (e.g., house area DU) exceeds one of the concentration criteria, the IVBA assay will be run using the one sample that has the maximum Pb concentration for that type of DU. To be clear, a maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property, except driplines; IVBA analysis will not be done for any samples collected from driplines.

Who will collect and generate the data?

All data for this study will be collected by an U.S. EPA Contractor (CH2M Hill). Samples will be collected using the IC sampling methodology and grab sampling methodology described in the FSP and associated SOPs. The laboratory (ALS Lab in Kelso, WA) will process the samples (drying, sieving, subsampling) and conduct the TAL metals (no Hg) analysis and Pb and As bioaccessibility analysis.

How will the data be reported?

All definitive data will be reported by the respective laboratory in a Level 4 Contract Laboratory Program (CLP), or

equivalent, data type package that will be a mixture of Stage 4 (S4VEM/S4VM) and Stage 2 validated or reviewed by third parties (Refer to Worksheet #14). The IVBA data will be verified and validated according to standard operating procedures in EPA's Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil (U.S. EPA, 2012a). Data will be reported in a technical memorandum (summary report) after receipt of the validated data.

How will the data be archived?

Data will provided electronically in an Excel file, and in Adobe AcrobatTM*.pdf format for inclusion in the project file. Data packages from the subcontract laboratory will be archived by the EPA Contractor Database Administrator both in hard copy and electronically. Data will be imported into a SCRIBE database maintained by the CH2M SCRIBE database manager and will also be posted to the ERT/IMS website. Data will also be archived in the TAI project database.

QAPP Worksheet #12-1: Measurement Performance Criteria Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or Both (S and A)
01, 02	MET-3050B.r13 MET-6020.r15 MET-ICP.r24	Accuracy/Bias	As per vendor's certificate of analysis	Laboratory Control Sample (LCS)	A
		Accuracy/Bias	%R = 75-125%	Matrix Spike (MS)	S & A
		Precision	RPD ±20%	MS/Matrix Spike Duplicate (MSD)	S & A
		Precision	RSD ≤ 20%	Laboratory Replicates	A
		Precision	RSD ≤ 30%	Field Replicates	S & A
		Accuracy/Bias (Contamination)	<MRL	Field Equipment Blank	S & A
		Accuracy/Bias (Contamination)	<RL No analytes detected > 1/2 MRL	Method Blank	A
		Accuracy/Bias (Contamination)	<MRL	Sieve Blank	A
		Precision	Per Regional Criteria	Field Duplicates	S & A
		Precision/Error	Per Regional Criteria	Split Samples	S & A
		Accuracy/Bias	%D ±10%	Serial Dilution	A
		Accuracy/Bias	%R = 85-115%	Post Spike	A

QAPP Worksheet #12-2: Measurement Performance Criteria Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Soil
Analytical Group	Metals –IVBA
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or Both (S and A)
01 (incremental composite sample collection)	MET-BIOACC.r1	Accuracy and Precision	Field and Laboratory Duplicates RPD Within lab limits Matrix Spike 75-125%R Standard Reference Material as per Manufacturers Spec.	Field Duplicate Laboratory Duplicate Matrix Spike Standard Reference Material	S A A A

QAPP Worksheet #13: Existing Data Criteria and Limitations Table

☐ Worksheet Not Applicable (State Reason)

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Risk Assessment Guidance	Bacom, A., Diamond, G., Thayer, B. (2012). Memorandum to Marc Stifelman, U.S. Environmental Protection Agency, Region 10. Subject: Toxicity Values for Risk Screening of Vanadium. SRC, Inc.: North Syracuse, NY. April 26.	Not Applicable	To establish RBC for vanadium.
Risk Assessment Guidance	CDC (Centers for Disease Control and Prevention). (2012). What Do Parents Need to Know to Protect Their Children? Centers for Disease Control and Prevention: Atlanta, GA. Available online at: http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm.	Not Applicable	To help determine which samples will undergo IVBA.
Risk Assessment Guidance	Diamond, G. and Thayer, B. (2011a). Memorandum to Marc Stifelman, U.S. Environmental Protection Agency, Region 10. Subject: Toxicity Values for Risk Screening of Antimony. SRC, Inc.: North Syracuse, NY. April 15.	Not Applicable	To establish RBC for antimony.
Risk Assessment Guidance	Diamond, G. and Thayer, B. (2011b). Memorandum to Marc Stifelman, U.S. Environmental Protection Agency, Region 10. Subject: Toxicity Values for Risk Screening of Vanadium. SRC, Inc.: North Syracuse, NY. April 15.	Not Applicable	To establish RBC for vanadium.
Incremental sampling methodology	HDOH (Hawaii Department of Health). (2009). Multi-increment Sample Collection. Hawaii Department of Health: Honolulu, HI. Available online at: www.hawaiidoh.org/tgm.aspx?p=0402a.aspx.	Not Applicable	Support the rationale for using incremental composite sampling approach.
Database of soil properties	NRCS (Natural Resources Conservation Service). (2014). SSURGO Database. U.S. Department of Agriculture: Washington, DC. Available online: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627.	Not Applicable	Used in sampling design to estimate the required minimum mass of the incremental composite samples (to provide sufficient <150um soil for analysis).
Surface soil data	Sanei, H. and F. Goodarzi. (2006). Relationship between organic matter and mercury in recent lake sediment: The physical–geochemical aspects. Appl. Geochem. 21: 1900–1912.	Sanei and Goodarzi, soil samples	support rationale for the Residential Soil Study

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Risk Assessment Guidance	U.S. EPA (U.S. Environmental Protection Agency). (1996). Soil Screening Guidance: User's Guide. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response: Washington, DC. Publication 9355.4-23. Available online at: http://www.epa.gov/superfund/health/conmedia/soil/.	Not Applicable	supports rationale for collecting samples from the 0-1" depth interval.
Risk Assessment Guidance	U.S. EPA (U.S. Environmental Protection Agency). (1998). OSWER Directive: Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. OSWER Directive #9200.4-27P. EPA/540/F-98/030. Available online at: http://www.epa.gov/superfund/lead/guidance.htm#interimsoillead.	Not Applicable	To help determine the RBC for lead
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2009a). Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. OSWER No. 9200.1-85. EPA-540-R-08-005. January. Available online at: http://www.epa.gov/superfund/policy/pdfs/EPA-540-R-08-005.pdf.	Not Applicable	Reference for verification and validation process for field and laboratory data
HHRA workplan for UCR Study Area	U.S. EPA (U.S. Environmental Protection Agency). (2009b). Human Health Risk Assessment Work Plan for the Upper Columbia River Site Remedial Investigation and Feasibility Study. Prepared for U.S. Environmental Protection Agency, Region 10 by Syracuse Research Corporation. Final. March. Available online at: http://yosemite.epa.gov/r10/cleanup.nsf/sites/upperc.	Not Applicable	Provides background information that was used to support rationale for the Residential Soil Study
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2010). U.S. EPA Contract Laboratory Program. National Functional Guidelines for Inorganic Superfund Data Review. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation: Washington, DC. EPA/540/R-10/011. January. Available online at: http://www.epa.gov/superfund/programs/clp/download/ism/ism1nfg.pdf.	Not Applicable	Reference for verification and validation process for field and laboratory data.
Incremental sampling methodology	U.S. EPA (U.S. Environmental Protection Agency). (2011b). U.S. EPA's User Guide, Uniform Federal Policy Quality Assurance Project Plan Template for Soils Assessment of Dioxin Sites. U.S. Environmental Protection Agency. September. Available online at: http://www.epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html.	Not Applicable	Reference for implementing the incremental composite sampling approach.

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2012a). Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil. OSWER 9200.2-86. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. April. Available online at: http://www.epa.gov/superfund/bioavailability/pdfs/EPA_Pb_IVBA_SOP_040412_FINAL_SRC.pdf.	Not Applicable	Reference for verification and validation process for field and laboratory data.
Upland Soils QAPP for UCR Study Area	Exponent, Hydoqual, Parametrix and Cardwell. (2013). Upper Columbia River, Soil Study Quality Assurance Project Plan. Prepared for Teck American Incorporated. September.	Not Applicable	Comparison and consistency purposes; reviewed for sampling design and analytical methods.
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2014). Metals and Cyanide Target Analyte List and Corresponding CRQLs. Environmental Protection Agency, Analytical Services Branch: Washington, DC. Available online at: http://www.epa.gov/superfund/programs/clp/ismtarget.htm.	Not Applicable	Reference for the metals included on the TAL.
Map of residential properties within the UCR Study Area	Stevens County Database	Stevens County Database	Residential parcels shown on the map will be targeted for the initial site visit
Surface soil data	Hart Crowser. (2013). Upper Columbia River Upland Soil Sampling Study, Stevens County, Washington. Seattle, WA, Prepared by Hart Crowser for the Washington State Department of Ecology: 22 pp. plus figures, tables, and appendices. Available online at: https://fortress.wa.gov/ecy/gsp/CleanupSiteDocuments.aspx?csid=12125.	Hart Crowser, Inc. Surface soil samples (4-point composite samples) were collected in October and November of 2012	Comparison and consistency purposes; reviewed for residential soil data from within the UCR Study Area

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Sulfur dioxide plume	Scheffer, T.C. and G.G. Hedgcock. 1955. Injury to northwestern forest trees by sulfur dioxide from smelters. Tech. Bull. U.S. Dep. Agric., No. 1117, 1.	Scheffer and Hedgcock (1955). Environmental observations of SO2 contamination were generally taken from 1928 to 1936 by the Division of Forest Disease Research throughout Stevens County, WA. Data provide insight into historical deposition.	Comparison and consistency purposes; historical information.
Surface soil data	Weston. (2005). LeRoi Smelter Removal Action Site Management Plan. TDD: 04-10-0008.	Region 10 START. Weston Solutions, Inc. 190 Queen Anne Avenue North, Seattle, WA 98109-4926	Reviewed for residential soil data from within the UCR Study Area
Surface soil sampling locations	Exponent, HydroQual, Parametrix and Cardwell Consulting LLC. (2013). Draft - Upper Columbia River Soil Study Quality Assurance Project Plan. Spokane, WA, Prepared for Teck American, Inc.: 190 pp. Appendices.	Exponent, HydroQual, Parametrix and Cardwell Consulting LLC. Surface soil samples will be collected in upland soil areas in 2014.	Reviewed to evaluate overlap between upland soil and residential soil sampling locations
Surface soil data	DOJ (U.S. Department of Justice). (2006). Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study at the Upper Columbia River Site. U.S. Department of Justice: Washington, DC. June 2, 2006.	Not Applicable	Reviewed for residential soil data from within the UCR Study Area

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Surface soil data	Goodarzi, F., Sanei, H., Garrett, R.G., Duncan, W.F. (2002). Accumulation of trace elements on the surface soil around the Trail smelter, British Columbia, Canada. Environ. Geol. 43: 29–38.	Composite surface soil samples (0-10 cm) were collected from 21 stations around the Teck Cominco smelter in Trail, BC. Study was funded by the Metals in the Environment Initiative of the Geological Survey of Canada and Teck Cominco Metals Ltd, Trail Operations.	Reviewed for residential soil data from within the UCR Study Area
Surface soil data	Goodarzi, F., Sanei, H., Garrett, R.G., Labonté, M., Duncan, W.F. (2006). A review of the moss-monitoring survey around the Trail smelter, British Columbia. Geochem. Explor. Environ. Anal. 6(2-3): 249–257.	Concentrations of six aerially deposited metals were measured in moss bags exposed to atmospheric deposition for 3 month periods from winter 1998 to autumn 1999 at 22 locations around the Teck Cominco Smelter in Trail, BC. Study was funded by the Metals in the Environment Initiative of the Geological Survey of Canada and Teck Cominco Metals Ltd, Trail Operations.	Reviewed for residential soil data from within the UCR Study Area

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Incremental sampling methodology	Hathaway, J.E., Schaalje, G.B., Gilbert, R.O., Pulsipher, B.A., Matzke, B.D. (2008). Determining the optimal number of increments in composite sampling. Environ. Ecol. Stat. 15: 313–327.	Not Applicable	Methods
Incremental sampling methodology	ITRC (Interstate Technology and Regulatory Council). (2012). Technical and Regulatory Guidance: Incremental Sampling Methodology. Interstate Technology and Regulatory Council: Washington, DC. 475 pp. Available online at: http://www.itrcweb.org/gd.asp.	Not Applicable	Methods
Risk assessment methods	Ruby, M. V. and Lowney, Y.W. (2012). Selective soil particle adherence to hands: Implications for understanding oral exposure to soil contaminants. Environ. Sci. Technol. 46(23): 12759–12771.	Not Applicable	Risk assessment
Risk assessment methods	Kissel, J. C., K. Y. Richter and R. A. Fenske (1996). "Factors affecting soil adherence to skin in hand-press trials." Bulletin of Environmental Contamination and Toxicology 56(5): 722-728.	Not Applicable	Risk assessment
Surface soil data	Shannon & Wilson, Inc. 2011. Soil Remediation, Land Port of Entry Facility, Boundary, Washington.] Seattle, WA 98103. Website: http://www.shannonwilson.com/.	Shannon & Wilson, Inc. implemented a clean up plan under lead contract Randolph Construction Services, Inc. (RCS), building a Land Port of Entry (LPOE) facility for U.S. Customs and Border Protection. HDR conducted surface soil sampling in April and May 2011,and the top 10 inches of soil was subsequently removed. Shannon & Wilson collected confirmation soil samples after the Phase 1 removal and again after Phase 2 excavation.	Reviewed for residential soil data from within the UCR Study Area

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Risk Assessment Guidance	U.S. EPA. (1989). Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002.	Not Applicable	Risk Assessment
Risk Assessment Guidance	U.S. EPA (U.S. Environmental Protection Agency). (1994a). Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. PB93-963510, OSWER 9285.7-15-1. February. Available online at: http://www.epa.gov/superfund/lead/products.htm.	Not Applicable	Risk assessment
Risk Assessment Guidance	U.S. EPA (U.S. Environmental Protection Agency). (1994b). Memorandum: OSWER Directive: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. OSWER Directive #9355.4-12. August. Available online at: http://epa.gov/superfund/lead/products/oswerdir.pdf.	Not Applicable	Risk assessment
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2000). EPA Quality Manual for Environmental Programs. CIO 2105-P-01-0 (formerly 5360 A1). U.S. Environmental Protection Agency, Office of Environmental Information: Washington, DC. May. Available online at: http://www.epa.gov/irmpoli8/policies/2105P010.pdf.	Not Applicable	QAPP preparation, study planning
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2002). Guidance for Quality Assurance Project Plans. EPA QA/G-5. U.S. Environmental Protection Agency, Office of Environmental Information: Washington, DC. EPA/240/R-02/009. December. Available online at: http://www.epa.gov/quality/qs-docs/g5-final.pdf.	Not Applicable	QAPP preparation, study planning
Risk Assessment Guidance	U.S. EPA (U.S. Environmental Protection Agency). (2003). Superfund Lead-Contaminated Residential Sites Handbook. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. OSWER Directive 9285. 7-50. August. Available online at: http://www.epa.gov/superfund/lead/products/handbook.pdf.	Not Applicable	Risk assessment
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2005a). Memorandum: OSWER Directive 9272.0-20. Applicability of the Uniform Federal Policy for Quality Assurance Project Plans. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. EPA 505-04-900A. Available online at: http://www.epa.gov/fedfac/pdf/oswer_9272.0_20.pdf.	Not Applicable	QAPP preparation, study planning

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2005b). Uniform Federal Policy for Quality Assurance Project Plans. Part 1: UFP-QAPP Manual. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. EPA-505-B-04-900A. March. Available online at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.	Not Applicable	QAPP preparation, study planning
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2005c). Workbook for Uniform Federal Policy for Quality Assurance Project Plans. Part 2A: UFP-QAPP Workbook. EPA-505-B-04-900C. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. March. Available online at: http://www.epa.gov/fedfac/pdf/ufp_wbk_0305.pdf.	Not Applicable	QAPP preparation, study planning
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2006). Guidance on Systematic Planning Using the Data Quality Objectives. EPA QA/G-4. U.S. Environmental Protection Agency, Office of Environmental Information. EPA/240/B-06/001. February. Available online at: http://www.epa.gov/quality/qs-docs/g4-final.pdf.	Not Applicable	QAPP preparation, study planning
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2007). Estimation of Relative Bioavailability of Lead Soil and Soil-like Materials using *In Vivo* and *In Vitro* Methods. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response: Washington, DC. May. Available online at: http://www.epa.gov/superfund/health/contaminants/bioavailability/lead_tsd_main.pdf.	Not Applicable	QAPP preparation, sample analysis
Site information	U.S. EPA (U.S. Environmental Protection Agency). (2008). Upper Columbia River Work Plan for the Remedial Investigation and Feasibility Study (RI/FS), modification of second draft RI/FS Work Plan provided by Teck American Incorporated. December. U.S. Environmental Protection Agency, Region 10. U.S. U.S. EPA (U.S. Environmental Protection Agency). (2009b). Human Health Risk Assessment Work Plan for the Upper Columbia River Site Remedial Investigation and Feasibility Study. Prepared for U.S. Environmental Protection Agency, Region 10 by Syracuse Research Corporation. Final. March. Available online at: http://yosemite.epa.gov/r10/cleanup.nsf/sites/upperc.	Not Applicable	Project planning

Existing Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Organization, Data Types, Data Generation/ Collection Dates)	How Data Will Be Used
Analytical methods	U.S. EPA (U.S. Environmental Protection Agency). (2011a). U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods. ISM01.3. Analytical Services Branch: Washington, DC. Available online at: http://www.epa.gov/superfund/programs/clp/ism1.htm#pdf.	Not Applicable	QAPP preparation, study planning
Project planning guidance	U.S. EPA (U.S. Environmental Protection Agency). (2012b). U.S. EPA Technical Team Level of Effort (LOE) for Sampling and Analysis of Soil in the Upper Columbia River Basin (Soil LOE). Environmental Protection Agency, Region 10: Seattle, WA. 9 pp.	Not Applicable	QAPP preparation, study planning
Project planning guidance	VSP (Visual Sampling Plan) Development Team. (2013). Visual Sample Plan: A Tool for Design and Analysis of Environmental Sampling. Version 6.5. Pacific Northwest National Laboratory: Richland, WA. Available online at: http://vsp.pnnl.gov.	Not Applicable	QAPP preparation. Estimating sample size
Soil criteria	ECY (Washington State Ecology). (2007). ModelToxicsControlAct.9406.pdf	Not Applicable	PRG

QAPP Worksheet #14: Summary of Project Tasks

☐ Worksheet Not Applicable (State Reason)

Sampling Tasks:

The UCR Residential Soil Study described in this QAPP was designed to provide information to characterize exposure and risk associated with metals in- soils in U.S. residential areas closest to the Teck smelter. Focused sampling of surface soil will be conducted on 86 residential properties located in the northernmost reaches of the Columbia River Study Area (in the U.S. north of Northport, WA to the U.S. – Canada border) using IC methodology. IC sampling entails the collection of multiple individual volumes of soil (termed "increments") from a target area (i.e., a DU) that are composited and subsampled according to a detailed standard operating procedure prior to laboratory analysis (ITRC, 2012). Landowners have been contacted and many have provided access agreements to allow EPA to perform the sampling. Participation of property owners in the study is voluntary. During an initial site visit conducted in the spring of 2014, each property was divided into one or more DUs for the IC soil sampling activities that will be conducted during the 2014 sampling season (a limited seasonal period when climatic conditions would likely exclude the presence of snow on the ground or frozen ground, typically April through October). The number and configuration of DUs for each property was determined based on property size and features (e.g., play areas, gardens, animal pens/riding areas) identified during and following the Spring 2014 visit to the UCR Study Area. Except for drip line DUs, care was taken to locate increments outside the drip line of the residence, and away from influences of any other painted surfaces. Areas near roadways and railways will also be avoided to prevent sampling soil that may be contaminated by non-air sources. A series of templates, shown in Figure 3 of this QAPP, were used to assign DUs to each property. One DU per property will be selected as described below, from which soil cores at 1-6" depth will be collected.

Property-specific sampling maps are presented in Attachment B. Each property-specific map shows the boundaries for each DU to be sampled on that property as well as the locations of 1-6" soil cores. Coordinates for the IC increments and the 1-6" soil cores are provided in Attachment B, Tables 1 and 2, respectively. Beach DUs will be delineated in the field with GPS at the time a property is sampled based on water elevation and information with the property owner(s) regarding use of the beach.

Three IC samples will be collected from each DU greater than 1000 square feet (sq. ft.), and each IC sample will consist of 30 increments. One IC sample will be collected from DUs less than 1000 square feet. Sampling will be conducted using methods described in the U.S. EPA's User Guide, Uniform Federal Policy Quality Assurance Project Plan Template For Soils Assessment of Dioxin Sites (September, U.S. EPA, 2011b), and Interstate Technology and Regulatory Council (ITRC)'s Technical and Regulatory Guidance: Incremental Sampling Methodology (2012),. Before sampling is initiated on well-maintained landscaped areas, property owners will be informed about the size, depth and number of surface holes that will be punched and given the option to proceed with sampling these areas. If the owner opts out of having the well-maintained lawn sampled, the location of that DU will be shifted outside of the well-maintained area. Increments will be located using systematic random sampling with a rectangular grid and random starting point. Samples will be dried and processed, and the entire sample will be sieved in the laboratory to a target particle size of <150 µm for soil samples and < 250 µm for beach samples. Details of the sample processing methodology are given in the laboratory SOP. Each IC sample will be analyzed for TAL metals (no Hg), and one of the IC samples from each DU type (except driplines) will be analyzed for Pb and As bioavailability if the measured Pb concentration is greater than or equal to 100 ppm or if the As concentration is greater than or equal to 20 ppm (U.S. EPA, 2007, 2012b). The 100 ppm level for Pb is based on soil Pb concentrations associated with the Centers for Disease Control (CDC) "reference value" for blood Pb in children (CDC recommends intervention for individual children and communities with blood Pb levels at and above 5 µg/dL) (CDC, 2012). U.S. EPA is still considering appropriate policy related to the 2012 CDC recommendation, so a value of 100 ppm is likely the best estimate that can be made at this time. For example, assuming a RBA of 80%, a soil lead concentration associated with a 10%

probability of exceeding 5 µg/dL for the 12 to 71 month age range is 117 ppm. A soil lead concentration based on a 5% probability of exceeding 5 µg/dL for the 12 to 71 month age range is 83 ppm. The CDC recommendation is consistent with U.S. EPA's position that there is no safe blood Pb level in children. U.S. EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) is in the process of evaluating the CDC recommendations and implications for site risk assessments. Because there is uncertainty in whether OSRTI will adopt 5 µg/dL as a level of concern for Pb, this value was used as the basis for establishing the target concentration so that sampling results can support site decisions if 5 µg/dL is adopted while the residential soil study is ongoing. All remaining sieved soil will be archived after analytical samples are obtained for later use, if necessary.

Five grab samples will be collected from the complete 1-6" depth interval from one DU per property. The grab samples are usually located in the DU closest to the house, or where exposure is expected to be highest (based on the interviews), and where the IC sample depth is 0-1" (i.e., not in gardens). The locations (coordinates) of the soil cores have been randomly determined using Visual Sampling Plan (VSP), version 6.5 (VSP Development Team, 2013) and are provided in Attachment B, Table 2. In the event one or more of the original soil locations cannot be sampled due to surface or subsurface obstructions, alternate soil core locations will be determined in the field by moving a pre-determined distance and direction from the original sample location as described in the FSP. Samples will be dried, processed and the entire sample sieved in the laboratory to a target particle size of <150 µm. Soil cores will be submitted for TAL metal analysis

The sampling depth will depend on the land use and will vary by DU. Surface soil will be collected from the entire 0-1" depth interval (top 2 cm, U.S. EPA, 2003) in DUs designated as house, agriculture, dripline, and "other-not specified.". For gardens (both vegetable and ornamental), the depth will be the tilling depth (typically 0-12"). Sampling depth for play areas will generally be 0-1". Based on observations made during the site visit, areas where soil disturbance is deeper than 1" will be sampled at a depth of 0-3" (e.g., animal activity areas). Beaches will generally be sampled at a depth of 0-6".

Five grab samples will be collected at a depth of 1-6" from one DU per property.

Analysis Tasks:

Lead: Bioavailability (IVBA) by EPA Method 9200.2-81 (U.S. EPA, 2012a) –. The number of analyses will depend on the Pb and As concentrations. Lead bioaccessibility testing will only be performed for IC samples with Pb concentrations ≥100 ppm or As concentration ≥20 ppm. If one of the concentration criteria (Pb ≥100 ppm, As ≥20 ppm) is met, both Pb and As IVBA assays will be done. If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. On a property basis, if one or more IC samples for a given DU type (e.g., other-not specified area DU) exceeds one of the concentration criteria, the IVBA assay will be run using the one sample that has the highest Pb concentration for that type of DU. A maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property.

Arsenic: Bioavailability (IVBA) by EPA Method 9200.2-81–see above; number of analyses will depend on Pb and As concentrations.

TAL metals (no Hg) by EPA Method 6020 or 6010 –639 IC samples 370 discrete samples (370 1-6" depth samples).

Laboratory methods are included as Attachment G to this QAPP.

Quality Control Tasks: Refer to Worksheet #20 for Field QC Samples and Worksheets #12 and #28 for Analytical QC Samples based on Subcontract Laboratory SOPs:

Some property owners have requested split soil samples from their properties. Because IC samples will not be homogenized in the field, a laboratory split sample (after soil is homogenized, dried and sieved) or a field duplicate sample (a separate IC sample in addition to the 3 IC samples being collected per DU) will be provided, if requested.

Field duplicate samples will be collected on 15% of the discrete samples. The samples will be homogenized in the

field and split between two sample containers.

As done in past UCR RI/FS studies, laboratory split samples will be collected on 15% of the soil samples collected during this sampling event after sieving and sent to the Manchester Environmental Laboratory (MEL) for TAL metal analysis to measure interlaboratory precision/error. Details are found in the laboratory SOP.

To help ensure data quality, QC samples will include laboratory replicate subsamples. At least 10% of the IC samples (ITRC, 2012) will include the preparation and analysis of three laboratory replicate subsamples for the purpose of estimating and assessing variability due to subsample processing and analytical error (combined). The methodology for subsampling is provided in the laboratory SOP. These subsamples will be prepared for at least one IC sample per DU for at least 10 DUs (or for 10 percent of the DUs, whichever is greater). The laboratory replicate subsamples will be analyzed in different analytical runs; this will give the best evaluation of analytical error. Acceptable relative standard deviations are 20% for laboratory replicates and 30% for field duplicates.

An experimental blank will be used to identify possible contamination from the laboratory and will be collected according to laboratory protocols. An experimental blank is similar to a rinsate blank and will be generated for equipment used in the laboratory's IC sieving process. Experimental blanks will be generated per batch of samples generated (i.e., 1 per 20) 1 per 20). Field equipment blanks will be collected once per day per field team, at the end of the sampling day. A matrix spike/matrix spike duplicate (MS/MSD) will be performed in the laboratory to assess the accuracy of the analyses. The MS/MSD will be performed according to the laboratory protocols and will occur at a frequency of at least once every 20 samples.

Existing Data:

All existing data (see Worksheet #13) will be compiled electronically for use in the residential soil study for the UCR Study Area.

The primary source of existing data that will be used in the residential soil study is the property map obtained from the Stevens County database.

Data Management Tasks:

Records will include documents and electronic deliverables related to field sampling (field notebook, sample logs, COC); laboratory documentation (e.g., laboratory records, data packages, project reports, electronic data deliverable [EDDs]); data validation; and data reports. All data collected for this sampling event will be compiled into a SCRIBE database. The SCRIBE Project Manager (EPA Contractor, CH2M Hill) will be responsible for sample management in the field, and for importing the final analytical data back into SCRIBE. All field sample collection, measurement, location, shipment, and analytical data will be recorded in SCRIBE using the R10 Template and according to the R10 requirements/training documents. Final data will be imported into the SCRIBE project file and published to SCRIBE.net within 2 months of receipt of the final data set from the lab(s). The final SCRIBE file will also be posted to the ERT/IMS website. Any geographic information system (GIS) materials created for the project will be delivered to EPA according to the R10 guidance document (provided). ALS will automatically upload the EDDs to TAI's database (database manager Cristy Kessel at Exponent) which will then alert the data validator so he/she will do the validation. This is all automatic and tracked by the database.

Minimum field records that will be maintained include the following:

- Field logbooks
- Photo documentation
- Field data forms
- Sample tracking/COC forms

Full laboratory data reports will be provided in electronic format to the task QA coordinator, who will oversee data verification and validation as well as archiving the final data and data quality reports in the project file. EDDs will be

prepared in spreadsheet format and will be compatible with the project database. All activities and results related to sample analysis will be documented at the laboratory. Internal laboratory documentation procedures are described in the laboratory QA manual (see Attachment H).

The analytical chemistry laboratory will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full CLP package. It will contain all information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- Sample receipt and analysis dates
- Final analyte concentration including reporting limit, laboratory qualifiers, and reanalysis
- Percent recovery of each compound in the MS sample
- MS recovery control limits
- Relative percent difference (RPD) for all MS/MSD and/or laboratory control sample (LCS)/laboratory control sample duplicate (LCSD) results

RPD control limits for MS/MSD and/or LCS/LCSD reports.

Documentation and Records:

Documents and records that will be generated during this project include: Work Plan, QAPP, FSP, Field Documentation, Laboratory Logbooks, Sample Labels, COC Records, Custody Seals, Analytical Report, Data Review Records, Data Reduction Records, SCRIBE Project File, and Field Change Forms, if necessary. The summary report will include Study Area background, observations, a description of sampling activities, results, risk calculations, conclusions and/or recommendations, and any deviations or approved field changes.

Assessment/Audit Tasks:

The tasks associated with the QAPP will be assessed using peer review and management system review. Peer review enables the TL to identify and correct reporting errors before reports are submitted. Management system reviews establish compliance with prevailing management structure, policies and procedures, and ensures that the required data are obtained.

The field team and laboratories will stay in close verbal contact with the task manager, the RSCC Coordinator, and the task QA coordinator during all phases of this task. This level of communication will serve to keep the management team apprised of activities and events, and any potential deviations. This will allow for informal but continuous task oversight.

Assessment activities will include readiness reviews prior to sampling and prior to release of the final data to the data users, and internal review while work is in progress.

The first readiness review will be conducted prior to field sampling. The field supervisor will verify all field equipment is ready for transfer to the Study Area, and that the field team and subcontractor(s), as required, have been scheduled and briefed (including review of the site health and safety plan [SHSP]). Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities. The second readiness review will be completed before final data are released for use. The database administrator will verify that all results have been received from each laboratory, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. The EPA Region 10 RPMs and RQAM will be notified of any problems that may affect the final outcome of this task.

Data Review Tasks:

Field and laboratory data for this task will undergo a formal verification and validation. Validation will be a mixture of two stages (10% S4VEM / 90% S2BVE) and more detailed validation would be performed on samples validated by S2BVE if issues are identified in samples validated by S4VEM. Data verification and validation for metals will be completed according to methods described in EPA's functional guidelines for inorganic data review (U.S. EPA, 2010). In addition, 2009 EPA Data Validation labelling will be used consistent with guidance found at http://www.epa.gov/superfund/policy/pdfs/EPA-540-R-08-005.pdf (OWSER directive found at http://www.epa.gov/superfund/policy/pdfs/Transmittal%20Memo-%20SF%20Data%20Validation%20Guidance.pdf). The IVBA data will be verified and validated according to standard operating procedures in EPA's Standard Operating Procedure for an *In Vitro* bioaccessibility for Pb in soil (U.S. EPA, 2012a).

All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data. Data review and validation will be conducted as described on Worksheets #34 thru #36.

QAPP Worksheet #15: Reference Limits and Evaluation Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low

Analyte	CAS Number	Project Action Limit[a] (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				Method Detection Limit	Quantitation Limit	Method Detection Limits (mg/kg)	Quantitation Limits (mg/kg)
Aluminum	7429-90-5	77,400	2	NS	NS	0.6	2
Antimony	7440-36-0	31.3[b]	0.05	NS	NS	0.2	0.05
Arsenic	7440-38-2	20[c]	0.5	NS	NS	0.02	0.5
Barium	7440-39-3	15,300	0.05	NS	NS	0.02	0.05
Beryllium	7440-41-7	156	0.02	NS	NS	0.005	0.02
Cadmium	7440-43-9	70.3	0.02	NS	NS	0.009	0.02
Calcium	7440-70-2	–	4	NS	NS	1	4
Chromium	7440-47-3	0.301 [d]	0.2	NS	NS	0.07	0.2
Cobalt	7440-48-4	23.4	0.02	NS	NS	0.009	0.02
Copper	7440-50-8	3,130	0.1	NS	NS	0.04	0.1
Iron	7439-89-6	54,800	4	NS	NS	2	4
Lead	7439-92-1	400	0.05	NS	NS	0.02	0.05
Magnesium	7439-95-4	–	2	NS	NS	0.2	2
Manganese	7439-96-5	1,830	0.05	NS	NS	0.02	0.05
Nickel	7440-02-0	1,550	0.2	NS	NS	0.04	0.2
Potassium	7440-09-7	–	40	NS	NS	10	40
Selenium	7782-49-2	391	1	NS	NS	0.2	1
Silver	7440-22-4	391	0.02	NS	NS	0.005	0.02
Sodium	7440-23-5	–	40	NS	NS	5	40
Thallium	7440-28-0	0.782	0.02	NS	NS	0.002	0.02
Vanadium	7440-62-2	5.472[e]	0.2	NS	NS	0.08	0.2
Zinc	7440-66-6	23,500	0.5	NS	NS	0.2	0.5

[a]Project action limits are residential soil screening levels that were calculated using U.S. EPA's Regional Screening Level Calculator http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) with default values for exposure factors.
[b]Values are for antimony potassium tartrate based on Diamond and Thayer (2011a). Antimony potassium tartrate is the most common form of antimony found in the environment.
[c]Washington state unrestricted land use value (ECY, 2007).
[d]Values are for chromium VI, and are based on a conservative estimate. Adjustments will be made to take into account ratio III:VI in soil for actual risk calculations.
[e]Value is from Diamond and Thayer (2011b), Bacom, et al. (2012), and not by the RSL calculator.

QAPP Worksheet #16: Project Schedule Timeline Table

☐ Worksheet Not Applicable (State Reason)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Task 1: Write draft QAPP	SRC	11/25/13	1/10/14	Draft EPA Review UFP-QAPP	1/10/14
Task 2: Draft QAPP review	EPA	1/10/14	1/21/14	Various	1/21/14
Task 3: Conference call to discuss EPA comments	SRC, EPA	1/23/14	1/23/14	N/A	1/23/14
Task 4: Revised draft initial QAPP delivered	To Be Determined	1/23/14	2/6/14	Draft Participating Parties Review UFP-QAPP	2/6/14
Task 5: Draft initial draft QAPP review	Participating Parties, Citizens for a Clean Columbia, TAI	2/6/14	3/6/14	Various	3/6/14
Task 6: Conference calls to discuss comments	EPA, Participating Parties, Citizens for a Clean Columbia, TAI, SRC	3/6/14	3/20/14	N/A	3/20/14
Task 7: Final EPA draft Phase 1 QAPP delivered to EPA	SRC	4/3/14	4/4/14	Revised Draft Participating Parties Review UFP-QAPP	4/3/14
Task 8: Initial site visit	EPA, SRC, CH2M Hill	April 2014	May 2014	Property-specific maps of potential DUs	
Task 9. Draft QAPP		May 2014	June 2014	Draft UFP-QAPP	
Task 10. QAPP review		July2014	August 2014	For Regional Comments	
Task 11. Final QAPP		August 2014	August 2014	UFP-QAPP, Upper Columbia River Residential Soil Study	8/15/14
Task 12: Residential soil sampling	EPA, CH2M Hill	August 2014	October 2014		
Task 13: Laboratory analysis	To Be Determined	To Be Determined	To Be Determined		
Task 14: Data validation	TAI	To Be Determined	To Be Determined		
Task 15: Data Review	EPA	To Be Determined	To Be Determined		

QAPP Worksheet #17: Sampling Design and Rationale

☐ Worksheet Not Applicable (State Reason)

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach):

This study was designed to provide additional information to characterize potential risk and exposure associated with historical deposition of metals in soils in residential areas closest to the Teck and Le Roi smelters. As such, residential properties within the Columbia River valley north of Northport, WA and extending to the U.S. – Canada border are the focus of this investigation. Landowners were contacted and provided access agreements to allow EPA to perform the sampling. The sampling is voluntary from the landowner. In the spring of 2014, each property owner who returned a signed access agreement to EPA was visited, the property owner(s) interviewed, and exposure areas were defined and mapped. A total of 86 parcels will be included in this study. Residential parcels in this rural area are quite large (the mean parcel size is 16 acres, and parcels range from 0.5 acres to approximately 80 acres). As such, portions of some large properties may not be utilized regularly by the property owners (e.g., forested land)). Given that the goal of the study is to sample soils in areas with high human exposure potential, this investigation places emphasis on the utilized portions of each parcel (i.e., the areas around each house where residents are most likely to come into contact with surface soils). Children's play areas and gardens will be targeted for soil sampling. Gardens are targeted because exposure may occur in these areas during digging in the surface soil for tilling and weeding, planting, and moving plants,. Areas that are intermittently accessed may also be sampled on a case-by-case basis (e.g., areas where children ride dirt bikes). Animal pens or riding areas will also be sampled because of potential for frequent human exposure to surface soils in these areas,. Except for drip lines, which will be sampled separately, care will be taken to locate increments outside the drip line of the residence, and away from influences of any other painted surfaces.

Residential soil samples will be collected using an IC sampling design (see Figure 2). IC sampling entails the collection of multiple individual volumes of soil (termed "increments") from a target area (sampling unit, SU or DU) that are composited and subsampled according to a detailed standard operating procedure prior to laboratory analysis (ITRC, 2012). The IC sampling method is described in detail by the ITRC (2012). The UCR Study Area residential soil sampling design includes three IC samples per DU and 30 increments per IC sample. The rationale for the number of IC samples and the number of increments per sample is provided below. Increments will be located using systematic random sampling with a rectangular grid and random starting point. The mean of the IC samples collected from each DU will be used as the EPC for Pb; the 95 percent upper confidence limit (95UCL) for the mean will be used as the EPC for all other metals (U.S. EPA, 1994a). IC was selected as the sampling strategy because it provides a more cost-effective alternative to discrete sampling when the objective is to estimate the mean concentration for a DU (Hathaway et al., 2008). Composite sample data have lower variability than discrete sample data and a higher reproducibility (HDOH, 2009).

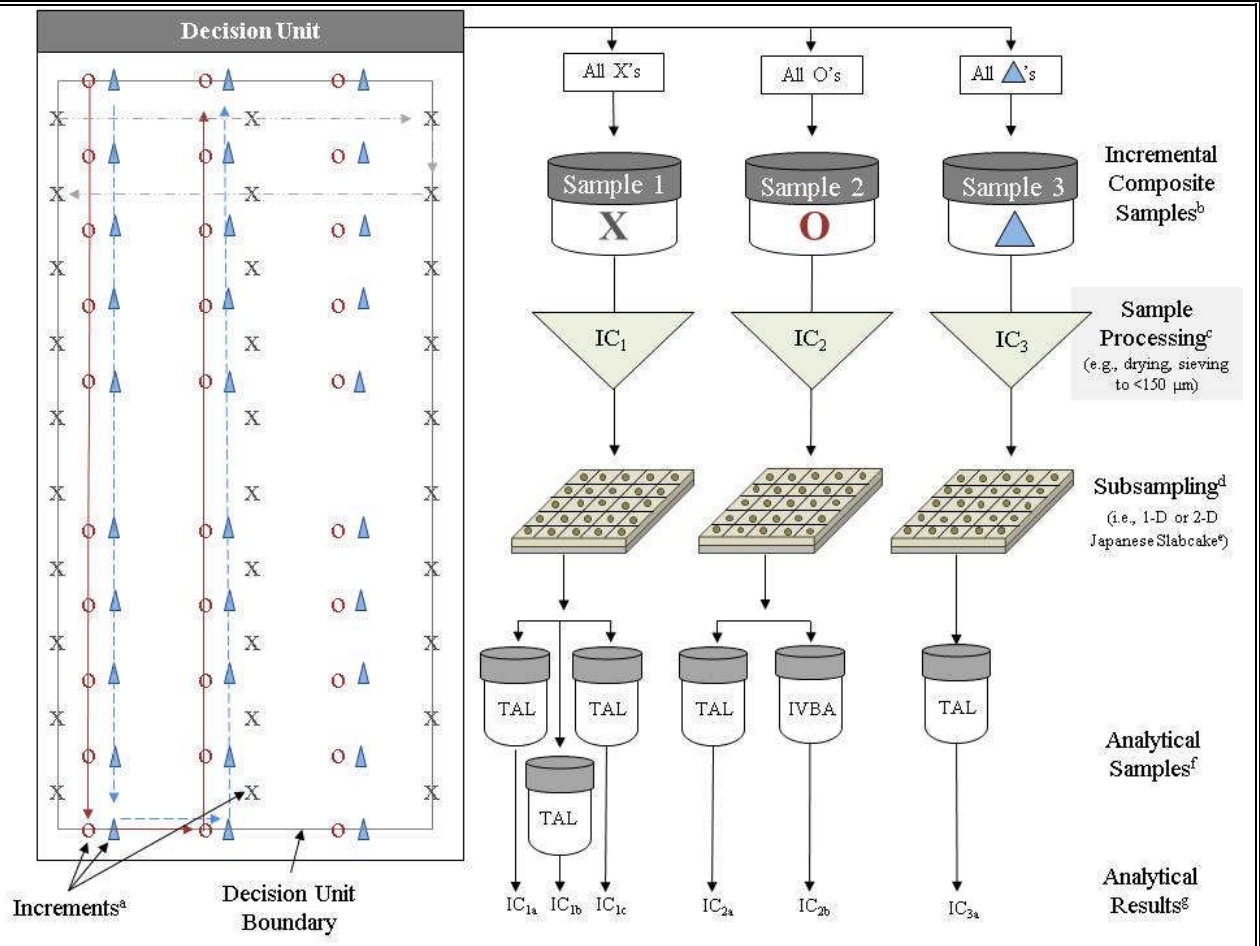


Figure 2. Overview of the IC sampling design for use in the UCR Residential Soil Study.

[a]Increments will be located by using systematic random sampling and a square grid.
[b]Thirty increments will be collected during the same field sampling event for each of the three IC samples. Equal volumes from each increment will be combined to create one IC sample (as shown). Additional information is available in the FSP.
[c]Sample processing will take place in the laboratory, by pre-sieving the sample to 2 mm and then passing the entire IC sample through a 150 micron sieve (see text for additional information on laboratory procedures).
[d] Laboratory subsampling will consist of 30 increments; all remaining sieved soil will be archived after analytical samples are obtained.
[d] No additional subsampling will be done once the laboratory subsample (2 grams of < 150 µm soil) is placed in the jar. If laboratory replicate samples or split samples are required from a particularsample, additionaljars will be required and 2 g of soil will be placed in each jar. Two g is the minimum mass required to control fundamental error (FE) at 5% for both <150 µm and <250 µm grain size fractions (latter applies to beach DUs only). Two g is also the minimum mass required to collect a representative subsample using incremental subsampling methods (Crumbling, 2014).
[e]As described in ITRC (2012).
[f]Each of the IC samples will be analyzed for TAL metals (no Hg). Lead and As bioaccessibility testing (U.S. EPA, 2007, 2012a) will only be performed for non-dripline IC samples with Pb concentrations ≥100 ppm or As concentration ≥20 ppm. If one of the concentration criteria (Pb ≥100 ppm, As ≥20 ppm) is met, both Pb and As IVBA assays will be done. If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. On a property basis, if more than one IC sample for a give DU type (e.g., play area DU) exceeds one of the concentration criteria, the IVBA assay will be run with using the one sample that has the maximum Pb concentration for that type of DU. To be clear, a maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property.
[g]At least 10% of the IC samples will include the preparation and analysis of three laboratory replicate subsamples for the purpose of estimating variance due to sample processing and analytical error (combined).

Figure adapted from ITRC (2012) and Hathaway et al. (2008).

Describe the sampling design and rationale in terms of what matrices will be sampled, what analytical groups will be analyzed and at what concentration levels, the sampling locations (including QC, critical, and background samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations) [May refer to map or Worksheet #18 for details]:

Number of Decision Units (DUs) per Property

A DU is defined as the smallest area about which a risk-based decision will be made. For this project, each of the 86 residential properties under investigation were divided into DUs based on property size and the presence of features that may influence exposure, such as children's play areas, gardens and discrete animal pens/riding areas. Drip lines around residences and other large, painted structures (e.g., barns) will be sampled. Areas near roadways and railways will be avoided to prevent sampling soil that may be contaminated by non-air sources; a 50-foot buffer in both directions from the center line of these features was implemented. The number of DUs per property was determined following a visit to each property for which an access agreement has been received by EPA in Spring 2014. Property-specific maps were generated that include DUs for areas near the homes that were most frequently utilized, children's play areas (when present; e.g., sandbox, swing set), gardens, and animal pens/riding areas. Boundaries for each DU were delineated based on land use and GPS data collected during a visit to each property.

Based on information available for the UCR Study Area and experience gained from Bunker Hill and several other sites, several templates were prepared to serve as starting points for the property-specific sampling designs (Figure 3). The templates depict various property sizes and features (e.g., gardens, play areas). The template best suited to the characteristics of a property was used as a starting point for the property-specific sampling design, and modified as necessary to accommodate the features and layout of the property. A summary of the templates is provided in Figure 3. Subsequent to the reconnaissance work, the distinction between maintained and unmaintained areas of the properties did not prove to be meaningful for the purposes of the sampling design because of the wide variety of land uses at each property; therefore, the 'maintained' and 'unmaintained' DU categories were replaced with the 'other-not specified' DU category.

Most of the properties have one DU ('House') that encompasses up to one acre immediately surrounding the residence. Distinct play areas, gardens and animal pens/ riding areas, were delineated as separate DUs. Properties that included other frequently used areas were delineated and assigned to the "other-not specified" DU category. Except for drip lines, care has been taken to locate increments outside the drip line of the residence, and away from influences of any other painted surfaces. Areas located close to roadways and railways were avoided to prevent sampling soil that is potentially contaminated by non-air sources (e.g., tire weights, fill soil from ballast).

For example, a property that includes five acres of utilized land which includes a child's play area, and a vegetable garden could have up to four DUs: one DU for up to one acre surrounding the residence (excluding gardens and play areas), one DU for the garden, one DU for the play area, and one DU for the remaining portion of the property that is regularly used ("other-not specified") (see Figure 3).

Residential Property

Template A	Template B	Template C	Template D	Template E	Template F
• Property: > 5 acres • Play and/or Garden Area Present	• Property: > 5 acres • Play and/or Garden Area **NOT** Present	• Property: < 5 acres • Play and/or Garden Area Present	• Property: < 5 acres • Play and/or Garden Area **NOT** Present	• Property: > 5 acres • Agricultural land Present • Animal Pens/Riding Areas Present	• Property: > 5 acres • Intermittently accessed unmaintained area
Decision Units • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU per additional 5-acre sections of maintained property (≤5 acres per DU rounded to the nearest integer) • 1 DU for Garden • 1 DU for Play Area	**Decision Units** • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU per additional 5-acre sections of maintained property (≤5 acres per DU rounded to the nearest integer)	**Decision Units** • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU for the remaining acreage of maintained property • 1 DU for Garden • 1 DU for Play Area	**Decision Units** • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU for the remaining acreage of maintained property	**Decision Units** • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU per additional 5-acre sections of maintained property (≤5 acres per DU rounded to the nearest integer) • 1 DU per 5-acres of agricultural or animal activity area (≤5 acres per DU rounded to the nearest integer)	**Decision Units** • 1 DU for residence drip line • 1 DU for up to one acre surrounding the house • 1 DU for drip lines associated with large, painted structures (e.g., barns) • 1 DU per additional 5-acre sections of maintained property (≤5 acres per DU rounded to the nearest integer • 1 DU per 5 acres of intermittently accessed unmaintained area (rounded to the nearest integer)

Figure 3. Property-specific sampling templates[3].

Number of IC Samples per DU, and Number of Increments per IC Sample

IC sampling produces an estimate of the mean contaminant concentration in soil within a DU. If a DU were perfectly homogenous and contaminants were equally distributed throughout the surface soil, all sampling approaches would yield the same resulting contaminant concentration. However, the distribution of contaminants within soil is heterogeneous, introducing variability into the estimation of the mean concentration. Three IC samples will be collected per DU, and each IC sample will consist of 30 increments (ITRC, 2012).

[3] Subsequent to the field work conducted in April-May of 2014, the distinction between maintained and unmaintained areas of the properties did not prove to be meaningful for the purposes of the sampling design; therefore, the 'maintained' and 'unmaintained' DU categories were replaced with the 'other-not specified' DU category.

To support human health risk management, it is appropriate to establish a null hypothesis (H_0) that presumes the presence of contamination at levels that pose an unacceptable risk to human health (U.S. EPA, 2006). The null hypothesis is retained unless the data indicate the soil is highly unlikely to pose unacceptable risk to human health. Typically, the null hypothesis corresponds to a RBC for the contaminant; e.g., a concentration of 400 ppm is used in the null hypothesis for Pb (U.S. EPA, 1994a). However, the RBC for As (9.4 ppm) is below WA state unrestricted land use value (20 ppm) (ECY, 2007). Therefore, for the purposes of the sampling design, the null and alternate hypotheses are based on bioaccessible adjusted concentrations of 20 and 400 ppm for As and Pb, respectively.

The null (H_0) and alternative (H_a) hypotheses for Pb are defined as follows:

> H_0 – the true mean concentration of Pb (before relative bioavailability (RBA)-adjustment) in the <150 µm fraction of the appropriate sampling depth interval is greater than or equal to 400 ppm (i.e., the RBC).
>
> H_a – the true mean concentration of Pb (before RBA-adjustment) in the <150 µm fraction of the appropriate sampling depth interval is less than 400 ppm.

The null (H_0) and alternative (H_a) hypotheses for As are defined as follows:

> H_0 – the true mean concentration of As (before RBA-adjustment) in the <150 µm fraction of the appropriate sampling depth interval is greater than or equal to 20 ppm.
>
> H_a – the true mean concentration of As (before RBA-adjustment) in the <150 µm fraction of the appropriate sampling depth interval is less than 20 ppm.

Tolerable Limits on Decision Errors. Given the above null hypothesis, two types of decision errors are possible:

- A false negative (type 1) decision error (α) would occur if a risk manager decides that exposure to soils is below a level of concern, when it is not.
- A false positive (type 2) decision error (β) would occur if a risk manager decides that exposure to soils is above a level of concern, when it is not.

EPA wishes to minimize false negative decision errors, to avoid leaving contamination in place that poses unacceptable risk to human health. For this reason, the probability of a false negative decision error of 5% was used in the sample plan design. This corresponds to comparing the 95UCL of the mean contaminant concentration to the RBC. When the data lead to a rejection of the null, the use of the 95UCL provides a high confidence in the conclusion that exposure to surface soil within the DU does not pose an unacceptable level of risk to human health; i.e., there is theoretically no more than a 5% probability that the true mean is above the RBC.

EPA is also concerned with the probability of making false positive decision errors because such error may result in management actions that are not actually needed to protect human health. For the purposes of this effort, a false positive decision error rate of 20% was used. To estimate a false positive error rate it is necessary to specify a hypothetical mean concentration that could be differentiated from the null concentration value, if in fact it were the true mean concentration. The difference between the null and this hypothetical concentration is called the *delta or gray region* (U.S. EPA, 2006). For Pb, the false positive decision error rate corresponds to a delta of 250 ppm; for As, the delta is 10 ppm. For example, if the true mean Pb concentration is ≤150 mg/kg, the probability that the 95UCL will equal or exceed the RBC (400 mg/kg) is no more than 20%. For As, the false positive decision error rate corresponds to the ability to detect a true mean As concentration of 10 ppm. In general, as the delta decreases, the minimum sample size required to satisfy the decision error rate criteria increases. Similarly, as the desired false positive error rate decreases, the required sample size increases. Sample size calculations for IC sampling designs require an estimate of the between-increment variability of the contaminants. For the residential soil QAPP, the variability of As and Pb concentration in surface soil were based on a soil study by the WA Department of Ecology (ECY) (Hart Crowser, 2013). The ECY study collected soil samples from 13 subareas located east and west of the Columbia River and within approximately 2 miles of the U.S. – Canada border. Some of the subareas are located within the northern region of the

residential soil sampling area (but not at residences). The subareas ranged in size from 1-2 square miles (Hart Crowser, 2013). The data for As and Pb variability consisted primarily of 8-10 composite samples per subarea that were collected from the 0-3" depth interval (0-3" below the non-decomposed litter layer; Hart Crowser, 2013). Hart Crowser (2013) also provided information from one discrete soil sample per subarea collected from the same 0-3" depth interval.

The standard deviation of As and Pb concentration measured in the discrete soil samples from upland soil areas was 6.1 and 439 ppm, respectively (Hart Crowser, 2013). The standard deviation of the composite samples ranged from approximately 3.4 to 16 ppm for As, and 34 to 552 ppm for Pb. The sample size calculations are based on a standard deviation of 10 ppm for As and 500 ppm for Pb. The standard deviation for As (10 ppm) exceeded the value for 10 of 13 subareas, while the standard deviation for Pb (500 ppm) exceeded all but one of the subarea standard deviations.

The parameter values used in the sample size calculations are provided in Table 1. The sample size calculations were performed in Visual Sampling Plan (VSP), version 6.5 (VSP Development Team, 2013). The calculations indicate three IC samples per DU, each consisting of 30 increments,[6] are required to achieve the decision error rate goals described above.

Table 1. Values used in VSP to Calculate Minimum Sample Sizes.

Parameter	As	Pb	Comment
False negative (type 1, α) error rate	0.05	0.05	
False positive (type 2, β) error rate	0.2	0.2	
Null hypothesis concentration (ppm)	20	400	
Delta or gray region (ppm)	10	150	
Standard deviation between increments (ppm)	10	500	
Standard deviation between subsamples (ppm)	3	50	Assumed to be 10% of the between-increment standard deviation
Number of increments in each IC sample[a]	30	30	
Number of analytical subsamples from each IC sample	1	1	One IC sample from each DU will include analysis of three subsamples

[a]One IC sample will be collected from DUs that are <1000 square feet.

Based on this evaluation, three IC samples consisting of 30 increments will be collected from DUs greater than 1000 sq ft. This will enable an estimate of sampling variance and a 95UCL for the mean, which will be used as the EPC for metals other than Pb. It will also allow risk managers to determine the amount of variation from the mean that will be considered when comparing average contaminant concentrations in the DU to applicable decision criteria. For this analysis, it is critical that the same number of increments be collected for each IC sample within a DU.

For DUs less than 1000 sq ft, only one IC sample will be collected. If there are multiple DUs of the same type on a parcel, three IC samples will only be collected on one of the DUs; one IC sample will be collected from the remainder (e.g., a parcel has four DUs identified as "other/not specified. Three IC samples will be collected from one of the four, and one IC sample will be collected from each of the other three).

Number of Grab Samples per Property

Five grab samples will be collected at a depth of 1-6" from one DU per property. The DU selected for collecting the grab samples is the DU closest to the house where exposure is expected to be highest and where the IC sample depth is 0-1".

Sample Locations Within a DU

A GPS receiver with differential correction will be used to locate each DU. Increments for each IC sample will be located using a systematic grid based on a random starting location (see Figure 2). The location of other features relevant to potential exposure will also be noted, such as play areas, gardens and animal pens/riding areas. A trial run (no sample collection) will be performed to establish the distance between increment collection points to achieve the targeted 30 increments, while using the flags or GPS coordinates (from VSP) as guides. Except for drip line DUs, care will be taken to locate increments outside the drip line of the residence, and away from influences of any other painted surfaces. This sampling design will result in approximately equally-spaced increments within the DU (i.e., uniform spatial distribution of increments). For example, a square-shaped DU may be divided into five rows with six increments collected from each row, using a systematic random fashion with an initial random starting point. For more rectangular-shaped DUs, fewer rows might be used, with more increments per row collected. Row lengths and increments per row may be modified as needed to accommodate a variety of DU shapes, orientations, and obstructions encountered in the field.

Beach sample locations will be delineated in the field based on water elevation at the time of sampling and interviews with property owners regarding use of the beach.

Five grab samples will be collected from the complete 1-6" depth interval from one DU per property. The grab samples are usually located in the DU closest to the house, or where exposure is expected to be highest (based on the interviews), and where the IC sample depth is 0-1" (i.e., not in gardens). The locations (coordinates) of the soil cores have been randomly determined using VSP and are provided in Attachment B, Table 2. In the event one or more of the soil original locations cannot be sampled due to surface or subsurface obstructions, alternate soil core locations will be determined in the field by moving a pre-determined distance and direction from the original sample location.

Procedure for Locating and Collecting Multiple IC Samples

All IC samples from each DU will be collected during the same field event. An identical number of increments will be collected for each of the three IC samples, with each set of increments using a new systematic grid.

Increment locations will be determined from GPS coordinates (e.g., produced with VSP) or by measuring and flagging locations within the field. The sampling team will begin at one end of a row/column of grid cells, and collect increments within each grid cell by walking through the gridded area. Each increment location will be flagged. When the team reaches the end of the row/column, they will then proceed along the next row/column, walking back in the direction of the initial point of increment collection, once again collecting an increment of sample within each grid. The sampling team continues in this serpentine pattern, until 30 increments have been collected for the IC sample, ending at the opposite corner or end of the field. At each increment collection point, a pin flag will be sunk and GPS coordinates may be captured. Sampling equipment is not decontaminated between increments for one IC sample.

Increment locations for each IC sample will be unique and will not be taken from co-located or adjacent locations. If increment locations are determined with GPS coordinates exported from VSP this should not be a concern (the quasi-random number generator option in VSP is required). If the increment locations are determined by measuring and flagging in the field, the sampling team will meet this criteria by returning to the initial increment collection point (marked by a flag) and move to the right (or left, forward, backward) a pre-determined distance and begin increment collection for the second IC set of increments. Since flags will have been placed at each of the original increment locations, increments for the second and third IC samples can be collected by moving the pre-determined distance and direction from each of the original flags.

Increment collection for the second and third IC samples will follow a serpentine pattern similar to the original sample but following a different path. For example, if the original sample is collected by following a path from north to south starting in the west and going east, a second IC sample would be collected walking a path from west to east starting in the north and moving south as shown in Figure 2 (but modified to collect 30 increments for each IC sample). The third

IC sample could be collected from south to north, moving from east to west.

Method for Collecting Increment Soil Samples

Individual soil increments will be collected using a cylindrical or core-shaped sampler to ensure that each increment contains a proportionate amount of soil particles over the entire depth of interest, with an equal volume of soil particles from the top of the sample as the bottom. The entire 0-1" interval will be collected. The objective is to collect equal volumes of soil from each increment location. IC samples will be collected according to the IC soil sampling SOP (Included with Attachment C). The diameter of the cylindrical or core-shaped sampler will be 2 to 4 cm but will remain constant within a DU. If a core sampler cannot be used (e.g., at a beach, depending on sediment substrate), it may be necessary to collect the sample with a stainless steel spoon.

Sample Depth

The exposure pathway of concern is incidental ingestion of surface soils resulting from contact with soil. The sampling depth will be the soil depth interval that people are most likely to come into contact with and will vary by DU. "With respect to risk assessment, the top inch of soil best represents current exposure to contaminants (U.S. EPA, 1989, 1996) and is the source of data used in the IEUBK model to represent exposure from soil" (U.S. EPA, 2003). Surface soil will be collected from the entire 0-1" depth interval (top 2 cm) below organic litter or sod (U.S. EPA, 2003) in house, agriculture, dripline, and "other-not specified" DUs. The sampling depth for gardens (both vegetable and ornamental) will be the tilled depth because it is reasonable to expect that people routinely come into contact with soil throughout the tilled depth (typically 0-12"). Sampling depth for play areas will generally be 0-1". Based on observations made during the site visit, areas where soil disturbance is deeper than 1" will be sampled at a depth of 0-3" (e.g., animal activity areas). Beaches will generally be sampled at a depth of 0-6" unless there were cultural resources concerns. Those beaches will be sampled at a depth of 0-1".

Five grab samples will be collected at depth (1-6") from one DU per property.

Mass of Soil Required

House, Garden, Play Area, Other/Not Specified, Agriculture, Animal Activity Area, Dripline DUs

The total mass of soil required for each IC sample depends on the mass required for each type of analysis, the grain size that will be analyzed and the grain size distribution of the soil. Based on the Soil Survey Geographic database (SSURGO) (NRCS, 2014), the soil types found in the initial sampling area range from gravelly loamy sand to silt loam. For the purposes of estimating the required mass of the IC sample, it was assumed the <150 µm particle size fraction could make up as little as 5% of the soil by mass in locations where loamy sand and gravelly loamy sand are found. Therefore, the minimum mass of the IC sample was estimated by dividing the mass of <150 µm soil required for laboratory analyses by 0.05. The mass of <150 µm soil required for laboratory analysis, quality control samples, and contingency for re-analysis is as follows: bioaccessibility (10 grams) and TAL (no Hg) metals (10 grams) (Table B3-1 of the Draft Final Soil QAPP; Exponent et al., 2014). The mass required for TAL (no Hg) analysis (10 grams) exceeds the minimum mass required to control fundamental error (FE) at 5% for both <150 µm and <250 µm grain size fractions (latter applies to beach DUs only). The mass required for TAL (no Hg) analysis also exceeds the minimum mass required to collect a representative subsample using incremental subsampling methods (approximately 2grams) (Crumbling, 2014). A minimum of 2 g < 150 µm soil will be used for TAL (no Hg) extraction, and a minimum or 1 g <150 µm soil will be used for the IVBA extraction.

IC samples that will provide three replicate subsamples for TAL (no Hg) analysis (Figure 2) will require a sample mass of 40 grams; this will require a total soil mass for the IC sample of 40/0.05, or 800 grams . Individual soil increments (that make up an IC sample) must weigh at least 27 grams (800 grams/30 increments).

IC samples that will provide three replicate subsamples for TAL (no Hg) analysis and a laboratory split sample (15% sent to MEL for analysis) will require a sample mass of 50 grams; this will require a total soil mass for the IC sample of 50/0.05, or 1000 grams. Individual soil increments (that make up an IC sample) must weigh at least 33 grams.

For the grab samples collected at depth, 10 grams of soil is needed for TAL (no Hg) analysis; a total soil mass of 200 grams (10/0.05) is needed for the core samples.

The mass of the <150 µm soil remaining after analysis will be archived; at a minimum, each IC sample must provide a mass of <150um soil for archiving that is sufficient to repeat all analyses performed for that IC sample. All archived samples will be retained until written approval from EPA is provided to destroy the archived samples.

Beach DUs

As above, the total mass of soil required for each IC sample depends on the mass required for each type of analysis, the grain size that will be analyzed and the grain size distribution of the soil. For the purposes of estimating the required mass of the beach IC samples, it was assumed the <250 µm particle size fraction could make up as little as 5% of beach sand. Therefore, the minimum mass of the IC sample was estimated by dividing the mass of <250 µm soil required for laboratory analyses by 0.05. The mass of <250 µm soil required for laboratory analysis, quality control samples, and contingency for re-analysis is as follows: bioaccessibility (10 grams) and TAL (no Hg) metals (10 grams. A minimum of 2 g < 250 µm soil will be used for TAL (no Hg) extraction, and a minimum or 1 g <250 µm soil will be used for the IVBA extraction.

IC samples that will provide three replicate subsamples for TAL (no Hg) analysis (Figure 2) will require a sample mass of 40 grams; this will require a total soil mass for the IC sample of 40/ 0.05, or 800 grams. Individual soil increments (that make up an IC sample) must weigh at least 27 grams (800 grams/30 increments).

IC samples that will provide three replicate subsamples for TAL (no Hg) analysis and a laboratory split sample (15% sent to MEL for analysis) will require a sample mass of 50 grams; this will require a total soil mass for the IC sample of 50/ 0.05, or 1000 grams. Individual soil increments (that make up an IC sample) must weigh at least 34 grams.

Grab samples will not be collected at the beach DUs.

The mass of the <250 µm soil remaining after analysis will be archived; at a minimum, each IC sample must provide a mass of <250um soil for archiving that is sufficient to repeat all analyses performed for that IC sample. All archived samples will be retained until written approval from EPA is provided to destroy the archived samples.

Sample Processing and Analysis

For this investigation mixing the increments and sieving will not be conducted in the field; the entire IC sample will be sent to the laboratory for processing (drying, sieving, subsampling). Physical disaggregation of samples will be conducted by breaking aggregates apart by hand but not through pounding with a mortar and pestle. This process is also expected to break down the dried vegetation such that the attached soil particles will be knocked loose. Grinding will not be conducted without prior approval from EPA. Samples will be dried and passed through a No. 10 sieve (2.0 millimeters [mm]) to remove large debris (e.g., sticks, stones) in the laboratory. The resulting material will be weighed and sieved through a No. 100 sieve to isolate the target particle size of <150 µm. This particle size fraction is intended to represent the fraction expected to adhere to skin via dermal contact (Ruby and Lowney, 2012). Beach samples will be sieved through a No. 60 sieve to isolate the target particle size of <250 µm. This particle size fraction represents dermal adherence under wet conditions (Kissel et al. 1996). The entire IC sample will be sieved to the target particle size.

No additional subsampling will be done once the laboratory subsample (2 grams of < 150 µm soil) is placed in the jar. If laboratory replicate samples or split samples are required from a particular sample, additional jars will be required and 2 g of soil will be placed in each jar. Two g is the minimum mass required to control FE at 5% for both <150 µm and <250 µm grain size fractions (latter applies to beach DUs only). Two g is also the minimum mass required to collect a representative subsample using incremental subsampling methods (Crumbling, 2014).

Each IC sample will be analyzed for TAL (no Hg) metals. Lead and As bioaccessibility testing will only be performed

for IC samples with Pb concentrations ≥100 ppm or As concentration ≥20 ppm. If one of the concentration criteria (Pb ≥100 ppm, As ≥20 ppm) is met, both Pb and As IVBA assays will be done. If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. On a property basis, if more than one IC sample for a given DU type (e.g., garden DU) exceeds one of the concentration criteria, the IVBA assay will be run with using the one sample that has the maximum Pb concentration for that type of DU.

Subsamples for IVBA analysis will be collected at the time subsamples for TAL (no Hg) analysis and laboratory replicate analysis are collected; they will be archived until laboratory analytical results are available. All archived samples will be retained until written approval from EPA is provided to destroy the archived samples. A maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property. IVBA will not be done on the dripline samples. All remaining sieved soil (<2 mm and <150 µm fractions for soil and <2 mm and <250 µm fractions for beach) will be archived after analytical samples are obtained and retained for later use, if necessary. All archived samples will be retained until written approval from EPA is provided to destroy the archived samples.

The grab samples will be dried and passed through a No. 10 sieve (2.0 millimeters [mm]) to remove large debris (e.g., sticks, stones) in the laboratory. The resulting material will be weighed and sieved through a No. 100 sieve to isolate the target particle size of <150 µm; this fraction will be submitted for TAL (no Hg) metal analysis.

Quality Assurance and Quality Control Samples

Some property owners have requested replicate soil samples from their properties. A field duplicate sample (a separate IC sample in addition to the 3 IC samples being collected per DU) will be provided if requested.

Field duplicate samples will be collected on 15% of the discrete samples. The samples will be homogenized in the field and split between two sample containers.

As done in past UCR RI/FS studies, laboratory split samples will be collected on 15% of the soil samples collected during this sampling event after sieving and sent to MEL for TAL metal analysis to measure interlaboratory precision/error. Samples will be selected for split sample analysis using procedures outlined in the Split Sample QAPP (to be provided by EPA Region 10). Quality control samples will include laboratory replicate subsamples. At least 10% of the IC samples will include the preparation and analysis of three laboratory replicate subsamples for the purpose of estimating and assessing variability due to subsample processing and analytical error (combined). The methodology for subsampling is provided in the laboratory SOP. These subsamples will be prepared for at least one IC sample per DU for at least 10 DUs (or for 10 percent of the DUs, whichever is greater). The laboratory replicate subsamples will be analyzed in different analytical runs; this will give the best evaluation of analytical error.

Field equipment rinsate blanks will be collected during field sampling efforts to identify possible contamination from field sampling equipment. An experimental blank will be used to identify possible contamination from the laboratory and will be collected according to laboratory protocols. Experimental blanks will be collected once per batch of 20 samples. A MS/MSD will be performed in the laboratory to assess the accuracy of the analyses. The MS/MSD will be performed according to the laboratory protocols and will occur at a frequency of at least once every 20 samples.

QAPP Worksheet #18: Sampling Locations and Methods/SOP Requirements Table

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	214	Soil	House	14985	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
5687700	214	Soil	House	14985	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5693400	22	Soil	House	2836	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	22	Soil	House	2836	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5087000	201	Soil	House	4452	0-1	3			TAL Metals (no Hg)	Unknown	01, 02
	201	Soil	House	4452	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	201DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	202	Soil	Beach	2191	0-6	3			TAL Metals (no Hg)	Unknown	01
	202	Soil	Beach	2191	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	201G	Soil	Garden	7057	0-12	3	1-6	5	TAL Metals (no Hg)	Unknown	01
	201G	Soil	Garden	7057	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5088000	9	Soil	Agriculture	200923	0-1	3			TAL Metals (no Hg)	Unknown	01
	9	Soil	Agriculture	200923	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	13	Soil	Other -Not Specified	109269	0-1	1			TAL Metals (no Hg)	Unknown	01
	13	Soil	Other -Not Specified	109269	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	14	Soil	Garden	4259	0-12	3			TAL Metals (no Hg)	Unknown	01
	14	Soil	Garden	4259	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	15	Soil	House	13686	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	15	Soil	House	13686	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	15DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	16	Soil	Other -Not Specified	46186	0-1	1			TAL Metals (no Hg)	Unknown	01
	16	Soil	Other -Not Specified	46186	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	17	Soil	Other -Not Specified	57634	0-1	3			TAL Metals (no Hg)	Unknown	01
	17	Soil	Other -Not Specified	57634	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5090900	59	Soil	House	15436	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	59	Soil	House	15436	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	59DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	59A	Soil	House	21260	0-1	3			TAL Metals (no Hg)	Unknown	01
	59A	Soil	House	21260	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5087300	35	Soil	House	5760	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	35	Soil	House	5760	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	35DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	39	Soil	Agriculture	9892	0-1	3			TAL Metals (no Hg)	Unknown	01
	39	Soil	Agriculture	9892	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	35PA	Soil	Play Area	1829	0-1	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	35PA	Soil	Play Area	1829	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5078100	216	Soil	House	18286	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	216	Soil	House	18286	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	216DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5085300	170	Soil	House	46568	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	170	Soil	House	46568	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1030	Soil	Other -Not Specified	60440	0-1	3			TAL Metals (no Hg)	Unknown	01
	1030	Soil	Other -Not Specified	60440	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1031	Soil	Garden	895	0-12	1			TAL Metals (no Hg)	Unknown	01
	1031	Soil	Garden	895	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5704000	168	Soil	House	2116	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	168	Soil	House	2116	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	168DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	169	Soil	Other -Not Specified	73582	0-1	1			TAL Metals (no Hg)	Unknown	01
	169	Soil	Other -Not Specified	73582	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	169A	Soil	Other -Not Specified	176625	0-1	3			TAL Metals (no Hg)	Unknown	01
	169A	Soil	Other -Not Specified	176625	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5689900	49	Soil	House	2163	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	49	Soil	House	2163	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5098600	231	Soil	House	2159	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	231	Soil	House	2159	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	231DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	231Lower	Soil	Other -Not Specified	2174	0-1	3			TAL Metals (no Hg)	Unknown	01
	231Lower	Soil	Other -Not Specified	2174	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
0615200	185	Soil	House	32197	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	185	Soil	House	32197	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	185DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	185G	Soil	Garden	131	0-12	1			TAL Metals (no Hg)	Unknown	01
	185G	Soil	Garden	131	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5689400	801	Soil	Other -Not Specified	1061	0-1	3			TAL Metals (no Hg)	Unknown	01
	801	Soil	Other -Not Specified	1061	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	800B	Soil	Beach	5158	0-6	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	800B	Soil	Beach	5158	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5086800	203	Soil	House	4046	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	203	Soil	House	4046	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	204	Soil	Beach	2100	0-6	3			TAL Metals (no Hg)	Unknown	01, 02
	204	Soil	Beach	2100	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	253	Soil	House	210442	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
5095700	253	Soil	House	210442	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	254DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	251B	Soil	Beach	102050	0-1	3			TAL Metals (no Hg)	Unknown	01
	251B	Soil	Beach	102050	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5689800	255	Soil	Beach	7980	0-6	3			TAL Metals (no Hg)	Unknown	01
	255	Soil	Beach	7980	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2391400	122	Soil	Other -Not Specified	3684	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	122	Soil	Other -Not Specified	3684	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5092100	123	Soil	House	29441	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	123	Soil	House	29441	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	135	Soil	Other -Not Specified	60204	0-1	3			TAL Metals (no Hg)	Unknown	01
	135	Soil	Other -Not Specified	60204	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
0616100	192	Soil	House	858	0-1	1	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	192	Soil	House	858	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	192DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	1060	Soil	House	584	0-1	1			TAL Metals (no Hg)	Unknown	01
	1060	Soil	House	584	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5089402[2]	1050	Soil	House	6025	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	1050	Soil	House	6025	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1051	Soil	Garden	3260	0-18	3			TAL Metals (no Hg)	Unknown	01
	1051	Soil	Garden	3260	0-18	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1052	Soil	Other -Not Specified	2887	0-1	3			TAL Metals (no Hg)	Unknown	01
	1052	Soil	Other -Not Specified	2887	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5098601	177	Soil	Agriculture	13773	0-1	3			TAL Metals (no Hg)	Unknown	01
	177	Soil	Agriculture	13773	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	176M	Soil	House	31801	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	176M	Soil	House	31801	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5690710	345	Soil	Play Area	522	0-1	1	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	345	Soil	Play Area	522	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5690710	346	Soil	Garden	9637	0-12	3			TAL Metals (no Hg)	Unknown	01
	346	Soil	Garden	9637	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5690800	347	Soil	Other -Not Specified	1177	0-1	3			TAL Metals (no Hg)	Unknown	01
	347	Soil	Other -Not Specified	1177	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5087315	7	Soil	Play Area	5728	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	7	Soil	Play Area	5728	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
0616500	186	Soil	House	9348	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	186	Soil	House	9348	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	186DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5704500	194	Soil	House	6737	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	194	Soil	House	6737	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	195	Soil	Beach	2579	0-6	3			TAL Metals (no Hg)	Unknown	01
	195	Soil	Beach	2579	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1021	Soil	House	4223	0-1	3			TAL Metals (no Hg)	Unknown	01
	1021	Soil	House	4223	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5704600	193	Soil	House	2016	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	193	Soil	House	2016	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	193DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	1020	Soil	Garden	3291	0-18	3			TAL Metals (no Hg)	Unknown	01
	1020	Soil	Garden	3291	0-18	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5084900	109	Soil	House	4058	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	109	Soil	House	4058	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	109DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
2393280	62	Soil	House	42073	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	62	Soil	House	42073	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	62DL1	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	62DL2	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	62G	Soil	Garden	10836	0-12	3			TAL Metals (no Hg)	Unknown	01
	62G	Soil	Garden	10836	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5706200	1005	Soil	Garden	5040	0-12	1			TAL Metals (no Hg)	Unknown	01
	1005	Soil	Garden	5040	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1005 (tentative)	Soil	Garden	5040	0-12	1			Replicate sample for property owner		
	1006	Soil	House	11226	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01
	1006	Soil	House	11226	0-1	1			Replicate sample for property owner		
	1006	Soil	House	11226	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01, 02
	1009DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	1009DL	Soil	Dripline		0-1	1			Replicate sample for property owner		01
	1007	Soil	Garden	2170	0-12	3			TAL Metals (no Hg)	Unknown	01
	1007	Soil	Garden	2170	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1007	Soil	Garden	2170	0-12	1			Replicate sample for property owner		
	1008	Soil	Agriculture	14950	0-1	1			TAL Metals (no Hg)	Unknown	01
	1008	Soil	Agriculture	14950	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1010	Soil	Agriculture	121982	0-1	1			TAL Metals (no Hg)	Unknown	01
	1010	Soil	Agriculture	121982	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1011	Soil	Agriculture	183941	0-1	3			TAL Metals (no Hg)	Unknown	01
5706200	1011	Soil	Agriculture	183941	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5090320	229	Soil	Play Area	3604	0-1	3			TAL Metals (no Hg)	Unknown	01
	229	Soil	Play Area	3604	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	230G	Soil	Garden	616	0-12	1			TAL Metals (no Hg)	Unknown	01
	230G	Soil	Garden	616	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5085825	196	Soil	House	855	0-1	1	1-6	5	TAL Metals (no Hg)	Unknown	01
	196	Soil	House	855	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01, 02
	197	Soil	Beach	3751	0-6	3			TAL Metals (no Hg)	Unknown	01
	197	Soil	Beach	3751	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2390500	121	Soil	House	8402	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	121	Soil	House	8402	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	121DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	280	Soil	Other -Not	19598	0-1	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
0615900			Specified								
	280	Soil	Other -Not Specified	19598	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	280yard	Soil	House	2928	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	280yard	Soil	House	2928	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	280DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5093101	246	Soil	Play Area	1590	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	246	Soil	Play Area	1590	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5087600	224	Soil	Beach	4147	0-6	3			TAL Metals (no Hg)	Unknown	01
	224	Soil	Beach	4147	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2402360	324	Soil	Beach	1304	0-6	3			TAL Metals (no Hg)	Unknown	01
	324	Soil	Beach	1304	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	325	Soil	Garden	18561	0-12	3			TAL Metals (no Hg)	Unknown	01
	325	Soil	Garden	18561	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	326	Soil	Other -Not Specified	5745	0-1	1			TAL Metals (no Hg)	Unknown	01
	326	Soil	Other -Not Specified	5745	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	327	Soil	Other -Not Specified	7878	0-1	3			TAL Metals (no Hg)	Unknown	01
	327	Soil	Other -Not Specified	7878	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5091300	85	Soil	House	42583	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	85	Soil	House	42583	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	85DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	86	Soil	Agriculture	200647	0-1	1			TAL Metals (no Hg)	Unknown	01
	86	Soil	Agriculture	200647	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	87	Soil	Agriculture	301932	0-1	1			TAL Metals (no Hg)	Unknown	01
5091300	87	Soil	Agriculture	301932	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	94M	Soil	Agriculture	265104	0-1	3			TAL Metals (no Hg)	Unknown	01
	94M	Soil	Agriculture	265104	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5693000	189	Soil	House	3787	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	189	Soil	House	3787	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1037	Soil	Garden	3652	0-12	3			TAL Metals (no Hg)	Unknown	01
	1037	Soil	Garden	3652	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5693100	1035	Soil	Garden	4311	0-12	3			TAL Metals (no Hg)	Unknown	01
	1035	Soil	Garden	4311	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1036	Soil	Play Area	4142	0-1	3			TAL Metals (no Hg)	Unknown	01
	1036	Soil	Play Area	4142	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	187DL	Soil	Dripline	133	0-1	1			TAL Metals (no Hg)	Unknown	01
5691100	75	Soil	House	10977	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	75	Soil	House	10977	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5703200	18	Soil	House	18740	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	18	Soil	House	18740	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	18DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	20	Soil	Garden	620	0-12	1			TAL Metals (no Hg)	Unknown	01
	20	Soil	Garden	620	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
5093150	154	Soil	House	1706	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	154	Soil	House	1706	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	154DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5703600	33	Soil	House	18178	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	33	Soil	House	18178	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2392940	82	Soil	House	52512	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01
	82	Soil	House	52512	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01, 02
	82DL1	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	82DL2	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5096217	317	Soil	House	43056	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	317	Soil	House	43056	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	318	Soil	Other -Not Specified	208213	0-1	1			TAL Metals (no Hg)	Unknown	01
	318	Soil	Other -Not Specified	208213	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	319	Soil	Other -Not Specified	240941	0-1	3			TAL Metals (no Hg)	Unknown	01
	319	Soil	Other -Not Specified	240941	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	317M	Soil	Play Area	5422	0-1	3			TAL Metals (no Hg)	Unknown	01
	317M	Soil	Play Area	5422	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	319M	Soil	House	4925	0-1	3			TAL Metals (no Hg)	Unknown	01
	319M	Soil	House	4925	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5096217	319DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5045800	175	Soil	Other -Not Specified	45093	0-1	3			TAL Metals (no Hg)	Unknown	01
	175	Soil	Other -Not Specified	45093	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	174M	Soil	House	9534	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	174M	Soil	House	9534	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	238G	Soil	Garden	2057	0-12	3			TAL Metals (no Hg)	Unknown	01
	238G	Soil	Garden	2057	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	238M	Soil	Agriculture	16545	0-1	3			TAL Metals (no Hg)	Unknown	01
	238M	Soil	Agriculture	16545	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5094800	116M	Soil	House	43889	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	116M	Soil	House	43889	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	116DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
2394200	25	Soil	House	10717	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	25	Soil	House	10717	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	25DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	27	Soil	Other -Not Specified	39131	0-1	1			TAL Metals (no Hg)	Unknown	01
	27	Soil	Other -Not Specified	39131	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	28	Soil	Garden	7218	0-12	3			TAL Metals (no Hg)	Unknown	01
	28	Soil	Garden	7218	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	29	Soil	Other -Not Specified	95728	0-1	1			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	29	Soil	Other -Not Specified	95728	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	30	Soil	Other -Not Specified	71881	0-1	3			TAL Metals (no Hg)	Unknown	01
	30	Soil	Other -Not Specified	71881	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	31	Soil	Other -Not Specified	61799	0-1	1			TAL Metals (no Hg)	Unknown	01
	31	Soil	Other -Not Specified	61799	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5096700	40	Soil	House	9257	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01
	40	Soil	House	9257	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01, 02
	40DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5094700	226	Soil	Beach	3304	0-1	3			TAL Metals (no Hg)	Unknown	01
	226	Soil	Beach	3304	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	226A	Soil	Beach	14568	0-1	3			TAL Metals (no Hg)	Unknown	01
	226A	Soil	Beach	14568	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5094700	226C	Soil	House	80347	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	226C	Soil	House	80347	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	226DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5095105[2]	48	Soil	House	9413	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	48	Soil	House	9413	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2399700	151	Soil	House	49394	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	151	Soil	House	49394	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	151DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	152	Soil	Other -Not Specified	48889	0-1	3			TAL Metals (no Hg)	Unknown	01
	152	Soil	Other -Not Specified	48889	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5091100	206	Soil	House	43603	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	206	Soil	House	43603	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	206DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	208	Soil	Other -Not Specified	138289	0-1	3			TAL Metals (no Hg)	Unknown	01
	208	Soil	Other -Not Specified	138289	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	208DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	213	Soil	Other -Not Specified	151298	0-1	1			TAL Metals (no Hg)	Unknown	01
	213	Soil	Other -Not Specified	151298	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	207G	Soil	Garden	709	0-12	1			TAL Metals (no Hg)	Unknown	01
	207G	Soil	Garden	709	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	208AA	Soil	Animal Activity Area	95219	0-3	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	208AA	Soil	Animal Activity Area	95219	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	209A	Soil	Agriculture	260641	0-1	3			TAL Metals (no Hg)	Unknown	01
	209A	Soil	Agriculture	260641	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5091700	206G	Soil	Garden	4145	0-12	1			TAL Metals (no Hg)	Unknown	01
	206G	Soil	Garden	4145	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	208BM	Soil	House	19435	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	208BM	Soil	House	19435	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	208G	Soil	Garden	5635	0-12	3			TAL Metals (no Hg)	Unknown	01
	208G	Soil	Garden	5635	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5087301	21	Soil	House	4029	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	21	Soil	House	4029	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	115SP	Soil	Other -Not Specified	1720	0-1	3			TAL Metals (no Hg)	Unknown	01
5087301	115SP	Soil	Other -Not Specified	1720	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	21G	Soil	Garden	11612	0-12	3			TAL Metals (no Hg)	Unknown	01
	21G	Soil	Garden	11612	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5045250	163	Soil	House	48201	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	163	Soil	House	48201	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	164	Soil	Agriculture	55823	0-1	1			TAL Metals (no Hg)	Unknown	01
	164	Soil	Agriculture	55823	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	167	Soil	Agriculture	228629	0-1	3			TAL Metals (no Hg)	Unknown	01
	167	Soil	Agriculture	228629	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	163G	Soil	Garden	166	0-12	1			TAL Metals (no Hg)	Unknown	01
	163G	Soil	Garden	166	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5045600	160	Soil	House	31918	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	160	Soil	House	31918	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2398875	315	Soil	House	12293	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	315	Soil	House	12293	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	315DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	316	Soil	Other -Not Specified	222648	0-1	3			TAL Metals (no Hg)	Unknown	01
	316	Soil	Other -Not Specified	222648	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5094400	303	Soil	Beach	3938	0-6	3			TAL Metals (no Hg)	Unknown	01
	303	Soil	Beach	3938	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	306	Soil	Other -Not Specified	61543	0-1	3			TAL Metals (no Hg)	Unknown	01
	306	Soil	Other -Not Specified	61543	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5089950	999DL2	Soil	Dripline	214	0-1	1			TAL Metals (no Hg)	Unknown	01
	999G1	Soil	Garden	8355	0-12	3			TAL Metals (no Hg)	Unknown	01
	999G1	Soil	Garden	8355	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	999M1	Soil	House	3298	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	999M1	Soil	House	3298	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	999DL1	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	999M2	Soil	Garden	681	0-12	1			TAL Metals (no Hg)	Unknown	01
	999M2	Soil	Garden	681	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	999M3	Soil	Other -Not Specified	27944	0-1	3			TAL Metals (no Hg)	Unknown	01
	999M3	Soil	Other -Not Specified	27944	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5090601	287	Soil	Agriculture	244109	0-1	3			TAL Metals (no Hg)	Unknown	01
	287	Soil	Agriculture	244109	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	284M	Soil	House	23106	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	284M	Soil	House	23106	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	284DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
5090601	285M	Soil	Other -Not Specified	154956	0-1	3			TAL Metals (no Hg)	Unknown	01
	285M	Soil	Other -Not Specified	154956	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5090700	288	Soil	House	15535	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	288	Soil	House	15535	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	291	Soil	Agriculture	246891	0-1	3			TAL Metals (no Hg)	Unknown	01
	291	Soil	Agriculture	246891	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	288G1	Soil	Garden	3190	0-12	1			TAL Metals (no Hg)	Unknown	01
	288G1	Soil	Garden	3190	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	288G2	Soil	Garden	10646	0-12	1			TAL Metals (no Hg)	Unknown	01
	288G2	Soil	Garden	10646	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	289G3	Soil	Garden	12819	0-12	3			TAL Metals (no Hg)	Unknown	01
	289G3	Soil	Garden	12819	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5045675	146	Soil	House	3526	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	146	Soil	House	3526	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	147	Soil	Garden	4658	0-12	3			TAL Metals (no Hg)	Unknown	01
	147	Soil	Garden	4658	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	146G	Soil	Garden	7606	0-12	1			TAL Metals (no Hg)	Unknown	01
	146G	Soil	Garden	7606	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5083600	249	Soil	Other -Not Specified	8964	0-1	3			TAL Metals (no Hg)	Unknown	01
	249	Soil	Other -Not Specified	8964	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	250	Soil	House	117633	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	250	Soil	House	117633	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5693200	67	Soil	Garden	19654	0-12	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	67	Soil	Garden	19654	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5693700	66	Soil	Other -Not Specified	139984	0-1	3			TAL Metals (no Hg)	Unknown	01
	66	Soil	Other -Not Specified	139984	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
0436000	218	Soil	House	2951	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	218	Soil	House	2951	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5089440	55	Soil	House	11696	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	55	Soil	House	11696	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	55DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	56	Soil	Other -Not Specified	64279	0-1	3			TAL Metals (no Hg)	Unknown	01
	56	Soil	Other -Not Specified	64279	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	58	Soil	Agriculture	119416	0-1	3			TAL Metals (no Hg)	Unknown	01
	58	Soil	Agriculture	119416	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5044000	60	Soil	Garden	2404	0-12	3			TAL Metals (no Hg)	Unknown	01, 02
	60	Soil	Garden	2404	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5044000	61	Soil	House	10784	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01
	61	Soil	House	10784	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	60DL	Soil	Dripline	500	0-1	1			TAL Metals (no Hg)	Unknown	01
5083200	181	Soil	House	41668	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	181	Soil	House	41668	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	181DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	183A	Soil	Animal Activity Area	12268	0-3	3			TAL Metals (no Hg)	Unknown	01
	183A	Soil	Animal Activity Area	12268	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	184G	Soil	Garden	3308	0-12	3			TAL Metals (no Hg)	Unknown	01
	184G	Soil	Garden	3308	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
2398900	110	Soil	House	9260	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	110	Soil	House	9260	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	110DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	111	Soil	Other -Not Specified	22102	0-1	3			TAL Metals (no Hg)	Unknown	01
	111	Soil	Other -Not Specified	22102	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	110G	Soil	Garden	612	0-12	1			TAL Metals (no Hg)	Unknown	01
	110G	Soil	Garden	612	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-189	430	Soil	Other -Not Specified	73481	0-3	1	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	430	Soil	Other -Not Specified	73481	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	431	Soil	Other -Not Specified	253599	0-3	3			TAL Metals (no Hg)	Unknown	01
	431	Soil	Other -Not Specified	253599	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	432	Soil	Other -Not Specified	3559	0-3	1			TAL Metals (no Hg)	Unknown	01
	432	Soil	Other -Not Specified	3559	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-192	420	Soil	Other -Not Specified	77720	0-3	1	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	420	Soil	Other -Not Specified	77720	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	421	Soil	Other -Not	119944	0-3	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
			Specified								
	421	Soil	Other -Not Specified	119944	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-193	258	Soil	Other -Not Specified	206127	0-3	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	258	Soil	Other -Not Specified	206127	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	259	Soil	Other -Not Specified	123308	0-3	1			TAL Metals (no Hg)	Unknown	01
	259	Soil	Other -Not Specified	123308	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-195	410	Soil	Other -Not Specified	139725	0-3	1	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	410	Soil	Other -Not Specified	139725	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	411	Soil	Beach	34674	0-6	3			TAL Metals (no Hg)	Unknown	01
	411	Soil	Beach	34674	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	412	Soil	Other -Not Specified	34951	0-3	3			TAL Metals (no Hg)	Unknown	01
	412	Soil	Other -Not Specified	34951	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	413	Soil	Other -Not Specified	225809	0-3	1			TAL Metals (no Hg)	Unknown	01
	413	Soil	Other -Not Specified	225809	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-196	401	Soil	Other -Not Specified	100911	0-3	1			TAL Metals (no Hg)	Unknown	01
	401	Soil	Other -Not Specified	100911	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	402	Soil	Other -Not Specified	59528	0-3	1			TAL Metals (no Hg)	Unknown	01
	402	Soil	Other -Not Specified	59528	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	403	Soil	Other -Not Specified	14674	0-3	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	403	Soil	Other -Not Specified	14674	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
151-H-197	440	Soil	Other -Not Specified	5540	0-3	3			TAL Metals (no Hg)	Unknown	01
	440	Soil	Other -Not Specified	5540	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	441	Soil	Other -Not Specified	19519	0-3	1			TAL Metals (no Hg)	Unknown	01
	441	Soil	Other -Not Specified	19519	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	442	Soil	Other -Not Specified	15908	0-3	1			TAL Metals (no Hg)	Unknown	01
	442	Soil	Other -Not Specified	15908	0-3	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	320new	Soil	Other -Not	42490	0-1	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
0615700			Specified								
	320new	Soil	Other -Not Specified	42490	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5096210	112	Soil	House	38750	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	112	Soil	House	38750	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	112DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	112G	Soil	Garden	3676	0-12	3			TAL Metals (no Hg)	Unknown	01
	112G	Soil	Garden	3676	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	113low	Soil	Other -Not Specified	137311	0-1	1			TAL Metals (no Hg)	Unknown	01
	113low	Soil	Other -Not Specified	137311	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	113up	Soil	Other -Not Specified	20750	0-1	3			TAL Metals (no Hg)	Unknown	01
	113up	Soil	Other -Not Specified	20750	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5092600	106	Soil	House	12969	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	106	Soil	House	12969	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	106DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	107	Soil	Garden	1834	0-12	1			TAL Metals (no Hg)	Unknown	01
	107	Soil	Garden	1834	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	108	Soil	Garden	5392	0-12	3			TAL Metals (no Hg)	Unknown	01
	108	Soil	Garden	5392	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5704900	173	Soil	Beach	7772	0-6	3			TAL Metals (no Hg)	Unknown	01
	173	Soil	Beach	7772	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	172U	Soil	Other -Not Specified	7206	0-1	3			TAL Metals (no Hg)	Unknown	01
	172U	Soil	Other -Not Specified	7206	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
5078600	42	Soil	House	8346	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	42	Soil	House	8346	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	42	Soil	House	8346	0-1	1			**Replicate sample for property own**		
	42DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	42DL	Soil	Dripline		0-1	1			Replicate sample for property owner		
	44	Soil	Agriculture	112864	0-1	3			TAL Metals (no Hg)	Unknown	01
	44	Soil	Agriculture	112864	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	44 (tentative)	Soil	Agriculture	112864	0-1	1			Replicate sample for property owner		
	46	Soil	Other -Not Specified	125101	0-1	3			TAL Metals (no Hg)	Unknown	01
	46	Soil	Other -Not Specified	125101	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	47	Soil	Agriculture	64087	0-1	1			TAL Metals (no Hg)	Unknown	01
	47	Soil	Agriculture	64087	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1015	Soil	Garden	629	0-12	1			TAL Metals (no Hg)	Unknown	01
	1015	Soil	Garden	629	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1017	Soil	Garden	2318	0-1	3			TAL Metals (no Hg)	Unknown	01
	1017	Soil	Garden	2318	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1018	Soil	Garden	1562	0-12	3			TAL Metals (no Hg)	Unknown	01

Sampling Location	Decision Unit	Matrix	Rationale for Sampling	DU Size (sq. ft.)	Incremental Composite Sample		Deep Core Samples		Analytical Group	Concentration Level	Sampling SOP Reference (Reference Number from Worksheet#21)
					Sample Depth (in)	No. of Samples	Sample Depth (in)	No. of Samples			
	1018	Soil	Garden	1562	0-12	1			Pb and As bioaccessibility (IVBA) [1]		
	1018	Soil	Garden	1562	0-12	1			Replicate sample for property owner	Unknown	01
	1000	Soil	Beach	24885	0-6	3			TAL Metals (no Hg)	Unknown	01
5704920	1000	Soil	Beach	24885	0-6	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	72	Soil	Garden	3889	0-12	3			TAL Metals (no Hg)	Unknown	01
5705035	72	Soil	Garden	3889	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	70	Soil	House	36990	0-1	3	1-6	5	TAL Metals (no Hg)	Unknown	01, 02
	70	Soil	House	36990	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	70DL	Soil	Dripline		0-1	1			TAL Metals (no Hg)	Unknown	01
	71	Soil	Garden	5311	0-12	3			TAL Metals (no Hg)	Unknown	01
	71	Soil	Garden	5311	0-12	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	1001	Soil	Other -Not Specified	26439	0-1	3			TAL Metals (no Hg)	Unknown	01
	1001	Soil	Other -Not Specified	26439	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	72M	Soil	Agriculture	14178	0-1	3			TAL Metals (no Hg)	Unknown	01
	72M	Soil	Agriculture	14178	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01
	72U	Soil	Other -Not Specified	19829	0-1	1			TAL Metals (no Hg)	Unknown	01
	72U	Soil	Other -Not Specified	19829	0-1	1			Pb and As bioaccessibility (IVBA) [1]	Unknown	01

[1] If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. On a property basis, if more than one IC sample for a give DU type (e.g., maintained area DU) exceeds one of the concentration criteria, the IVBA assay will be run using the one sample that has the maximum Pb concentration for that type of DU. To be clear, a maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property.

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[2] The property owner has requested their property not be sampled.

QAPP Worksheet #19: Analytical SOP Requirements Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference[1]	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
Soil	TAL Metals (no Hg)	Low	MET-3050B.r13 MET-6020.r15 MET-ICP.r24 IC Sample Preparation and Subsampling ICP-AES 6010C Prep method 3050B	2 g [2]	1 – 2 g. wide-mouth clear polyethylene jar	None	6 months (others)
Soil	TAL Metals (no Hg)	Low	MET-3050B.r13 MET-6020.r15 MET-ICP.r24 IC Sample Preparation and Subsampling ICP-AES 6010C Prep method 3050B	8 g [3]	4 – 2 g. wide-mouth clear polyethylene jar	None	6 months (others)
Soil	IVBA	Low	MET-3050B.r13 MET-6020.r15 MET-BIOACC.r1	5 g	NA – Generated in Laboratory	None	5 months
Water (Field Equipment Blank)	TAL Metals (no Hg)	Low	MET-DIG.r15 MET-6020.r15 MET-ICP.r24	500 mL	500 mL poly;	pH<2 w/HNO_3	6 months (others)

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (see Worksheet #23).
[2] Regular sample
[3] Sample designated for lab QC

QAPP Worksheet #20: Field Quality Control Sample Summary Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Replicate Pairs	No. of Inorganic Matrix Spikes	No. of Field Blanks	No. of Equip. Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Soil – IC samples	TAL Metals	Low	MET-3050B.r13 MET-6020.r15 MET-ICP.r24	251 primary	330 (322 replicates for selected DUs, see WS#18; 8 replicates for property owners parcels 5706200 and 5078600)	5% (29 samples, collected at lab after processing)	NA	1 per day per field team	NA	581 (primary and replicate samples), plus 29 MS/MSDs
Soil – IC samples	TAL Metals	Low	MET-3050B.r13 MET-6020.r15 MET-ICP.r24	15% lab split samples for EPA						86 (15% of 573 primary and replicate samples)
Soil – Discrete Samples 1-6”	TAL Metals	Low	MET-3050B.r13 MET-6020.r15 MET-ICP.r24	370 primary	15% field duplicates (56 samples) 15% field splits for EPA lab (56 samples)	5% (19 samples)	NA	NA	NA	370 primary samples, plus 56 field duplicates, 56 EPA splits, and 19 MS/MSDs

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations	No. of Field Replicate Pairs	No. of Inorganic Matrix Spikes	No. of Field Blanks	No. of Equip. Blanks	No. of Proficiency Testing Samples	Total No. of Samples to Lab
Water – Rinsate Blanks	TAL Metals	Low	MET-DIG.r15 MET-6020.r15 MET-ICP.r24					1 per day per field team		
Soil	IVBA	Unknown		Maximum of 207 primary	15% duplicates (obtained after lab processing)		NA	NA	NA	Up to 207 primary samples, plus 15% duplicates

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

QAPP Worksheet #21: Project Sampling SOP References Table

☐ Worksheet Not Applicable (State Reason)

Reference Number	Title, Revision Date, and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Check if yes)	Comments
01	SOP 3 -- Incremental Composite Sample Collection	CH2MHill	Multi-increment sampling tool (MIST)	☒	See Attachment C, Field Sampling Plan for more information
02	SOP 4 -- Discrete Soil Sample Collection	CH2MHill	Hand tools	☒	See Attachment C, Field Sampling Plan for more information
03	Global Positioning Satellite System (GPS) Surveying	CH2MHill	Trimble	☒	See Attachment C, Field Sampling Plan for more information
04	SOP 1 – Positioning at Soil Sample Collection Areas	CH2MHill	Trimble		See Attachment C, Field Sampling Plan for more information
05	SOP 2 – Underground Utility Location	CH2MHill			See Attachment C, Field Sampling Plan for more information
06	SOP 5 – Field Determination of Incremental Sample Locations	CH2MHill	Trimble		See Attachment C, Field Sampling Plan for more information

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
GPS	None	Keep batteries charged	Field Performance	Visual Inspection	At time of use	Receiving GPS satellite	Send to manufacturer for repair and calibration	CH2MHill	03

[1]Specify the appropriate reference letter or number from the Project Sampling SOP References table (see Worksheet #21)

QAPP Worksheet #23: Analytical SOP References Table

☐ Worksheet Not Applicable (State Reason)

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
MET-3050B.r13	MET-3050B.r13; Metals Digestion	Definitive	TAL Metals (Soil)	ICP/MS; ICP/AES	ALS/Kelso	☐
MET-6020.r15	MET-6020.r15; Determination of Metals and Trace Element by ICP/MS					
MET-ICP.r24	MET-ICP.r24; Determination of Metals and Trace Element by ICP/AES					
MET-3050B.r13	MET-DIG.r15; Metals Digestion	Definitive	TAL Metals (Water)	ICP/MS; ICP/AES	ALS/Kelso	☐
MET-6020.r15	MET-6020.r15; Determination of Metals and Trace Element by ICP/MS					
MET-ICP.r24	MET-ICP.r24; Determination of Metals and Trace Element by ICP/AES					

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
GEN-SUBS.r5	GEN-SUBS.r5; Sub-sampling and Compositing of Samples	Definitive	TAL Metals	Sieve, Balance	ALS/Kelso	☐
MET-BIOACC.r1	MET-BIOACC.r1; Bioaccessibility of Metals in Soils and Waste	Definitive	IVBA	MET-BIOACC.r1; Bioaccessibility of Metals in Soils and Waste	ALS/Kelso	

QAPP Worksheet #24: Analytical Instrument Calibration Table

☐ Worksheet Not Applicable (State Reason)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
ICP-AES EPA Method 6010C	Establish IDLs	Every 3 months	In accordance with manufacturer's recommendation or lab SOP.	Notify the manufacturer if problem occurs.	Certified instrument technician	MET-ICP
	Calibrate using LLICV at MRL	Daily prior to sample analysis	±30% of the true value	Identify and correct problem then recalibrate if necessary.	Lab Manager/Analyst or certified instrument technician	
	Establish linear dynamic range	Once every 6 months or when the system is repaired	The calculated value should be within ± 10% of the true value.	Correct problem then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	
	Run interference check solution (ICS)	At the beginning of analytical run	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Correct problem then repeat the calibration process or use internal standards to eliminate the problem.	Lab Manager/Analyst or certified instrument technician	
	Run second source calibration verification (ICV)	Once after standard calibration	±10% of its true value.	Correct problem then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	
	Run CCV	Once every 10 samples	±10% of its true value.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
	Run CCB	Once every 10 samples	Less than the established lower limit of quantitation for any desired target analyte.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	
ICP-MS EPA Method 6020A	IDLs	Every 3 months	In accordance with manufacturer's recommendation or laboratory SOP.	Notify the manufacturer if problem occurs.	Lab Manager/Analyst or certified instrument technician	MET-6020
	Tuning	Prior to initial calibration	Mass calibration ≤0.1 amu from true value; Resolution <0.9 amu full width at 10% peak height; For stability, RSD ≤5% for at least four replicate analyses.	Correct problem, then repeat tuning.	Lab Manager/Analyst or certified instrument technician	
	IC using either single or multi-point standard calibration	Daily prior to analysis of sample	Correlation coefficient ≥0.998.	Correct problem, then repeat initial calibration.	Lab Manager/Analyst or certified instrument technician	
	Linear dynamic range or high level check standard	Once every 6 months or when the system is repaired	The calculated value should be within ±10% of the true values.	Correct problem, then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
	Interference check solution	At the beginning of each analytical run	ICS-A: Absolute value of concentration for all non-spiked analytes <2 × MDL (unless they are a verified trace impurity from one of the spiked analytes). ICS-AB: Within ±20% of its true value.	Correct problem, then repeat the calibration process or use internal standards to eliminate the problem.	Lab Manager/Analyst or certified instrument technician	
	Second-source ICV	Once after standard calibration	Within ±10% of its true value.	Correct problem, then repeat the calibration process.	Lab Manager/Analyst or certified instrument technician	
	Run lower limit of quantitation limit	Once after ICV	Within ±20% of its true value.	Qualify the data as estimated values.	Lab Manager/Analyst or certified instrument technician	
	Internal standards	Every analysis	Internal standard intensity within 30–120% of intensity of the internal standard in the initial calibration.	Terminate the analysis, correct the problem, recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	
	CCV	Following IC, after every 10 samples and the end of the sequence	±10% of its true value.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	
	CCB	After IC, after CCV calibration, after every 10 samples and the end of the sequence	Less than 1/2 reporting limit.	Terminate analysis; recalibrate and reanalyze the samples.	Lab Manager/Analyst or certified instrument technician	

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

☐ Worksheet Not Applicable (State Reason)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
ICP/MS	Clean the instrument. Change gas, gas purifier, and tubing. Dispose of wastes.	Check instrument connections, gas flow, pressure, ion mass, and detector sensitivity.	Visually inspect for wear or damage; check indicators from computer controls	Daily or when needed	Intensity of spectrum is within manufacturer's recommendation and mass calibration difference is < 0.1 amu from the true value	Call for maintenance service	Analyst or certified instrument technician	QAM App E Analytical SOP MET-6020
ICP/AES	Check argon dewar. Replace peristaltic pump tubing. Empty waste container. Clean nebulizer, spray chamber, and torch. Replace water filter. Replace vacuum air filters.	N/A	Visually inspect	Daily Daily Weekly Every 2 wks Quarterly Monthly	In accordance with manufacturer's recommendation or lab SOP	Perform activity	Analyst or certified instrument technician	QAM App E Analytical SOP MET-ICP

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

QAPP Worksheet #26: Sample Handling System

☐ Worksheet Not Applicable (State Reason)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Reuben Greer/CH2MHILL
Sample Packaging (Personnel/Organization): Reuben Greer/CH2MHILL
Coordination of Shipment (Personnel/Organization): Brittany Prentice/CH2MHILL
Type of Shipment/Carrier: FEDEX or courier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Les Kennedy/ALS
Sample Custody and Storage (Personnel/Organization): Les Kennedy/ALS
Sample Preparation (Personnel/Organization): Lance Jording/ALS
Sample Determinative Analysis (Personnel/Organization): Jeff Coronado/ALS
SAMPLE ARCHIVING
Field Sample Storage (no. of days from sample collection): Les Kennedy/ALS
Sample Extract/Digestate Storage (no. of days from extraction/digestion): Lance Jording/ALS
Biological Sample Storage (no. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Les Kennedy/ALS
Number of Days from Analysis: All samples will be archived until EPA notifies the laboratory that they are no longer needed

QAPP Worksheet #27: Sample Custody Requirements

☐ Worksheet Not Applicable (State Reason)

Field Sample Custody Procedures (sample collection, packaging, shipment, delivery to laboratory):
Field sample collection and custody procedures are detailed in the Field Sampling Plan (Attachment C). Scribe software will be used to document and manage sample custody, location information, and field data measurements associated with any samples submitted for chemical analysis.

Scribe is a software tool developed by the USEPA's ERT to assist in the process of managing environmental data. Scribe captures sampling, observational, and monitoring field data for sampling. Scribe can import electronic data deliverable (EDD) files including analytical lab result EDD files and sampling location EDD data files.

Scribe outputs include labels for collected samples, chain of custody generation and analytical lab result data reports. Scribe provides a flexible user interface to manage, query and view all this information.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): See Worksheet #26 and Field Sampling Plan

Sample Identification Procedures:
Each IC and discrete sample will be assigned a unique sample identification number that includes the study name, medium, sample location (i.e., DU number), sample type, and sample type number. The unique sample number will be entered in the field notebook, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities. The following sample numbering convention will be used for normal and replicate samples:

Study Prefix – Medium – Location – Sample Type Sample Number

Explanation:

Study Prefix: 2014R = 2014 Residential Soil Study

Medium: SS = Surface Soil

Location: DU number (unique numbers assigned to individual properties)

Sample Type: IC = incremental composite

D = discrete

Sample Type Number: 01 = primary sample

02 = first replicate sample (used for both discrete and IC samples)

03 = second replicate sample (only used for IC samples)

COC Procedures:
COC procedures are detailed in the Field Sampling Plan (Attachment C). Scribe software (described above) will be used to document and manage sample custody.

QAPP Worksheet #28: Quality Control (QC) Samples Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low
Sampling SOP	01, 02
Analytical Method/ SOP Reference	MET-DIG; MET-6020; MET-ICP
Sampler's Name	TBD
Field Sampling Organization	CH2MHill
Analytical Organization	ALS-, Kelso
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Matrix Spike/Duplicate Matrix Spike (MS/MSD)	One per matrix per analytical method for each batch of at most 20 samples per site.	%R = 75-125 RPD ±20%	Examine the project-specific DQOs. Notify lab QA Officer and Project Chemist of additional measures to be taken.	Analyst Project Chemist	Accuracy/ Precision	For matrix evaluation, use LCS acceptance criteria.
Field Replicates	Each Sample	NS	Examine incremental sampling records	Analyst Project Chemist	Precision	RSD $\leq$ 30
Laboratory Control Sample (LCS)	Each group of 20 or less prior or analysis of samples.	As per vendor's certificate of analysis	Correct problem, then re-digest and reanalyze the LCS and all samples in the associated batch.	Analyst Project Chemist	Accuracy	As per vendor's certificate of analysis

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low
Sampling SOP	01, 02
Analytical Method/ SOP Reference	MET-DIG; MET-6020; MET-ICP
Sampler's Name	TBD
Field Sampling Organization	CH2MHill
Analytical Organization	ALS-, Kelso
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank (MB)	Each time samples are extracted.	No analytes detected > 1/2 MRL.	Correct problem, then re-digest and reanalyze the MB and all samples in the associated batch.	Analyst Project Chemist	Accuracy/Bias (Contamination)	No analytes detected > 1/2 MRL
Lab Replicates	10% of all IC samples	NS	Report data, document in final deliverable	TL	Precision	< 20% RSD
Field Duplicate	15% of all samples	NS	As per Regional Criteria	TL	Precision	As per Regional Criteria
Split Samples	15% of all samples	NS	As per Regional Criteria	EPA R10 MEL	Precision/Error	As per Regional Criteria
Field Equipment Blank	1 per day of sampling	NS	Document in final deliverable	TL	Accuracy/Bias (Contamination)	<MRL
Sieve Blank	1 per 20 samples	NS	Qualify data	Analyst	Accuracy/Bias (Contamination)	<MRL
Serial Dilution	1 per 20 samples	%D ±10	Run method of standard additions or qualify data	Analyst	Accuracy/Bias	%D ±10
Post Spike	1 per 20 samples	%R = 85-115	Run serial dilution	Analyst	Accuracy/Bias	%R = 85-115

QAPP Worksheet #29: Project Documents and Records Table

☐ Worksheet Not Applicable (State Reason)

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
• Incremental sample collection forms • Discrete sample collection forms • Field logbooks • Sample management software (Scribe) • Chains of custody • Sample labels • Custody seals • Sample tracking log • Field deviation form • Copies of signed access agreements • Property information (electronic database), sample location coordinates, and maps	•	• Instrument run logs • Sample digestion logs • Preventative maintenance logs • Instrument printouts • Internal COC records • Temperature logs • Standard receipt logs • Standard prep logs • Data reduction/data review records • Analytical results • Incremental sampling records (laboratory)	• Data assessment forms	• Analytical reports • Validation reports • Field Data Summary Report

QAPP Worksheet #30: Analytical Services Table

☐ Worksheet Not Applicable (State Reason)

Matrix	Analytical Group	Concentration Level	Sample Location/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number)	Backup Laboratory/Organization (name and address, contact person and telephone number)
Soil	TAL Metals	Low	See Worksheet #18	MET-DIG; MET-6020; MET-ICP; Method 6010C Prep method 3050B	28 days	Jeff Christian ALS Environmental 1317 South 13th Avenue Kelso, WA 98626 360-501-3316	Jeff Coronado ALS Environmental 1317 South 13th Avenue Kelso, WA 98626 360-501-3330

QAPP Worksheet #31: Planned Project Assessments Table

☐ Worksheet Not Applicable (State Reason)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions (title and organizational affiliation)
Readiness Review	Before mobilizing to the field	Internal	CH2MHILL	Health and Safety Manager, Quality Manager, Project Delivery Manager, Environmental Compliance Manager	Project Manager Field Team Manager	Project Manager Field Team Manager	Project Manager Field Team Manager
Field Safety Audit	Once during sampling	Internal	CH2MHILL	Health and Safety Manager	Project Manager Field Team Manager	Project Manager Field Team Manager	Project Manager Field Team Manager
Data Quality Review	Following sample analysis and validation	External	EPA	EPA QAO	Laboratory Manager Data Validator	EPA QAO Teck Project Chemist	EPA QAO

QAPP Worksheet #32: Assessment Findings and Corrective Action Responses

☐ Worksheet Not Applicable (State Reason)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Peer Review	Directly onto the deliverable	Bill Thayer, SERAS TL	Task dependent	Comments made directly onto the deliverable	Bill Thayer, SERAS TL	Prior to deliverable due date
Readiness Review	Readiness Review Checklist	CH2MHILL Project Manager	Immendiately	Comments made directly on checklist	CH2MHILL Project Manager CH2MHILL Field Team Manager	Prior to onset of field work
Field Observations/ Deviations from QAPP	Logbook and Field Change Form	CH2MHILL Project Manager EPA Project Manager	Immediately	Field Change Form	CH2MHILL Project Manager EPA Project Manager	Within 24 hours of change
Health and Safety	Audit Report	CH2MHILL Project Manager CH2MHILL Field Team Manager	Immediately	Comments made directly on Audit Report	CH2MHILL Health and Safety Manager	Within 24 hours
Lab Performance Audits	Audit Report	Laboratory	Within 30 days	Corrective Action Plan	Regulatory Agency	Within 30 days

QAPP Worksheet #33: QA Management Reports Table

☐ Worksheet Not Applicable (State Reason)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Monthly Progress Report	Monthly	3rd Friday of the month following performance period	Project Manager, EPA R10	EPA Project Manager

QAPP Worksheet #34: Verification (Step I) Process Table

☐ Worksheet Not Applicable (State Reason)

Verification Input	Description	Internal/ External	Responsible for Verification (name, organization)
COC Record	Reviewed by Field Sampling Personnel in field and Data Validation Group prior to final analytical report preparation	Internal	EPA Contractor TL EPA Contractor QA/QC Group
Laboratory Data Package	Reviewed for measurement performance criteria	Internal/External	EPA Contractor, Laboratory Personnel
Analytical Report	Reviewed for completeness	Internal	Peer Review Team
Analytical Report	An S4 level data validation review will be performed prior to data release	Internal	R10 QA
Field Sampling Report	Reviewed for completeness	External	EPA Contractor Peer Review Team
Summary Report	Reviewed for completeness	Internal	Peer Review Team
Completeness Check	Review of Planning Documents, Analytical Data Package, Sampling Documents and External Reports, as applicable, using the UFP-QAPP Checklist	Internal	EPA Contractor TL EPA Contractor QA/QC Group

QAPP Worksheet #35: Validation (Steps IIa and IIb) Process Table

☐ Worksheet Not Applicable (State Reason)

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SOPs	Ensure that the sampling methods/procedures outlined in QAPP were followed, and that any deviations were noted and that field change orders are approved and followed.	EPA Contractor TL and ERT WAM
IIb	SOPs	Determine potential impacts from noted deviations and approved field changes, in regard to practical quantitation objectives (PQOs).	EPA Contractor QA/QC Group
IIa	Chains of custody	Examine COC forms against QAPP and laboratory contract requirements (e.g., analytical methods, sample identification, etc.).	EPA Contractor TL, EPA Contractor QA/QC Group
IIa	Laboratory data package	Examine packages against QAPP and laboratory contract requirements, and against COC forms (e.g., holding times, sample handling, analytical methods, sample identification, data qualifiers, QC samples, etc.).	EPA Contractor and Outside Laboratory Personnel
IIb	Laboratory data package	Determine potential impacts from noted/approved deviations, in regard to PQOs. Examples include practical quantitation limit and QC sample limits (precision/accuracy).	EPA Contractor QA/QC Group

QAPP Worksheet #36: Validation (Steps IIa and IIb) Summary Table

☐ Worksheet Not Applicable (State Reason)

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa/IIb	Soil	TAL Metals	Low	US EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, January 2010	Chemistry Quality Assurance Personnel, Environmental Standards, Inc.
IIa/IIb	Soil	IVBA	Low	US EPA Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil, April 2012 http://www.epa.gov/superfund/bioavailability/pdfs/EPA_Pb_IVBA_SOP_040412_FINAL_SRC.pdf	Chemistry Quality Assurance Personnel, Environmental Standards, Inc.

QAPP Worksheet #37: Usability Assessment

☐ Worksheet Not Applicable (State Reason)

Summarize the usability assessment process and all procedures, including interim steps and any statistical, equations, and computer algorithms that will be used:
Describe the evaluative procedures used to assess overall measurement error associated with the project:
Identify the personnel responsible for performing the usability assessment:
Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they can identify trends, relationships (correlations), and anomalies:

The following items will be assessed and conclusions drawn based on the results:

Holding Time: All sample data will be checked to verify that both sample preparation and analysis were performed within the required method holding time.

Calibration: Data associated with instrument calibration and verification of calibration will be reviewed to confirm that all data were generated using properly calibrated instrumentation.

Accuracy/Bias Contamination: Results for all field blanks, laboratory method blanks, and instrument calibration blanks will be checked against performance criteria specified in Worksheet #28; results for analytes that exceed criteria will be identified and the impact on field sample data will be assessed. Data will be summarized by type of blank.

Accuracy/Bias Overall: Reported values of laboratory control samples, performance samples, and matrix spikes will be evaluated against the spiked or certified concentration and the percent recovery will be calculated and compared to the criteria specified in Worksheet #28. The percent recovery information will be used to assess the bias associated with the analysis. Recovery for matrix spikes in conjunction with the recovery reported for performance samples and laboratory control samples will provide information on the impact of the sample matrix on specific analyses. Average recoveries will be calculated and reported by analyte for each type of QC sample.

Precision: Results of the RPD will be calculated for each analyte in laboratory. These RPDs will be checked against measurement performance criteria presented on Worksheet #28; RPDs exceeding the stated criteria will be identified.

Sensitivity: Reporting limits will be checked against the criteria presented on Worksheet #15 and quantitation limits presented on Worksheet #15.

Representativeness: A review of field records will be used to confirm that sample collection and handling was performed in a manner that conformed to the designated SOP. Similarly laboratory preparation procedures will be reviewed during validation to ensure that a representative sample was selected for analysis. Any deviations or modifications to field or laboratory procedures which might impact the representativeness of the sample will be discussed in the project final report.

Comparability: The sampling and analytical procedures which will be used in this program have been selected to ensure that the resulting data will be comparable to data from similar programs conducted

previously or which will be conducted in the future. Any modifications or deviations from stated procedures which might impact data comparability will be addressed in the project final report.

Completeness: Completeness for the analytical program will be calculated as the number of data points that are accepted as usable based on the validation process divided by the total number of data points for each analysis.

ATTACHMENT A: DATA QUALITY OBJECTIVES

DQOs define the type, quality, quantity, purpose, and intended uses of data to be collected. In brief, the DQO process typically follows a seven-step procedure, as follows:

1. State the Problem

Historic emissions from the Trail smelting facility in Trail, BC have included metal-enriched particulates and aerosols. These airborne particles were deposited at varying distances from the smelter and became incorporated into the soil horizon. Various studies and soil sampling activities conducted in the Columbia River valley corridor south of the U.S. – Canada border (Hart-Crowser, 2013; Shannon & Wilson, Inc., 2011) have demonstrated the presence of elevated[4] heavy metal concentrations in the upper horizons of minimally disturbed soils. Elevated metal concentrations also have been mapped in surface soils collected by Canadian investigators between Trail, BC and the U.S. – Canada border (Goodarzi et al., 2002, 2006; Sanei and Goodarzi, 2006).

A 2007 Cantox Environmental Inc. memorandum to Teck Metals Ltd titled *Potential Chemicals of Concern for Terrestrial Wildlife in the Trail Wide-area Site ERA* states that "metal concentrations of antimony, arsenic, cadmium, copper, lead, mercury and zinc in soil are related to past smelter activities." The highest metal concentrations within soils in the UCR Study Area in areas close to the U.S. – Canada border appear to occur primarily along the side slopes of the Columbia River valley and its associated tributaries (Hart-Crowser, 2013).

The areal extent of contamination for the UCR Study Area has not been fully delineated; EPCs for WA state residents living within the UCR Study Area, including gardeners and Tribal members, need to be refined. EPA is planning a focused rural residential investigation of the northernmost reaches of the UCR Study Area (north of the town of Northport to the U.S.-Canada border) to assess potential risks to existing residents from exposure to metals in soils. This residential soil investigation will be coordinated with and complement other soil sampling planned for the Upper Columbia RI/FS Soil Investigation (EPA Technical Team for the UCR RI/FS 2012; Exponent et al., 2013).

2. Identify the Goal of the Study

Sample surface soil in locations where there is a high potential for exposure by residents, especially young children. Young children and gardeners are likely to be exposed to possible metal exposure via direct soil ingestion.

Principal Human Health Risk Study Question:

Do Pb and As concentrations (and possibly other TAL metals) in the fine-grained fraction of sediment and soils[5] from rural residential parcels pose an unacceptable risk to human health, particularly to children who live within the UCR Study Area (see Figure 1)?

[4]The term "elevated" refers to concentrations that exceed final RBCs presented in Attachment E of this QAPP.
[5]For soils, the particle size in question is <150 μm; for beach sand, the particle size in question is <250 μm.

3. Identify Information Inputs

- EPA Technical Team Level of Effort (LOE) for Sampling and Analysis of Soil in the Upper Columbia River Basin (Soil LOE) (EPA Technical Team for the Upper Columbia River RI/FS, 2012)
- DRAFT - Upper Columbia River Soil Study Quality Assurance Project Plan (Exponent et al., 2013)
- Upper Columbia River Upland Soil Sampling Study, Stevens County, Washington. Seattle, WA, Prepared by Hart Crowser for the Washington State Department of Ecology (Hart Crowser, 2013).
- Soil Remediation, Boundary Land Port of Entry, Stevens County, Washington (Shannon & Wilson, Inc., 2011).
- Land use data from county tax assessor maps and the Confederated Tribes of the Colville Indian Reservation (CCT)
- Proximity relative to Trail, BC, the Le Roi smelter location, and the Columbia River
- Assistance from CCT, local government, community groups, school district, property owners, and residents to identify residential land use and obtain access to target properties
- Upper Columbia River Residential Soil Study, Washington State (SRC, Inc., 2014)

Human health risk-based concentrations (RBCs) for Pb and As (see Attachment D of the QAPP for risk-based concentrations for TAL metals):

- 400 mg/kg Pb
- 20 mg/kg As (WA state unrestricted land use concentration; ECY, 2007)

Data to be collected will incorporate the following objectives and considerations:

- Inferred exposure areas based on communications with residents, accessibility of soil, gardens, agricultural land, or other visual information at each property.
- The target particle size for soil is <150 µm representative of dermal adherence as a proxy for inadvertent soil ingestion (Ruby and Lowney, 2012); the target particle size for beach sediment is <250 µm, representative of dermal adherence of wet sediment (Kissel et al. 1996).
- Estimates of bioavailability based on *in vitro* bioaccessibility for lead and arsenic (U.S. EPA, 2007)

4. Define the Boundaries (in space and time) of the Study

Available soils data indicate that transport of the metals from the Trail smelter into the UCR Study Area was most concentrated along and adjacent to the northern end of the Columbia River valley. The soil data collected by the ECY in 2012 documented maximum surface soil Pb and As concentrations of 1,920 and 56 mg/kg, respectively, from minimally disturbed soils on non-residential properties. In addition to the Trail BC smelter, the smaller historic Le Roi smelter operated in Northport and was located approximately 7 air miles south of the U.S. – Canada border. Stack emissions from Le Roi represent an additional source of metals. Residents within incorporated Northport previously participated in risk reduction measures in 2004 and 2005 as part of an interim emergency EPA Removal Action.

The initial focus is on residential properties located north of Northport and south of the U.S. – Canada border, within the Columbia River valley (UCR Study Area; see Figure 1)

Study boundaries will be reevaluated as results are available, including locations, frequency, and magnitude of soil concentrations above RBCs.

Potential to segregate portions of each property for evaluation and potential remediation, depending upon size, access, known presence of imported fill, historical activities such as tilling, topography, and other features will inform DU design.

The target particle size is <150 µm representative of dermal adherence as a proxy for inadvertent soil ingestion (Ruby and Lowney, 2012). The <250 µm particle size fraction will be used for beach areas.

The IC sampling depth will be based on the soil depth interval that people are most likely to come into contact with and will vary by DU. The 0-1" depth interval for soil is the primary focus of this study because the top inch of soil best represents current exposure (EPA, 1989, 1996) and will provide data that is recommended for use with the IEUBK model (EPA, 2003). The sampling depth for gardens will be the tilled depth (generally 0-12"); the sampling depth for beaches will be 0-6." In a subset of DUs, where the IC sampling depth is 0-1", additional samples will be collected from the 1-6" depth interval to provide additional information on the vertical nature and extent of contamination near houses or where exposure is expected to be highest based on interviews and site visits.

Samples will be collected during a limited seasonal period when climatic conditions would likely exclude the presence of snow on the ground or frozen ground (typically April through October).

5. Develop the Analytic Approach

Surface soil samples will be collected following an IC sampling design from property-specific DUs. These DUs will be identified and defined based on potential exposure areas that are observed at each residential property. Thus, a residential parcel may involve the establishment of one or more DUs depending on the size, features, and usage patterns associated with the property.

Each incremental sample will consist of 30 increments. The increments for each sample will be collected using a systematic grid to provide uniform spatial coverage (ITRC, 2012). Drip lines of residences and other large painted structures (e.g., barns) will be sampled. Drip lines are being sampled as they may represent a combination of aerial deposition and lead-based paint contribution.

Samples collected from the 1-6" depth interval to provide additional information on the vertical nature and extent of contamination will be located in a subset of DUs that are "… most likely to cause high exposure to residents, (e.g., from yards or other decision units receiving high use or likely to undergo disturbance)." (EPA, 2014). DUs selected for additional sampling will be those where the primary sampling depth is 0-1" (e.g., not gardens or beaches). Five grab samples will be collected from the 1-6" depth interval in each of these DUs at a frequency of no more than one DU per parcel.

Areas near roadways and railways will be avoided to prevent sampling soil that may be contaminated by non-air sources; a 50-foot buffer in either direction from the center line of these features was established. TAL metals (no Hg) and Pb and As bioaccessibility will be measured. TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

6. Specify Performance or Acceptance Criteria

This will be detailed in the sampling plan.

7. Develop the Detailed Plan for Obtaining Data

This will be detailed in the sampling plan.

ATTACHMENT B: SAMPLE LOCATIONS AND DECISION UNITS

Residential Property

Template A

- Property: > 5 acres
- Play and/or Garden Area Present

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)
- 1 DU for Garden
- 1 DU for Play Area

Template B

- Property: > 5 acres
- Play and/or Garden Area **NOT** Present

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)

Template C

- Property: < 5 acres
- Play and/or Garden Area Present

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU for the remaining acreage of the property where use is indicated
- 1 DU for Garden
- 1 DU for Play Area

Template D

- Property: < 5 acres
- Play and/or Garden Area **NOT** Present

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU for the remaining acreage of the property where use is indicated

Template E

- Property: > 5 acres
- Agricultural land Present
- Animal Pens/Riding Areas Present

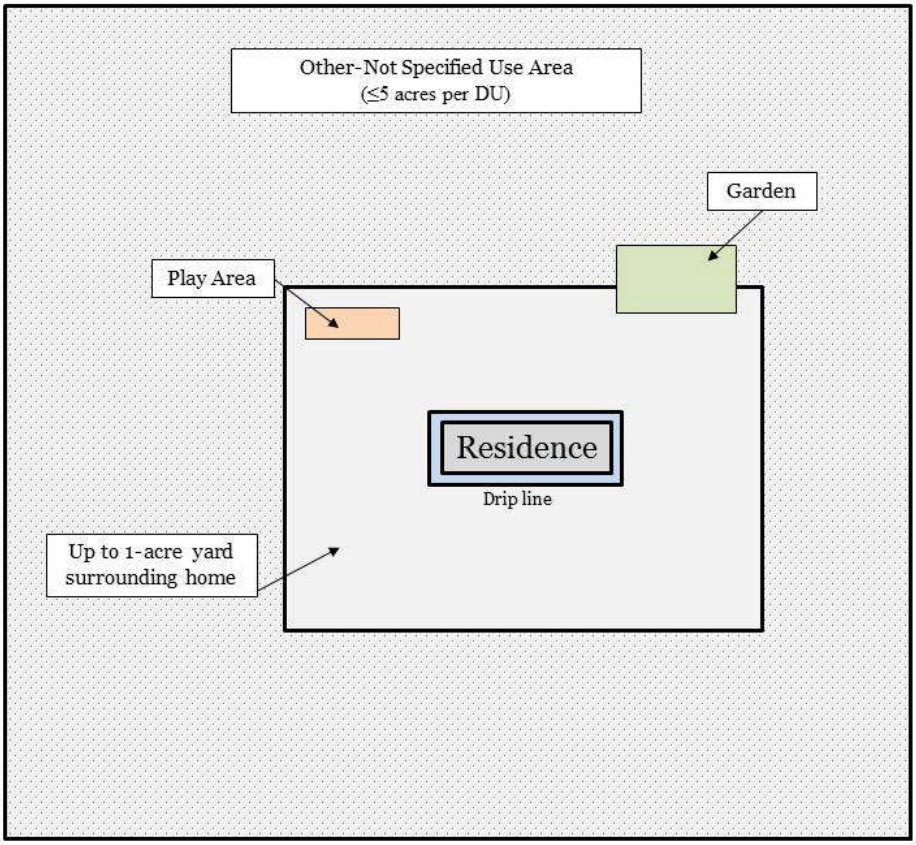
Decision Units

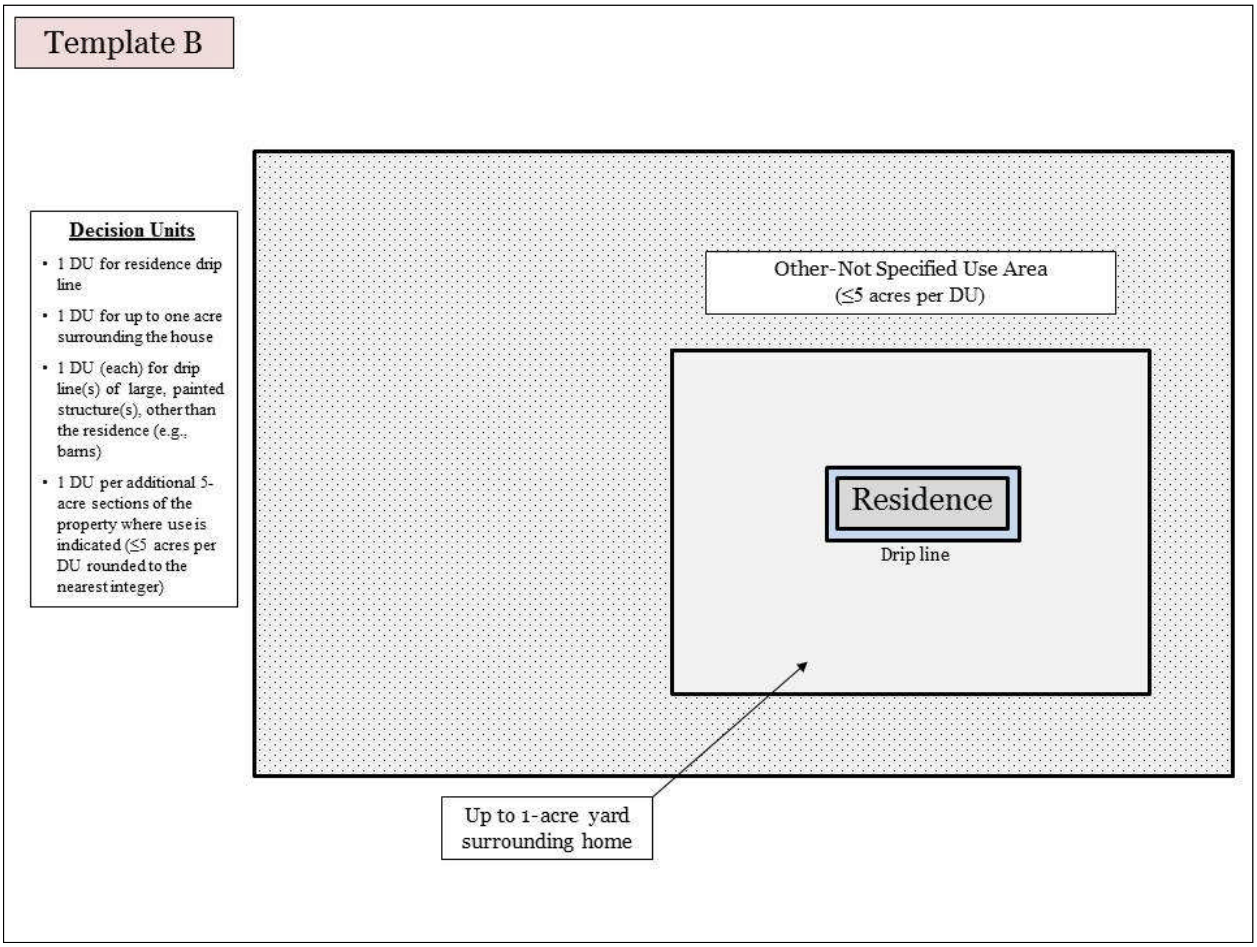
- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)
- 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)

Template A

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)
- 1 DU for Garden
- 1 DU for Play Area

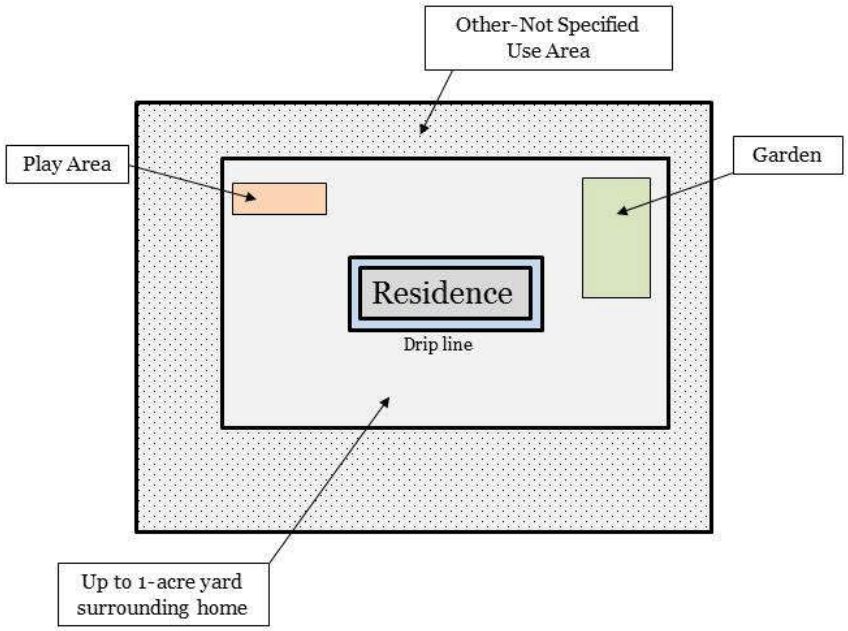


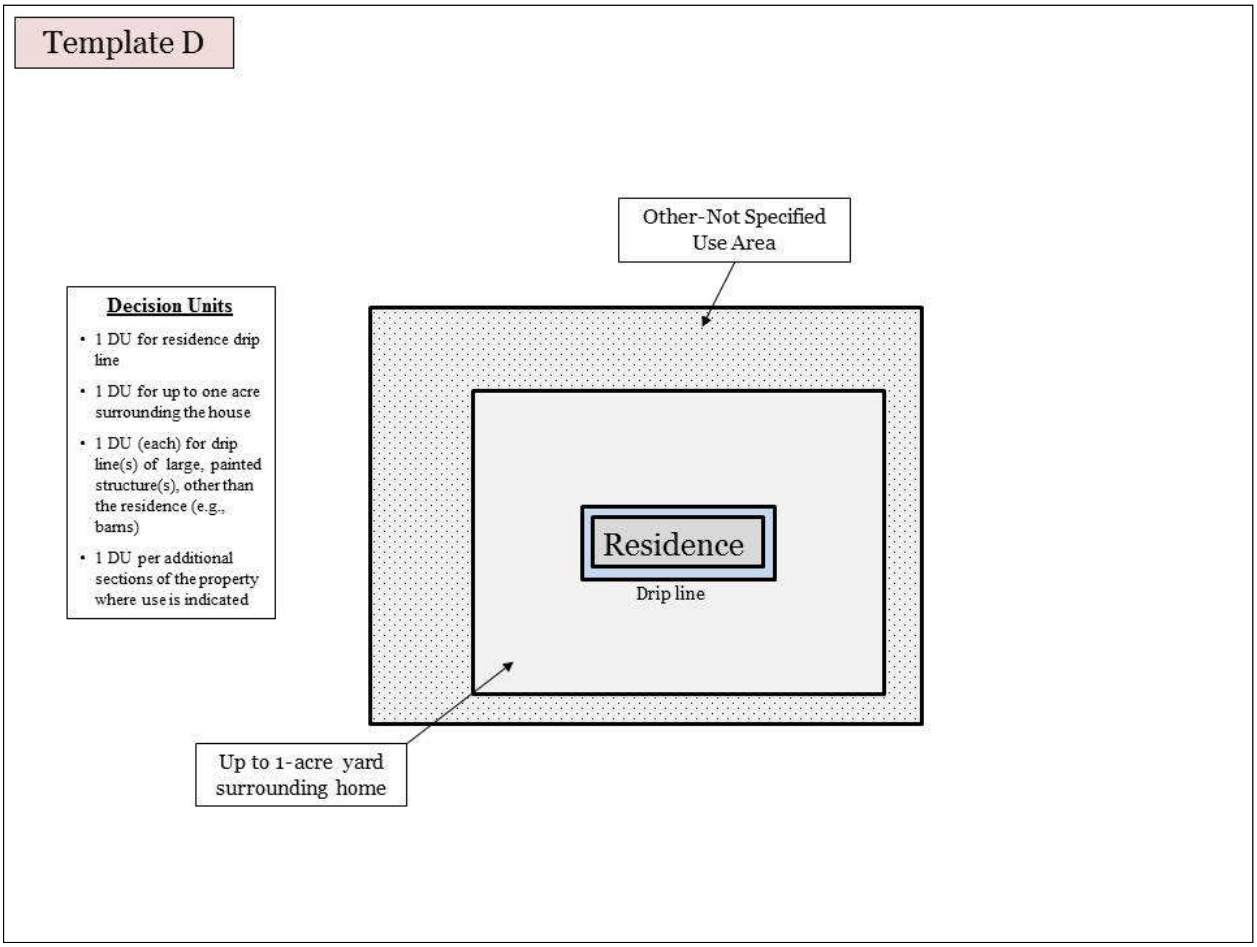

Template B
Decision Units
• 1 DU for residence drip line
• 1 DU for up to one acre surrounding the house
• 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
• 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)
Other-Not Specified Use Area
(≤5 acres per DU)
Residence
Drip line
Up to 1-acre yard surrounding home

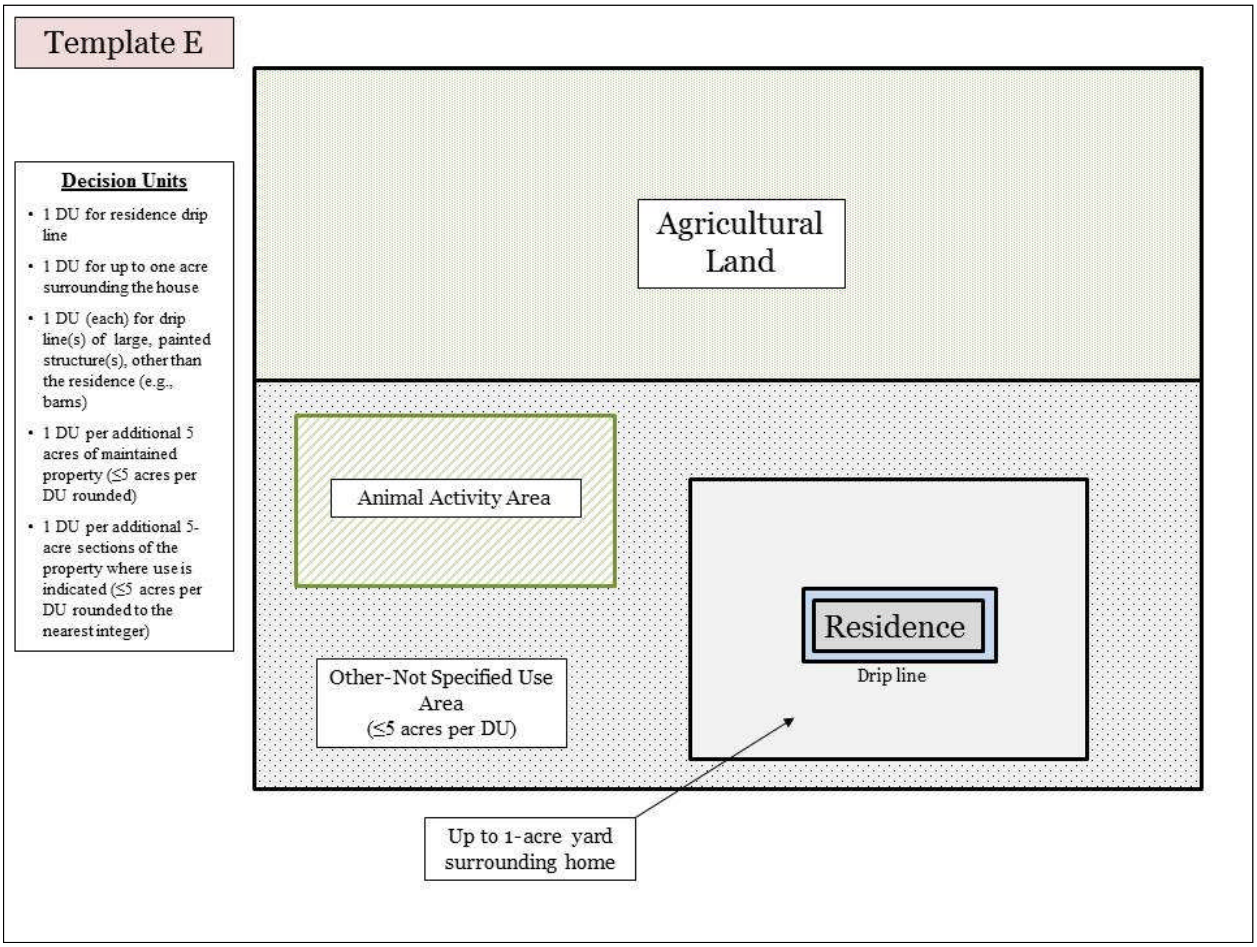
Template C

Decision Units

- 1 DU for residence drip line
- 1 DU for up to one acre surrounding the house
- 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
- 1 DU for Garden
- 1 DU for Play Area
- 1 DU per additional sections of the property where use is indicated




Template D
Other-Not Specified Use Area
Decision Units
• 1 DU for residence drip line
• 1 DU for up to one acre surrounding the house
• 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
• 1 DU per additional sections of the property where use is indicated
Residence
Drip line
Up to 1-acre yard surrounding home


Template E
Decision Units
• 1 DU for residence drip line
• 1 DU for up to one acre surrounding the house
• 1 DU (each) for drip line(s) of large, painted structure(s), other than the residence (e.g., barns)
• 1 DU per additional 5 acres of maintained property (≤5 acres per DU rounded)
• 1 DU per additional 5-acre sections of the property where use is indicated (≤5 acres per DU rounded to the nearest integer)
Agricultural Land
Animal Activity Area
Residence
Drip line
Other-Not Specified Use Area (≤5 acres per DU)
Up to 1-acre yard surrounding home

ATTACHMENT C: FIELD SAMPLING PLAN

[See attached SOPs from CH2MHill]

Final

Phase 2 Field Sampling Plan Upper Columbia River Residential Soil Study

Prepared for

EPA Region 10

August 14, 2014

CH2MHILL®

2020 SW 4th Avenue
Portland, OR 97201

Contents

Figures

Acronyms and Abbreviations

bgs	Below ground surface
CD	Compact disk
DU	Decision unit
EDD	Electronic data deliverable
EPA	Environmental Protection Agency
ERT	Environmental Response Team
FSP	Field Sampling Plan
GIS	Geographic information system
GPS	Global positioning system
HHRA	Human health risk assessment
HSP	Health and safety plan
IC	Incremental composite (sample)
IDW	Investigation derived waste
ITRC	Interstate Technology and Regulatory Council
IVBA	*In vitro* bioaccessibility assay
kg	kilogram(s)
MS/MSD	Matrix spike/matrix spike duplicate
MIST	Multi-Incremental Sampling Tool
PPE	Personal protective equipment
ppm	parts per million
QA	Quality assurance
QAPP	Quality assurance project plan
QA/QC	Quality assurance/quality control
RI/FS	Remedial Investigation and Feasibility Study
RPM	Remedial Project Manager
RQAM	Regional Quality Assurance Manager
RSCC	Regional Sample Control Coordinator
Site	Upper Columbia River site
SOP	Standard operating procedure
TAI	Teck American, Incorporated
TAL	Target analyte list
UCR	Upper Columbia River
µm	micrometers
U.S.	United States
VSP	Visual sampling plan (software supported by EPA to determine the number of samples or increments)
WA	Washington

SECTION 1

Introduction

The objective of the Upper Columbia River (UCR) Residential Soil Study is to generate analytical data for soil samples that will be used to refine exposure estimates for residents in the northernmost reaches of the UCR Study Area to support the human health risk assessment (HHRA). Specifically, surface soils will be collected from rural residential properties in the Columbia River valley north of Northport, Washington (WA) and extending to the U.S. – Canada border (Figure 1). The owners of the properties to be sampled volunteered to participate after the U.S. Environmental Protection Agency notified land owners in the Residential Soil Study Area about the sampling program.

Surface soil sampling will be focused on locations where there is a high potential for exposure by residents, especially young children. Young children and subsistence gardeners are most susceptible to possible metal exposure as a result of ingestion of fine soil particles (less than 150 micrometers [µm] for soil; 250 µm for beach sediment) that adhere to skin. Soil samples collected during the Residential Soil Study will be analyzed for target analyte list (TAL) metals (except mercury)[1] and the in vitro bioaccessibility (IVBA) of lead and arsenic in soil will be measured in some samples[2].

The field efforts for this study consist of reconnaissance (Phase 1) and sampling (Phase 2). Phase 1 reconnaissance occurred in the spring of 2014 and consisted of visiting each property where landowners agreed to participate in the study in order to observe property features and to interview the landowner or resident to determine the locations for sampling decision units (DUs). Phase 2 sampling will occur in the summer 2014 and consist of collecting incremental composite (IC) and discrete soil samples at the DUs established for each property.

The Residential Soil Study represents one of the tasks that will be completed as part of the remedial investigation and feasibility study (RI/FS). The RI/FS is being conducted under a Settlement Agreement between Teck American, Incorporated (TAI) and the U.S. Environmental Protection Agency (EPA).

[1] TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Risk-based action levels are listed in the Residential Soil Study QAPP.

[2] Bioaccessibility testing will only be run for increment composite samples that have a lead or arsenic concentration greater than or equal to 100 or 20 parts per million (ppm), respectively.

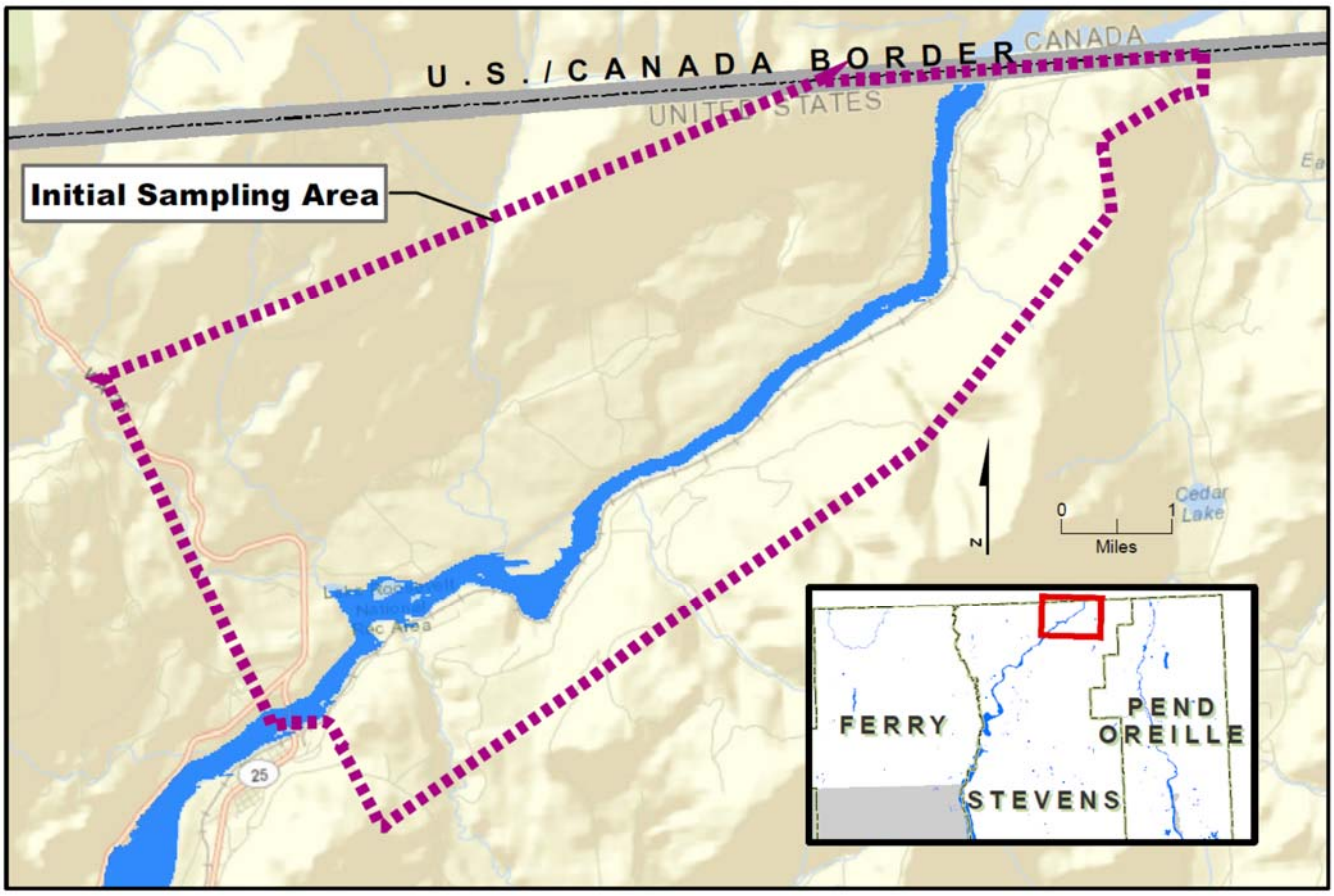


FIGURE 1
Residential Soil Study Area

1.1 Purpose and Objectives

The purpose of this **Phase 2 Field Sampling Plan (FSP)** is to document the approach and field procedures to execute Phase 2 field sampling activities. Analytical data for samples collected during the sampling effort will be used to assess residential exposure to metals in surface soil.

The rationale and decision logic for selecting the number, size, and sample depth for DUs at the properties are described in the *Residential Soil Study Quality Assurance Project Plan (Residential Soil Study QAPP) Upper Columbia River Washington State* (SRC, 2014). Property-specific details, including the locations and sizes of the sampling DUs were determined during Phase 1 field reconnaissance activities.

1.2 Document Organization

This Phase 2 FSP has been developed as a support document for the Residential Soil Study QAPP. This Phase 2 FSP constitutes Attachment D of the Residential Soil Study QAPP.

In addition to this introduction, the Phase 2 FSP includes the following sections and attachments:

- Section 2 presents the approach for the field investigation
- Section 3 details the sampling tasks and data collection procedures.
- Section 4 provides references used in the development of this FSP.
- Attachment 1 presents project-specific field forms for Phase 2 sampling.
- Attachment 2 contains the standard operating procedures (SOPs) for sample collection and field documentation.

- Attachment 3 contains the Health and Safety Plan (HSP) for the project.

SECTION 2

Field Investigation Approach

This section provides information about the design of the Residential Soil Study

2.1 General Overview

The objective of the Residential Soil Study is to generate analytical data for soil samples that will be used to refine exposure estimates for residents in the northernmost reaches of the UCR Study Area to support the HHRA. Specifically, surface soils will be collected from rural residential properties in UCR Study Area north of Northport, Washington (WA) and extending to the U.S. – Canada border (Figure 1). Surface soil samples will be collected from locations where there is a high potential for exposure by residents, especially young children, based on activities determined from interviews and site visits. Young children and subsistence gardeners are most likely to be exposed to metals as a result of ingestion of fine soil particles that adhere to skin. Soil samples collected during the Residential Soil Study will be analyzed for TAL metals (except mercury)[3] and the IVBA of lead and arsenic in soil in some samples.

2.2 Rationale for Sampling Designs

The rationale for the sampling designs to be employed during the Residential Soil Study is detailed in Worksheet 17 (Sampling Design and Rationale) of the Residential Soil Study QAPP (SRC, 2014). The sampling design for each DU takes into account the anticipated depth of exposure to soil, with IC sampling depths of 0 to 1 inch below ground surface (bgs), 0 to 3 inches bgs, 0 to 6 inches bgs, 0 to 12 inches bgs, and 0 to 18 inches bgs. Discrete soil samples will also be obtained depths of 1 to 6 inches bgs in selected DUs at each property.

The locations and extent of sampling DUs at each property were determined based on property-specific information obtained during Phase 1 field reconnaissance conducted in late April and May, 2014.

2.3 Rationale for Analyte List

Target analytes for the Residential Soil Study include TAL metals (except mercury) with a focus on IVBA lead and arsenic. These analytes are included in the study because data on historical and continuing discharges of metals from the Teck smelter in Trail, British Columbia, the results of previous soil investigations conducted in the study area, and the need for IVBA data to complete human health risk assessments. More information about the rationale for the analyte list is provided in Worksheet 10 (Problem Definition) of the Residential Soil Study QAPP.

2.4 Summary of Sampling Activities

Soil sampling will be conducted at approximately 86 residential parcels located in the study area. The majority of the samples will be collected using IC methodology. IC sampling entails the collection of multiple individual volumes of soil (termed “increments”) from a target area (i.e., a DU) that are composited and subsampled prior to laboratory analysis (Interstate Technology and Regulatory Council [ITRC], 2012). Discrete soil samples will also be obtained within selected DUs at each property. The overall Phase 2 sampling programs is summarized in Table 1 and detailed in Table 2, which due to its size appears after the main text of the FSP.

Because field sampling methods associated with this investigation involve penetration/disturbance of the ground surface, the field teams will include cultural observers who will assess the effects of the planned work and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties.

[3]TAL metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Risk-based action levels are listed in the Residential Soil Study QAPP.

Table 1
Summary of Residential Soil Sampling Program

Total Properties	Total Decision Units	Decision Unit Sizes (range)	Total Incremental Composite Samples	Total Discrete Samples
86	251	0.003 to 6.93 acres (131 to 301,935 square feet))	573 (including replicates)	426(370 primary samples plus 15% field duplicates)

2.5 Project Organization

The Residential Soil Study is being conducted by EPA and funded by Teck. The project organization and lines of authority for the field investigation are illustrated on Figure 2.

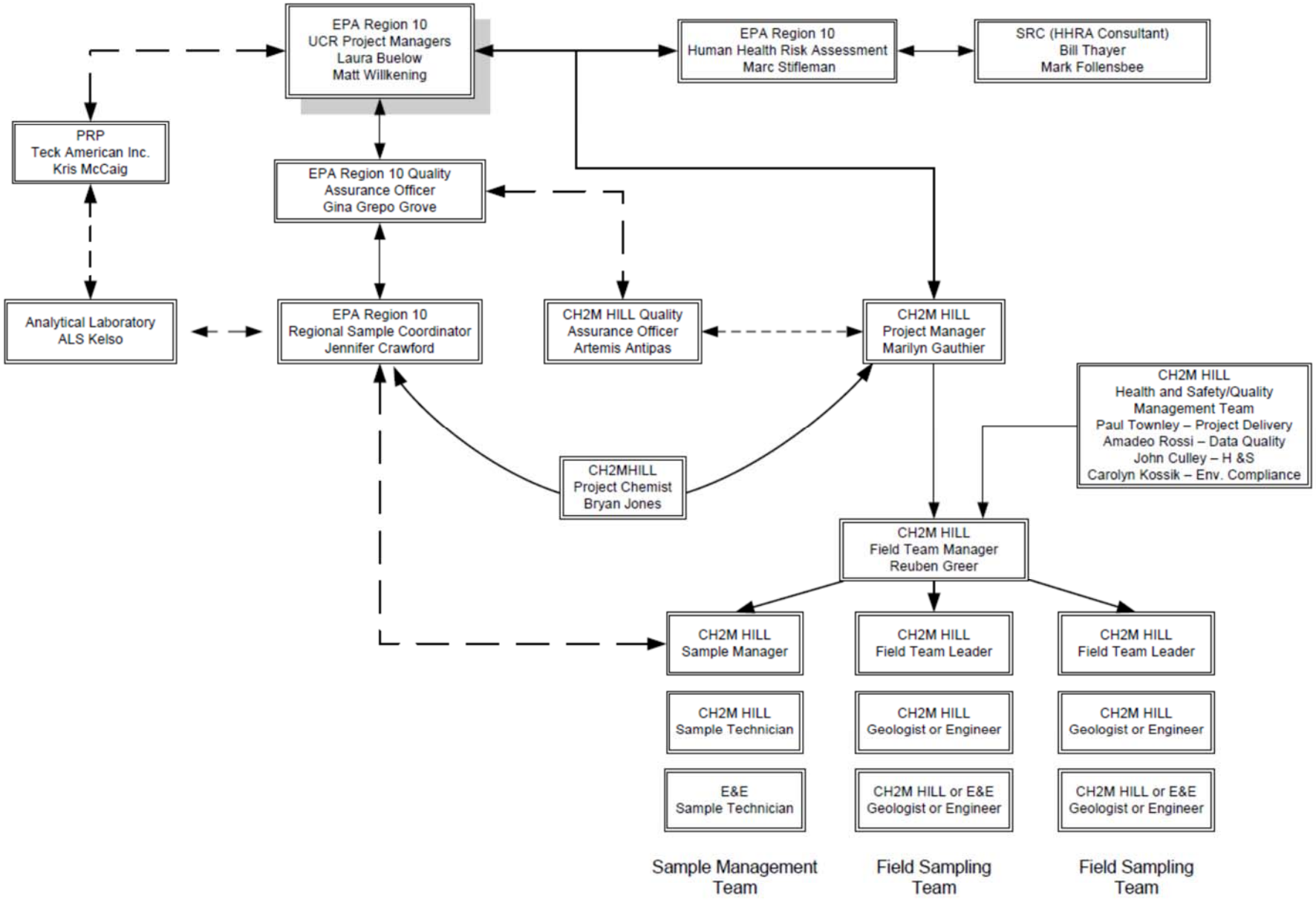


Figure 2
Residential Soil Study Organizational Chart

2.6 Project Communications

Frequent and detailed communication between field personnel and management staff is essential to successful completion of the sampling events. The anticipated lines of communication for different elements of the field effort are as follows:

1. **Project Kickoff Meeting –** Approximately 10 days before the start of field work, all personnel will participate in a project kickoff meeting to review the scope of work, schedule, and health and safety and project quality requirements for the project.

2. **Property Owner Notifications** – Approximately 7 days before the start of field work, an EPA representative will call property owners to inform them of the sample collection effort and, if needed, schedule an appointment for sampling.

3. **Utility Locates** – Approximately 7 days before the start of field work, a CH2MHILL representative will contact the 811 (call before you dig) number and request utility locates at all of the properties with physical addresses. A CH2MHILL representative will also call the property owner before sampling is scheduled to take place to conduct a short interview about possible buried utilities at the property.

4. **Day to Day Operations** – The sampling teams and sample management team will participate in meetings to coordinate logistics and plan each day's work. These meetings will include daily safety briefings. These meetings will also be attended by EPA field personnel, cultural observers, and other interested parties who may be present during sampling activities. At the end of the sampling day, each field team leader and the sample manager will provide daily reports (by telephone or email) to the CH2M HILL project manager, summarizing each day's activities and describing activities planned for the next day. Any issues regarding schedule, safety, cultural resources, or logistics that cannot be resolved in the field should also be reported immediately to the project manager who will bring the issue to the attention of EPA managers, as appropriate.

5. **Deviations from QAPP, FSP, and SOPs** – Any changes to the sampling program or changes in procedures will be recorded in the field log book and on a field change form. The field form will document the reason for the changes and the names of people making and authorizing the changes (only EPA personnel can authorize a change). Modifications to DU boundaries and/or sample depths constitute significant changes, which require consultation with CH2M HILL and written approval by EPA project managers prior to making the change, to make sure the IC subsample and/or discrete sample locations are appropriately distributed within the modified location or dimensions of the DU.

6. **Sample Receipts** – The CH2MHILL field team leaders will provide property owners with a receipt detailing the samples collected on the property (receipts will be mailed to owners who are not present during sample collection.

7. **Laboratory Communications** – The CH2M HILL project manager will be the primary liaison with TAI and TAI's contract analytical laboratory. EPA SCRIBE software will be used to generate labels, chains-of-custody, and tracking forms for all sample shipments. Any issues identified by the laboratory will be communicated to the EPA Regional Sample Coordinator and to the CH2M HILL project manager.

8. **Quality and Completeness Issues -** Changes to the sampling program that have the potential to affect quality and completeness will be communicated directly (telephone or email) to the CH2M HILL project manager as soon as possible or at the end of each day. The CH2M HILL project manager will contact the EPA to determine an appropriate path forward if direct communication between field personnel and EPA is not possible.

9. **Health and Safety –** All field work will be conducted in accordance with the project-specific HSP, which is included as Attachment 3 to this FSP. Compliance with the HSP will be documented in Safe Behavior Observation Forms and at least one safety audit will be conducted by the CH2M HILL Regional Health and Safety Manager during the course of the field work.

SECTION 3

Field Procedures

This section describes the required sampling equipment and procedures for collection of soil and QA/QC samples and documentation of the sampling efforts.

3.1 Tasks to Be Performed

Implementation of the Phase 2 FSP includes the following tasks at each property to be sampled:

- Mobilize and demobilize field crew
- Locate and establish boundaries of each DU (or DUs) using listed GPS coordinates, adjust boundaries as needed based on site-specific conditions.
- Locate and mark each subsample increment and discrete soil sample location using listed GPS coordinates, adjust locations as needed in the event of rocks or other obstructions.
- Collect IC and discrete soil samples at each designated DU.
- Decontaminate soil sampling equipment between DUs and discrete sample locations
- Sample identification and labeling (per EPA's Scribe protocol)
- Sample handling and custody
- Document sample collection activities
- Manage investigation derived waste (IDW)

3.2 Field Equipment and Supplies

The following equipment and materials will be needed for soil sampling:

- Project-specific documents (such as QAPP, Phase 2 FSP with attachments)
- Global Positioning Unit (GPS) handheld unit (for example Trimble GeoXT or GeoXH)
- Compass
- Calculator
- Engineering tape measure (min 100 meters, 300 feet)
- Tape measure
- Survey stakes
- Pin-flags
- Survey twine
- Stake hammer (2 pounds)
- Stainless steel soil sample coring device, minimum diameter of 16 mm (such as a Multi-Incremental Sampling Tool [MIST™])
- Large stainless steel spoons or scoops
- Pre-certified clean plastic buckets (1 to 5 gallons) and lids
- Sample bottles (16-ounce)
- Chain-of-custody records, custody seals, and sample labels

- Disposable gloves and appropriate personal protective equipment (PPE) per HSP
- Field data sheets and field notebook
- Pens
- Digital camera
- Cellular phone (and/or radios if no cell reception)
- Decontamination supplies (potable water, alconox, plastic wash tubs, brushes, etc.)
- Plastic trash bags

3.3 Incremental Composite Soil Sample Collection

Collection and processing of IC samples will be conducted in accordance with the incremental sampling guidance (ITRC, 2012). Each IC sample will consist of 30 increments or subsamples located within the boundaries of each DU. For most DUs, the increment locations have been pre-selected using visual sampling plan (VSP) software and the results of field reconnaissance conducted in April and May 2014. GPS equipment will be used to locate the increment locations (see SOP 1). However, at certain types of DUs or in situations where GPS reception is poor, the increment locations will be determined in the field (see SOP 5). The sampling depth for each DU has been pre-determined based on the results of field reconnaissance conducted in April and May 2014 and cultural resource considerations. For example, beaches will generally be sampled at a depth of 0 to 6 inches below ground surface (bgs). However, beaches with cultural resources concerns will be sampled at a depth of 0 to 1 inch bgs. The sampling plan for each property, including the sample depth for each DU, is summarized in Table 2. .

The IC samples will be dried, processed and the entire sample will be sieved in the laboratory to a target particle size of less than 150 µm or <250 µm (beach DUs only). The resulting samples will be analyzed for TAL metals (except mercury). If the measured concentration in an IC sample from a property is greater than or equal to 100 parts per million (ppm) lead or 20 ppm arsenic, one of the IC samples from each DU will be analyzed for lead and arsenic bioavailability. All remaining sieved soil samples will be archived for later use after analytical samples are obtained.

The SOP for IC sample collection (SOP 3) in Attachment 2 provides more details about IC sample collection procedures. Sample collection details for each sample will be recorded on the IC Soil Sample Collection Form (see Attachment 2).

As indicated in Worksheet 17 of the QAPP, based on the type of soil found in the Study Area (generally sandy loam and gravelly loam), the amount of soil in the particle size of interest (150 µm) is expected to be limited (5 to 10% of total grain size distribution), therefore at least 1000 grams (g) of soil must be collected for each IC sample in order to have sufficient mass for analysis and quality control samples (i.e., splits and MS/MSDs) after sieving and subsampling. This means that at least 34 grams (1.16 ounces) of soil needs to be collected at each of the 30 increment locations. The estimated volumes and weights that would result for each interval, assuming sandy and gravelly loam soil (~1.65 grams per cubic cm [g/cm^3]), are as follows:

- 0 to 1 inch x 4 centimeter (cm) bit = 1,580 g
- 0 to 3 inches (7.62 cm) x 2 cm bit = 1,185 g
- 0 to 6 inches (15.24 cm) x 2 cm bit = 2,370 g
- 0 to 12 inches (30.48 cm) x 2 cm bit = 4,740 g
- 0 to 18 inches (46 cm) x 2 cm bit = 7,000 g

The 2 cm bit will also provide sufficient mass of beach sediment for the 0 to 6 inch IC samples collected from beach DUs. When necessary to avoid disturbing cultural artifacts, the 4 cm bit is required for the 0 to1 inch bgs depth IC samples collected from beach DUs.

A variety of bucket sizes, ranging from 1 to 5 gallons, will be available to hold and transport the samples. However, most samples are expected to fit in 1 or 2.4 gallon buckets.

3.4 Discrete Sample Collection

In addition to the IC samples, discrete samples will be obtained at 5 random (as determined by VSP) locations within selected DUs (1 DU per property). These discrete samples will be obtained from the 1 to 6 inch bgs interval within the designated DU and will be from locations that are separate from the IC subsample locations in the DU. The DUs where discrete samples will be collected are listed on Table 2 and the detailed sampling plan for each property specifies the location coordinates for the discrete soil samples. The samples will be collected using hand tools, including trowels and/or the MIST™ (or equivalent) sampling device. The sample will be transferred to sample jars in the field per SOP 4.

The SOP for discrete soil sample collection (SOP 4) in Attachment 3 provides more details about discrete soil sample collection procedures. Sample collection details for each sample will be recorded on the Discrete Soil Sample Collection Form (see Attachment 1).

The discrete soil samples will be dried and sieved in the laboratory to a target particle size of less than 150 µm. The resulting samples will be analyzed for TAL metals (except mercury). As indicated in Worksheet 17 of the QAPP, at least 200 g of soil must be collected for each discrete sample in order to have sufficient mass for analysis after sieving. Assuming use of the 4 cm bit and 5 inches of sandy or gravelly loam soil (1.65 g/cm^3), each discrete sample should weigh about 263 g.

3.5 Quality Assurance/Quality Control Sample Collection

This section describes procedures for collecting and submitting QA/QC samples for analysis.

3.5.1 Replicates of Incremental Composite Samples

Replicate (duplicate and triplicate) IC samples will be collected at several DUs at each property (see Table 2) to ensure reliable estimates of the mean concentration of target analytes within the DU. The locations for the replicate IC subsample increments (duplicate, and triplicate) within a DU may be pre-determined or will be determined in the field using a systematic approach based on the spacing between primary subsample increments (see SOP 3). The replicates will be analyzed for TAL metals.

3.5.2 Field Duplicate Samples

Field duplicate samples will be collected to assess the homogeneity of discrete samples collected in the field and the precision of the sampling process. Field duplicate samples will be prepared by collecting two aliquots of sample from the sampling equipment and submitting them for sieving and analysis as separate samples (aliquots of soil will be homogenized prior to splitting into separate samples). Field duplicates will be collected from at least 15 percent of the discrete sampling locations at a property, with a minimum of one field duplicate sample per property where discrete samples are collected. The duplicate samples will be submitted to the laboratory blind and will be analyzed for TAL metals.

3.5.3 Equipment Rinsate Blank

Equipment rinsate blanks are used to evaluate sampling device cleanliness and potential carryover of target contaminants from equipment contribution. Equipment rinsate blanks will be collected from decontaminated sample collection equipment on a daily basis (one rinsate blank per field team per day). The equipment rinsate samples will consist of ASTM Type II water (purchased and certified from a commercial vendor) poured over or through the sampling device and collected in a pre-preserved sample container. The rinsate blanks will be analyzed for total TAL metals (except mercury).

3.5.4 Matrix Spike/Matrix Spike Duplicate Samples

Analyses of matrix spike/matrix spike duplicate (MS/MSD) samples will be performed in the laboratory to assess the accuracy of the analyses. These analyses will be performed according to the laboratory protocols and will occur at a frequency of once every 20 samples using extra volumes of sample matrices obtained after laboratory

processing (i.e., the volume of field-collected sample listed in Sections 3.3 and 3.4 accounts for potential MS/MSD volumes).

3.6 Individual Sample Identification Numbers

All samples will be initially labeled in the field at the time of collection and shall contain the following information:

- Unique sample identification number
- Property identification (parcel ID)
- DU number
- Sample date and time
- Sample type (IC or D)
- QA/QC type (field duplicate, IC duplicate, IC triplicate)
- Sample team initials

The following sections describe how the unique sample identification numbers will be determined.

3.6.1 Soil Samples

Each IC and discrete sample will be assigned a unique sample identification number that includes the study name, medium, sample location (i.e., DU number), sample type, and sample type number. The unique sample number will be entered in the field notebook, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities. The following sample numbering convention will be used for normal and replicate soil samples:

Study Prefix – Medium – Location – Sample Type - Sample Number

Explanation:

Study Prefix:	2014R = 2014 Residential Soil Study
Medium:	SS = Surface Soil
Location:	DU number (unique numbers assigned to individual properties)
Sample Type:	IC = incremental composite
	D = discrete
Sample Type Number:	01 = primary sample
	02 = duplicate sample (used for both discrete and IC samples)
	03 = triplicate sample (only used for IC samples)

For example:

- *2014R-SS-137-IC-01* is a primary IC surface soil sample collected at DU137.
- *2014R-SS-137-D-01* is a primary discrete surface soil sample collected at DU137.
- *2014R-SS-137-IC-03* is a triplicate IC surface soil sample collected at DU137.
- *2014R-SS-137-D-02* is a field duplicate discrete surface soil sample collected at DU137.

Preliminary sample identification numbers for all designated 2014 soil samples are listed by property on Table 2.

3.6.2 Equipment Rinsate Blank Samples

Each equipment rinsate blank will be assigned a unique sample identification number that includes the study name, medium, sample location (i.e., DU number), sample type, and sample type number. The unique sample

number will be entered in the field notebook, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities. The following sample numbering convention will be used for equipment blanks:

Study Prefix – Medium – Sample Team Leader Initials- Date

Explanation:

Study Prefix:	2014R = 2014 Residential Soil Study
Medium:	EB = Equipment Blank
Initials:	Initials of the field team leader
Date:	Date of collection (month, date, year [8 digits])

For example:

- *2014R-EB-NB-08192014* is an equipment blank collected by Nicole Badon's team on August 19, 2014

3.7 Sample Management

The following section discusses various sample management procedures that will be followed after collection of the samples in the field and before transfer to the laboratory (sample management after samples are received by the laboratory and transfer of samples for IVBA analysis are not covered here). Included in these sections are procedures for sample packaging and transportation, sample labeling, and sample documentation. Sample volume, container, preservative and holding time requirements are listed in Table 3. Note that the EPA quality assurance officer has approved storage and shipment of the soil samples without refrigeration or use of ice.

TABLE 3
Sample Volumes, Containers, Preservatives, and Hold Times

Medium	Analyses	Method	Minimum Sample Volume	Container	Preservative	Maximum Hold Time	Quantity (includes IC replicates and field duplicates
Soil (IC)	Total TAL Metals (except Hg)	6010c/6020 or CLP	1000 grams	Pre-cleaned plastic bucket (1 – 5 gallons)	None	180 days	573, plus 8 replicates for land owners
Soil (discrete)	Total TAL Metals (except Hg)	6010c/6020 or CLP	200 grams	Pre-cleaned 16 ounce plastic jar	None	180 days	426
Water	Total TAL Metals (except Hg)	6010a/6020 or CLP	250 ml	250-ml polyethylene	HNO3 to pH <2	180 days	62

IC = incremental composite
Hg = mercury
mL = milliliter

The Sample Manager will use the preliminary label and sample documentation to generate a formal label and chain-of-custody record for each sample using SCRIBE software. In addition to the field-generated information listed above, the SCRIBE-generated labels will also include:

- EPA Case Number
- Matrix
- SCRIBE sample identification number
- Analytical methods requested

The SCRIBE labels will be affixed to the sample containers and covered with clear tape prior to packaging for shipment to the laboratory. The labeled sample containers will be placed in re-sealable bags and boxes for shipment to the laboratory. All samples will be packaged and labeled for shipment in compliance with current regulations.

- The samples will be shipped to the laboratory by courier on a weekly basis. No Saturday deliveries are anticipated. The sample manager will notify the analytical laboratory coordinator that the samples will be delivered to the laboratory and the estimated arrival time. Copies of all chain-of-custody forms will be provided to the analytical laboratory coordinator.

The Region 10 Regional Sample Control Coordinator must be contacted within 24 hours of sample shipment and be provided the following information:

- Sampling contractor's name
- Site name and/or case number
- Regional Project code
- Labs shipped to
- Turnaround time
- Samples designated for QC
- Required .xml and .xls export files
- Total number(s) by concentration and matrix of samples shipped to each laboratory
- Carrier, air bill number(s), method of shipment
- Shipment date and intended laboratory receipt date
- Irregularities or anticipated problems associated with the samples
- Whether the current shipment is the final shipment or if additional samples will be shipped under the same case number

3.8 Equipment Decontamination

Sampling equipment must be decontaminated consistently to ensure the quality of the samples collected. All equipment that comes into contact with potentially contaminated soil will undergo a thorough decontamination between discrete soil sample locations and between each DU (IC samples). Temporary decontamination stations and related containment will be established near the work area at each DU. Disposable equipment intended for one-time use that is factory-wrapped generally does not need to be decontaminated before it is used unless there is evidence of contamination present. All one-time use, disposable sampling equipment and accessories will be discarded once used, and a new set of equipment will be used for each subsequent sample.

Equipment decontamination procedures are as follows:

- Wear the appropriate PPE as required by the HSP.
- Use the following sequence for actual decontamination process:
    1. Remove as much gross contamination (such as residual soil) as possible from equipment at the sampling site.
    2. Wash sampling equipment thoroughly and vigorously with potable water containing nonphosphate laboratory-grade detergent such as liquinox, alconox, or equivalent. Use a bristle brush or similar utensil to remove remaining residual contamination.
    3. Thoroughly rinse equipment with potable water (first rinse).

4. Thoroughly rinse equipment with distilled or deionized water (second rinse).
5. Perform air drying at a location where dust or other fugitive contaminants may not contact the sample equipment. Alternatively, use a clean, disposable paper towel to assist the drying process. All equipment should be dry before reuse.

- If the equipment is not used soon after decontamination, cover or wrap it in new, oil-free aluminum foil or new, unused plastic bags to protect the decontaminated equipment from fugitive contaminants before reuse.
- Store decontaminated equipment at a secure, unexposed location, out of the weather and potential contaminant exposure.

3.9 Personnel Decontamination

Decontamination of personnel and PPE will prevent undesired exposure to contaminants via ingestion, absorption, and inhalation. Decontaminate all personnel and PPE as outlined in the HSP (see Attachment 4). Address any further concerns regarding personnel and PPE decontamination procedures directly to the project manager or Health and Safety Manager.

3.10 Management of Investigation-Derived Waste

Sampling activities are anticipated to generate limited quantities of potentially contaminated materials that will require handling and disposal as described below:

- Field sampling activities will be conducted in Level D PPE and/or modified Level D PPE. Used PPE (primarily nitrile gloves) will be temporarily containerized in heavy-duty trash bags and transported and disposed of in an off-site licensed waste facility (i.e., active Municipal Solid Waste Landfill operated under Chapter 173-351 of the Washington Administrative Code).
- The sampling programs detailed in this plan are not expected to generate surplus soil that will not be submitted to the testing laboratory for analysis. If surplus soil is generated, the surplus will be returned to the portion of the property where it was collected.
- Equipment decontamination will take place in the individual DUs where samples are collected. Any liquids that collect during the process will be discharged to the ground in the area in which the samples were collected.

3.11 Field Documentation

The following sections provide information regarding field documentation procedures.

3.11.1 Field Forms

All sampling and associated activities will be documented on activity-specific field forms (see Attachment 1).

3.11.2 Field Logbook

Daily field activities will be documented through journal entries in a bound field logbook, which is dedicated to each field team for the residential sampling effort. The field logbook will be water-resistant, and all entries will be made in indelible ink. The field logbook will contain all pertinent information about sampling activities, site conditions, field methods used, general observations, and other pertinent technical information. Language used will be objective, factual, and free of personal opinions. Hypotheses for observed phenomena may be recorded; however, they must be clearly identified as such and only relate to the subject of observation. Field logbooks will become part of the permanent project record. Examples of typical field logbook entries include the following:

- Personnel present
- Subcontractors' names and companies
- Time of arrival and departure at each site

- Daily temperature and other climatic conditions
- Field measurements, activities, and observations, including discussions resulting in pertinent field decisions
- Referenced sampling location description (in relation to a stationary landmark) and maps
- Sample collection methods and equipment
- Date and time of sample collection
- Types of sample containers used, sample identification and cross-referencing, sample types and preservatives used, and analytical parameters
- Quality control (QC) sample (duplicate or blank) sample location and sampling method
- Field instrument calibration information
- Documentation of equipment decontamination
- Site sketches and or reference to photographs taken
- Instrument calibration procedures and frequency
- Visitors to the site

The FTL or designee will be responsible for the daily maintenance of all field records. Each page of the field logbook will be sequentially numbered, dated, and signed by the person making the entry. Corrections to the field logbook will be made by using a single strike mark through the entry to be corrected, then recording and initialing the correct entry. For corrections made later, the date of the correction will be noted. Unused portions of the pages will be crossed out, signed, and dated at the end of each day.

3.11.3 Chain-of-Custody Procedures

Chain-of-custody procedures should be followed to document sample possession as follows.

3.11.3.1 Definition of Custody

A sample is under custody if one or more of the following criteria are met:

- The sample is in a person's physical possession
- The sample is in a person's view after being in his or her physical possession
- The sample was in a person's physical possession and was then locked up or sealed to prevent tampering
- The sample is kept in a designated secured area

3.11.3.2 Field Custody

Only enough material to provide a good representation of the media being sampled will be collected. To the extent possible, the quantity and types of samples and sample locations are determined before the actual fieldwork. As few people as possible should handle samples.

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly.

The PM will determine whether proper custody procedures were followed during the fieldwork, and will decide whether additional samples are required.

3.11.3.3 Transfer of Custody and Shipment

Samples should be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving the samples should sign, date, and note the time on the record. This record documents custody transfer from the sampler, often through another person, to the analyst at the laboratory.

Samples should be packaged properly for shipment and dispatched to the appropriate laboratory for analysis with a separate chain-of-custody record accompanying each shipment. Courier names and other pertinent information are entered in the “Received by” section of the chain-of-custody record.

All shipments should be accompanied by the chain-of-custody record identifying its contents. The original record and one copy should accompany the shipment to the laboratory, and a second copy will be retained by the sample manager.

Freight bills, postal service receipts, and bills of lading should be retained as part of the permanent documentation.

3.11.3.4 Laboratory Custody Procedures

A designated sample custodian should accept custody of the shipped samples and verify that the sample numbers match those on the chain-of-custody records. Pertinent information regarding shipment, pickup, and courier should be in the “Remarks” section. The custodian should enter the sample numbers into a bound notebook. The laboratory custodian will use the sample identification number or assign a unique laboratory number to each sample, and will be responsible for ensuring that all samples are transferred to the proper analyst or stored in the appropriate secure area.

The custodian will distribute samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received, until the sample is exhausted or returned to the custodian. The data from sample analyses should be recorded on the laboratory report form.

When sample analyses and necessary QC checks have been completed in the laboratory, the unused portion of the sample will be archived until the EPA notifies the laboratory that the samples are no longer needed. All identifying sample tie tags, data sheets, and laboratory records will be retained as part of the documentation. Sample containers and remaining samples should be disposed of by the laboratory in compliance with all federal, state, and local regulatory requirements.

3.12 Digital Pictures

Color digital pictures taken during sampling activities will be numbered to correspond to photo log entries. The name of the photographer, date, time, site location, and photograph number will be documented in the field logbook. Photo number and scene description will be entered sequentially in the photo log as photographs are taken. At a minimum, one digital photo will be taken of each DU and associated sample locations at the time of sampling. A dry-erase white board bearing the location identification, date, and time, will be held in the photograph by a field team member.

SECTION 4

References

Interstate Technology and Regulatory Council (ITRC), 2012. Technical and Regulatory Guidance: Incremental Sampling Methodology. Interstate Technology and Regulatory Council: Washington, DC. 475 pp. Available online at: http://www.itrcweb.org/gd.asp.

SRC Inc., 2014. Upper Columbia River Residential Soil Study, Phase 2 Quality Assurance Project Plan.

Table 2

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5687700	214	Soil	House	14985	0-1	3	1 - 6	5	1
5693400	22	Soil	House	2836	0-1	3	1 - 6	5	1
5087000	201	Soil	House	4452	0-1	3			
5087000	202	Soil	Beach	2191	0-6	3			
5087000	201DL	Soil	Dripline		0-1	1			
5087000	201G	Soil	Garden	7057	0-12	3	1 - 6	5	1
5088000	9	Soil	Agriculture	200923	0-1	3			
5088000	13	Soil	Other -Not Specified	109269	0-1	1			
5088000	14	Soil	Garden	4259	0-12	3			
5088000	15	Soil	House	13686	0-1	3	1 - 6	5	1
5088000	16	Soil	Other -Not Specified	46186	0-1	1			
5088000	17	Soil	Other -Not Specified	57634	0-1	3			
5088000	15DL	Soil	Dripline		0-1	1			
5090900	59	Soil	House	15436	0-1	3	1 - 6	5	
5090900	59A	Soil	House	21260	0-1	3			
5090900	59DL	Soil	Dripline		0-1	1			
5087300	35	Soil	House	5760	0-1	3	1 - 6	5	1
5087300	39	Soil	Agriculture	9892	0-1	3			
5087300	35DL	Soil	Dripline		0-1	1			
5087300	35PA	Soil	Play Area	1829	0-1	3			
5078100	216	Soil	House	18286	0-1	3	1 - 6	5	1
5078100	216DL	Soil	Dripline		0-1	1			
5085300	170	Soil	House	46568	0-1	3	1 - 6	5	1
5085300	1030	Soil	Other -Not Specified	60440	0-1	3			
5085300	1031	Soil	Garden	895	0-12	1			
5704000	168	Soil	House	2116	0-1	3	1 - 6	5	1
5704000	169	Soil	Other -Not Specified	73582	0-1	1			
5704000	168DL	Soil	Dripline		0-1	1			
5704000	169A	Soil	Other -Not Specified	176625	0-1	3			
5689900	49	Soil	House	2163	0-1	3	1 - 6	5	
5098600	231	Soil	House	2159	0-1	3	1 - 6	5	1
5098600	231DL	Soil	Dripline		0-1	1			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5098600	231Lower	Soil	Other -Not Specified	2174	0-1	3			
615200	185	Soil	House	32197	0-1	3	1 - 6	5	1
615200	185DL	Soil	Dripline		0-1	1			
615200	185G	Soil	Garden	131	0-12	1			
5689400	801	Soil	Other -Not Specified	1061	0-1	3			
5689400	800B	Soil	Beach	5158	0-6	3	1 - 6	5	1
5086800	203	Soil	House	4046	0-1	3	1 - 6	5	1
5086800	204	Soil	Beach	2100	0-6	3			
5095700	253	Soil	House	210442	0-1	3	1 - 6	5	1
5095700	251B	Soil	Beach	102050	0 - 1	3			
5095700	254DL	Soil	Dripline		0-1	1			
5689800	255	Soil	Beach	7980	0-6	3			
2391400	122	Soil	Other -Not Specified	3684	0-1	3	1 - 6	5	1
5092100	123	Soil	House	29441	0-1	3	1 - 6	5	
5092100	135	Soil	Other -Not Specified	60204	0-1	3			
616100	192	Soil	House	858	0-1	1	1 - 6	5	1
616100	1060	Soil	House	584	0-1	1			
616100	192DL	Soil	Dripline		0-1	1			
5089402	1050	Soil	House	6025	0-1	3*	1 - 6	5*	
5089402	1051	Soil	Garden	3260	0-18	3			
5089402	1052	Soil	Other -Not Specified	2887	0-1	3			
5098601	177	Soil	Agriculture	13773	0-1	3			
5098601	176M	Soil	House	31801	0-1	3	1 - 6	5	1
5690710	345	Soil	Play Area	522	0-1	1	1 - 6	5	
5690710	346	Soil	Garden	9637	0-12	3			
5690800	347	Soil	Other -Not Specified	1177	0-1	3			
5087315	7	Soil	Play Area	5728	0-1	3	1 - 6	5	1
616500	186	Soil	House	9348	0-1	3	1 - 6	5	1
616500	186DL	Soil	Dripline		0-1	1			
5704500	194	Soil	House	6737	0-1	3	1 - 6	5	1
5704500	195	Soil	Beach	2579	0-6	3			
5704500	1021	Soil	House	4223	0-1	3			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5704600	193	Soil	House	2016	0-1	3	1 - 6	5	1
5704600	1020	Soil	Garden	3291	0-18	3			
5704600	193DL	Soil	Dripline		0-1	1			
5084900	109	Soil	House	4058	0-1	3	1 - 6	5	1
5084900	109DL	Soil	Dripline		0-1	1			
2393280	62	Soil	House	42073	0-1	3	1 - 6	5	1
2393280	62DL1	Soil	Dripline		0-1	1			
2393280	62DL2	Soil	Dripline		0-1	1			
2393280	62G	Soil	Garden	10836	0-12	3			
5706200	1005	Soil	Garden	5040	0-12	1			
5706200	**1005 (HO replicate)**	**Soil**	**Garden**	**5040**	**0-12**	**1**			
5706200	1006	Soil	House	11226	0-1	3	1 - 6	5	
5706200	1007	Soil	Garden	2170	0-12	3			
5706200	1008	Soil	Agriculture	14950	0-1	1			
5706200	1010	Soil	Agriculture	121982	0-1	1			
5706200	1011	Soil	Agriculture	183941	0-1	3			
5706200	1009DL	Soil	Dripline		0-1	1			
5090320	229	Soil	Play Area	3604	0-1	3			
5090320	230G	Soil	Garden	616	0-12	1			
5085825	196	Soil	House	855	0-1	1	1 - 6	5	1
5085825	197	Soil	Beach	3751	0-6	3			
2390500	121	Soil	House	8402	0-1	3	1 - 6	5	1
2390500	121DL	Soil	Dripline		0-1	1			
615900	280	Soil	Other -Not Specified	19598	0-1	3			
615900	280DL	Soil	Dripline		0-1	1			
615900	280yard	Soil	House	2928	0-1	3	1 - 6	5	1
5093101	246	Soil	Play Area	1590	0-1	3	1 - 6	5	
5087600	224	Soil	Beach	4147	0-6	3			
2402360	324	Soil	Beach	1304	0-6	3			
2402360	325	Soil	Garden	18561	0-12	3			
2402360	326	Soil	Other -Not Specified	5745	0-1	1			
2402360	327	Soil	Other -Not Specified	7878	0-1	3			
5091300	85	Soil	House	42583	0-1	3	1 - 6	5	1
5091300	86	Soil	Agriculture	200647	0-1	1			
5091300	87	Soil	Agriculture	301932	0-1	1			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5091300	85DL	Soil	Dripline		0-1	1			
5091300	94M	Soil	Agriculture	265104	0-1	3			
5693000	189	Soil	House	3787	0-1	3	1 - 6	5	1
5693000	1037	Soil	Garden	3652	0-12	3			
5693100	1035	Soil	Garden	4311	0-12	3			
5693100	1036	Soil	Play Area	4142	0-1	3			
5693100	187DL	Soil	Dripline	133	0-1	1			
5691100	75	Soil	House	10977	0-1	3	1 - 6	5	
5703200	18	Soil	House	18740	0-1	3	1 - 6	5	1
5703200	20	Soil	Garden	620	0-12	1			
5703200	18DL	Soil	Dripline		0-1	1			
5093150	154	Soil	House	1706	0-1	3	1 - 6	5	1
5093150	154DL	Soil	Dripline		0-1	1			
5703600	33	Soil	House	18178	0-1	3	1 - 6	5	1
2392940	82	Soil	House	52512	0-1	3	1 - 6	5	1
2392940	82DL1	Soil	Dripline		0-1	1			
2392940	82DL2	Soil	Dripline		0-1	1			
5096217	317	Soil	House	43056	0-1	3	1 - 6	5	
5096217	318	Soil	Other -Not Specified	208213	0-1	1			
5096217	319	Soil	Other -Not Specified	240941	0-1	3			
5096217	317M	Soil	Play Area	5422	0-1	3			
5096217	319DL	Soil	Dripline		0-1	1			
5096217	319M	Soil	House	4925	0-1	3			
5045800	175	Soil	Other -Not Specified	45093	0-1	3			
5045800	174M	Soil	House	9534	0-1	3	1 - 6	5	1
5045800	238G	Soil	Garden	2057	0-12	3			
5045800	238M	Soil	Agriculture	16545	0-1	3			
5094800	116DL	Soil	Dripline		0-1	1			
5094800	116M	Soil	House	43889	0-1	3	1 - 6	5	1
2394200	25	Soil	House	10717	0-1	3	1 - 6	5	
2394200	27	Soil	Other -Not Specified	39131	0-1	1			
2394200	28	Soil	Garden	7218	0-12	3			
2394200	29	Soil	Other -Not Specified	95728	0-1	1			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
2394200	30	Soil	Other -Not Specified	71881	0-1	3			
2394200	31	Soil	Other -Not Specified	61799	0-1	1			
2394200	25DL	Soil	Dripline		0-1	1			
5096700	40	Soil	House	9257	0-1	3	1 - 6	5	1
5096700	40DL	Soil	Dripline		0-1	1			
5094700	226	Soil	Beach	3304	0-1	3			
5094700	226A	Soil	Beach	14568	0-1	3			
5094700	226C	Soil	House	80347	0-1	3	1 - 6	5	1
5094700	226DL	Soil	Dripline		0-1	1			
5095105	48	Soil	House	9413	0-1	3*	1 - 6	5*	
2399700	151	Soil	House	49394	0-1	3	1 - 6	5	1
2399700	152	Soil	Other -Not Specified	48889	0-1	3			
2399700	151DL	Soil	Dripline		0-1	1			
5091100	206	Soil	House	43603	0-1	3	1 - 6	5	1
5091100	208	Soil	Other -Not Specified	138289	0-1	3			
5091100	213	Soil	Other -Not Specified	151298	0-1	1			
5091100	206DL	Soil	Dripline		0-1	1			
5091100	207G	Soil	Garden	709	0-12	1			
5091100	208AA	Soil	Animal Activity Area	95219	0-3	3			
5091100	208DL	Soil	Dripline		0-1	1			
5091100	209A	Soil	Agriculture	260641	0-1	3			
5091700	206G	Soil	Garden	4145	0-12	1			
5091700	208BM	Soil	House	19435	0-1	3	1 - 6	5	
5091700	208G	Soil	Garden	5635	0-12	3			
5087301	21	Soil	House	4029	0-1	3	1 - 6	5	1
5087301	115SP	Soil	Other -Not Specified	1720	0-1	3			
5087301	21G	Soil	Garden	11612	0-12	3			
5045250	163	Soil	House	48201	0-1	3	1 - 6	5	
5045250	164	Soil	Agriculture	55823	0-1	1			
5045250	167	Soil	Agriculture	228629	0-1	3			
5045250	163G	Soil	Garden	166	0-12	1			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5045600	160	Soil	House	31918	0-1	3	1 - 6	5	1
5089950	999DL1	Soil	Dripline		0-1	1			
5089950	999DL2	Soil	Dripline	214	0-1	1			
5089950	999G1	Soil	Garden	8355	0-12	3			
5089950	999M1	Soil	House	3298	0-1	3	1 - 6	5	1
5089950	999M2	Soil	Garden	681	0-12	1			
5089950	999M3	Soil	Other -Not Specified	27944	0-1	3			
5090601	287	Soil	Agriculture	244109	0-1	3			
5090601	284DL	Soil	Dripline		0-1	1			
5090601	284M	Soil	House	23106	0-1	3	1 - 6	5	
5090601	285M	Soil	Other -Not Specified	154956	0-1	3			
5090700	288	Soil	House	15535	0-1	3	1 - 6	5	1
5090700	291	Soil	Agriculture	246891	0-1	3			
5090700	288G1	Soil	Garden	3190	0-12	1			
5090700	288G2	Soil	Garden	10646	0-12	1			
5090700	289G3	Soil	Garden	12819	0-12	3			
2398875	315	Soil	House	12293	0-1	3	1 - 6	5	1
2398875	316	Soil	Other -Not Specified	222648	0-1	3			
2398875	315DL	Soil	Dripline		0-1	1			
5094400	303	Soil	Beach	3938	0-6	3			
5094400	306	Soil	Other -Not Specified	61543	0-1	3			
5045675	146	Soil	House	3526	0-1	3	1 - 6	5	1
5045675	147	Soil	Garden	4658	0-12	3			
5045675	146G	Soil	Garden	7606	0-12	1			
5083600	249	Soil	Other -Not Specified	8964	0-1	3			
5083600	250	Soil	House	117633	0-1	3	1 - 6	5	
5693200	67	Soil	Garden	19654	0-12	3	1 - 6	5	1
5693700	66	Soil	Other -Not Specified	139984	0-1	3			
436000	218	Soil	House	2951	0-1	3	1 - 6	5	1
5089440	55	Soil	House	11696	0-1	3	1 - 6	5	1
5089440	56	Soil	Other -Not Specified	64279	0-1	3			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5089440	58	Soil	Agriculture	119416	0-1	3			
5089440	55DL	Soil	Dripline		0-1	1			
5044000	60	Soil	Garden	2404	0-12	3			
5044000	61	Soil	House	10784	0-1	3	1 - 6	5	
5044000	60DL	Soil	Dripline	500	0-1	1			
5083200	181	Soil	House	41668	0-1	3	1 - 6	5	
5083200	181DL	Soil	Dripline		0-1	1			
5083200	183A	Soil	Animal Activity Area	12268	0-3	3			
5083200	184G	Soil	Garden	3308	0-12	3			
2398900	110	Soil	House	9260	0-1	3	1 - 6	5	1
2398900	111	Soil	Other -Not Specified	22102	0-1	3			
2398900	110DL	Soil	Dripline		0-1	1			
2398900	110G	Soil	Garden	612	0-12	1			
151-H-189	430	Soil	Other -Not Specified	73481	0-3	1	1 - 6	5	1
151-H-189	431	Soil	Other -Not Specified	253599	0-3	3			
151-H-189	432	Soil	Other -Not Specified	3559	0-3	1			
151-H-192	420	Soil	Other -Not Specified	77720	0-3	1	1 - 6	5	1
151-H-192	421	Soil	Other -Not Specified	119944	0-3	3			
151-H-193	258	Soil	Other -Not Specified	206127	0-3	3	1 - 6	5	
151-H-193	259	Soil	Other -Not Specified	123308	0-3	1			
151-H-195	410	Soil	Other -Not Specified	139725	0-3	1	1 - 6	5	1
151-H-195	411	Soil	Beach	34674	0-6	3			
151-H-195	412	Soil	Other -Not Specified	34951	0-3	3			
151-H-195	413	Soil	Other -Not Specified	225809	0-3	1			
151-H-196	401	Soil	Other -Not Specified	100911	0-3	1			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
151-H-196	402	Soil	Other -Not Specified	59528	0-3	1			
151-H-196	403	Soil	Other -Not Specified	14674	0-3	3	1 - 6	5	1
151-H-197	440	Soil	Other -Not Specified	5540	0-3	3			
151-H-197	441	Soil	Other -Not Specified	19519	0-3	1			
151-H-197	442	Soil	Other -Not Specified	15908	0-3	1			
615700	320new	Soil	Other -Not Specified	42490	0-1	3			
5096210	112	Soil	House	38750	0-1	3	1 - 6	5	
5096210	112DL	Soil	Dripline		0-1	1			
5096210	112G	Soil	Garden	3676	0-12	3			
5096210	113low	Soil	Other -Not Specified	137311	0-1	1			
5096210	113up	Soil	Other -Not Specified	20750	0-1	3			
5092600	106	Soil	House	12969	0-1	3	1 - 6	5	1
5092600	107	Soil	Garden	1834	0-12	1			
5092600	108	Soil	Garden	5392	0-12	3			
5092600	106DL	Soil	Dripline		0-1	1			
5704900	173	Soil	Beach	7772	0-6	3			
5704900	172U	Soil	Other -Not Specified	7206	0-1	3			
5078600	42	Soil	House	8346	0-1	3	1 - 6	5	1
5078600	**42 (HO replicate)**	**Soil**	**House**	**8346**	**0-1**	**1**			
5078600	42DL	Soil	Dripline		0-1	1			
5078600	**42DL (HO replicate)**	**Soil**	**Dripline**		**0-1**	**1**			
5078600	44	Soil	Agriculture	112864	0-1	3			
5078600	**44 (HO replicate)**	**Soil**	**Agriculture**	**112864**	**0-1**	**1**			
5078600	46	Soil	Other -Not Specified	125101	0-1	3			
5078600	47	Soil	Agriculture	64087	0-1	1			
5078600	1015	Soil	Garden	629	0-12	1			
5078600	1017	Soil	Garden	2318	0-1	3			
5078600	1018	Soil	Garden	1562	0-12	3			

Table 2

Residential Soil Sampling Program by Location

					Incremental Composite Samples		Discrete Core Samples		
Sampling Location	**Decision Unit**	**Matrix**	**Rationale for Sampling**	**DU Size (sq. ft)**	**Sample Depth (in)**	**No. of Samples**	**Sample Depth (in)**	**No. of Samples**	**Field Duplicates**
5078600	**1018 (HO replicate)**	**Soil**	**Garden**	**1562**	**0-12**	**1**			
5704920	1000	Soil	Beach	24885	0-6	3			
5705035	72	Soil	Garden	3889	0-12	3			
5705655	70	Soil	House	36990	0-1	3	1 - 6	5	1
5705655	71	Soil	Garden	5311	0-12	3			
5705655	1001	Soil	Other -Not Specified	26439	0-1	3			
5705655	70DL	Soil	Dripline		0-1	1			
5705655	72M	Soil	Agriculture	14178	0-1	3			
5705655	72U	Soil	Other -Not Specified	19829	0-1	1			
					Total Samples	**572**		**355**	**54**

* Homeowner has decided not to participate in study, samples are not included in total samples to be collected.

Attachment 1
Field Forms

U.S. Environmental Protection Agency
Region 10

Residential Soil Study
Phase 2 Field Reconnaissance
Notice of Site Visit and Sample Collection

EPA representatives visited this property on date and time listed below as part of the Residential Soil Study being conducted at the Upper Columbia River Site.

Property:	
Date:	
Time:	
EPA Representative:	
Notes:	

The purpose of the site visit was to collect soil samples for Phase 2 of the Residential Soil Study. A receipt documenting the samples collected at your property is attached.

What Happens Next ?

EPA will analyze the samples, evaluate the data, and notify you of the results in late January/early February 2015.

Please call **Kay Morrison at 1-800-424-4372 ex. 8321** or **Laura Buelow at 1-800-424-4372 ex. 65466** if you have any questions.

UCR Residential Soil Sampling Form - Sample Receipt

Owner Name: _____ DECISION UNITS: _____

Property ID _____ DATE: _____

Field Team: _____

Samples collected at property

Sample ID	Sample Depth	Comments

_____ _____

Field Team Leader Date

UCR Residential Soil Sampling Form - Field Change Request

Field Change No. _____ Project Number: 350521.FI.16.02

Page: _____ of _____

Field Team: _____

Change Request

Description of Change: _____

Reason for Change: _____

Requested by: _____ _____

Field Team Leader Date

Acknowledged by: _____ _____

Field Manager Date

Field Manager Recommendation: _____

Change Approval/Disapproval

Field Team Leader

Final Disposition: _____

Approved/Disapproved by: _____ _____

EPA Representative Date

UCR Residential Soil Sampling Form - Photo Log

PROPERTY ID: ______________________ DECISION UNIT: ______________

DATE: ______________

Field Team: ______________________ Project Number: 350521.FI.16.02

Photo #	Description

UCR Residential Soil Sampling Form - Incremental Composite Samples

PROPERTY ID: _____ DECISION UNIT: _____

Weather: _____ Start Time: _____ End Time: _____ DATE: _____

Field Team: _____ Project Number: 350521.FI.16.02

Primary Sample

Sample ID: _____ Sample Time: _____

Interval: _____ inches **Total Volume: (G)** _____

Sample Description _____

Deviations

Increment #	Issue	Resolution

Replicate Sample 1 (duplicate)

Sample ID: _____ Sample Time: _____

Interval: _____ inches **Total Volume: (G)** _____

Sample Description _____

Deviations

Increment #	Issue	Resolution

Replicate Sample 2 (triplicate)

Sample ID: _____ Sample Time: _____

Interval: _____ inches **Total Volume: (G)** _____

Sample Description _____

Deviations

Increment #	Issue	Resolution

UCR Residential Soil Sampling Form - Discrete Soil Samples

PROPERTY ID: _____ DECISION UNIT: _____

Weather: _____ DATE: _____

Field Team: _____ Project Number: 350521.FI.16.02

Location ID	Sample ID	Time	QA/QC ID	Time
D-1				
Sample Description				
D-2				
Sample Description				
D-3				
Sample Description				
D-4				
Sample Description				
D-5				
Sample Description				

Analysis: TAL Metals

Comment/Deviations:

Attachment 2
Residential Soil Study
Standard Operating Procedures

FIELD SOP 1

Positioning at Soil Sample Collection Areas

Scope and Applicability

This standard operating procedure (SOP) describes procedures used for locating soil sampling stations during the Residential Soil Study being conducted for the United States Environmental Protection Agency in the northern portion of the Upper Columbia River site in northeastern Washington. Please refer to the Phase 2 Residential Soil Study Quality Assurance Project Plan (QAPP) for more information about the objectives of the project and rationale for the data to be collected. .

Accurate station positioning is required to ensure quality and consistency in sample collection and data analysis. Station positioning must be both absolutely accurate in that it correctly defines a position by latitude and longitude, and relatively accurate in that the position must be repeatable. The methods described in this SOP are usable for any handheld geographic positioning system (GPS); however, consult the owner's manual for any GPS unit used to support this SOP.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Handheld GPS unit (e.g., Trimble GeoXH)
- Spare batteries
- Charging unit.

A GPS hardware system will be used for locating sampling stations, such as a Trimble GeoXH GPS (or equivalent device). The GPS unit will be loaded with previously-selected soil sampling locations prior to any visit to the Site. The standard projection method to be used during field activities is the horizontal datum of World Geodetic System of 1984 (WGS 1984).

Positioning System Verification

GPS does not require any calibration because all signal propagation is controlled by the U.S. government (the Department of Defense for satellite signals, and the U.S. Coast Guard and U.S. Forest Service for differential corrections). Verification of the accuracy of the GPS requires that coordinates be known for one (or more) horizontal control points within the study area. The GPS position reading at any given station can then be compared to the known control point. GPS accuracy will be verified at the beginning or at the end of each sampling day by logging the location of known reference point.

Procedures and Guidelines

Pre-selected sampling station locations, along with other applicable geographic information systems (GIS) data layers (e.g., aerial photographs, topography), will be uploaded into the handheld GPS unit(s) prior to the sampling effort. Any errors in location data or GPS projection will be noted in field notes. In the event that GPS coordinates are not provided for a DU, or if GPS reception is poor, refer to SOP 5 (Field Determination of Incremental Sample Locations) to locate sample increments.

A consistent routine will be used for each day's positioning activities. At the beginning of a sampling day, the field team leader will define the order in which the increment and discrete sample locations at each decision unit (DU) will be visited. The increment locations then will be selected one at a time from the pre-determined increment locations. Upon selection of a target increment location, the positioning data of the increment location will be displayed on the handheld unit to assist the field team in proceeding to the location. Ancillary information will be recorded in the field logbook, and should include the personnel operating the GPS system, elevation, and the time samples were collected.

A brief summary of procedures to locate a specific increment location using a handheld GPS unit follows:

- Turn on the unit.
- Wait for it to acquire the location of satellites.
- Select desired soil increment location.
- Follow GPS directions to desired increment location.
- If a soil sample is not accessible, move north within 2 feet of the GPS location. If still inaccessible, move 2 feet west, south, and east, until a soil sample is obtained.
- Charge the unit and batteries when not in use.

FIELD SOP 2

Underground Utility Location

Scope and Applicability

This standard operating procedure (SOP) describes procedures used for ensuring that the areas where samples are to be collected for the Residential Soil Study are clear of underground utilities. This SOP is specific to the Residential Soil Study being conducted for the United States Environmental Protection Agency (EPA) in the northern portion of the Upper Columbia River site in northeastern Washington and reflects project-specific information in the Health and Safety Plan (see Attachment 3 of the Field Sampling Plan [FSP]).

Procedures

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during collection of soil samples. The assessment must be conducted before any intrusive subsurface activity and must include at least the following elements:

1. A background and records assessment of known utilities or other subsurface obstructions. ***Specifically ask the resident if they buried any lines on their property (e.g. water, gas, electric), and follow the avoidance techniques listed below.***
2. Contacting and using the designated local utility locating service (e.g. 811)**.** ***The locating service will be notified of all properties to be sampled via fax approximately 7 days before sampling is scheduled to start.***
3. Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above. **NOTE: This requirement has been removed for the Residential Soil Study only if all of the other three provisions are followed, and the employee using the soil probe is wearing insulated "lineman" gloves when pushing the instrument into the ground (no exceptions).**
4. A visual survey of the area to validate the chosen location.

The following bullets describe the procedures for conducting each of the assessments

- **Background and Records Assessment of Known Utilities** - Interview the landowner about the locations of any buried utilities within or adjacent to the DU. If possible, obtain available utility diagrams and/or as-built drawings for the property. Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, electrical fences, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.
- **Designated Local Utility Locating Service** - Contact the designated local utility locating service (811 in Washington) to identify and mark the location of utilities at each property to be sampled. Contacting the local utility locating service is a legal requirement in most jurisdictions.
- **Independent Field Survey** - As noted above, this requirement has been removed for the Residential Soil Study due to the remote nature of the properties.
- **Visual Assessment before and during Intrusive Activities** - Perform a "360 degree" assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the sampling area.

The visual survey shall include all surface landmarks; **sheds or shops with power running to them, partially day-lighted lines**, manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

- **Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty** - When intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing or hand digging. Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.
- **Intrusive Activities within 2 feet of a "day-lighted" Underground Utility** - Use non-aggressive methods (hand digging) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.
- **Spotter** - A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility. Aggressive methods (including the soil probe) are never allowed within 2 feet of an identified high risk utility (see paragraph below). Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

FIELD SOP 3

Incremental Composite Soil Sample Collection

Scope and Applicability

This standard operating procedure (SOP) describes procedures used for collecting incremental composite (IC) soil samples during the Residential Soil Study being conducted for the United States Environmental Protection Agency (EPA) in the northern portion of the Upper Columbia River site in northeastern Washington. Please refer to the Phase 2 Residential Soil Study Quality Assurance Project Plan (QAPP) for more information about the objectives of the project and rationale for the data to be collected and Table 2 of the Field Sampling Plan (FSP) for the location and assigned sample depths for each IC sample. The procedures listed below may be modified in the field by the field supervisor (in consultation with EPA) based on conditions encountered in the field. Such changes and the EPA representative authorizing the change should be noted in the field logbook and on field change forms.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Handheld global positioning system (GPS) device
- Soil probes capable of collecting soil cores 2 to 4 cm in diameter and 1 to 18 inches deep
- Stainless steel shovel, trowel, or spoons
- Insulated lineman gloves
- Tape measure
- Survey flags (separate colors for primary, duplicate, and triplicate IC samples)
- Aerial photographs showing DU boundaries and increment locations
- Camera and digital storage card
- Field logbook (bound and paginated)
- Pens and pencils
- Chain-of-custody records and custody seals
- Field forms
- Sample labels
- Pre-cleaned plastic buckets (1 to 5 gallon size)
- Re-sealable plastic bags
- Plastic sheeting on which to work with collected samples
- Disposable nitrile gloves for handling soil samples
- Decontamination supplies
- Radios (for communication)
- Project-specific FSP and health and safety plan (HSP).

Procedures for Soil Sample Collection

The steps below detail the soil collection procedures for each primary and replicate (duplicate and triplicate) IC sample to be collected within a decision unit (DU). NOTE, not all DUs will require collection of replicate samples (see the sampling design for each DU summarized in Table 2 of the FSP).

Preparation for Sampling

1. Transport field personnel and sampling equipment to the decision unit (DU) selected for sampling.
2. Perform DU-specific utility location procedures (see SOP 2).
3. Check the sample location map and data table for the DU to determine whether replicates are required and the depth interval for the samples.
4. Locate each increment location for the primary IC sample using a handheld GPS unit (SOP 1) or by laying out the sampling grid (SOP 5). Place a flag labeled with the Location ID at the location.

   If replicates are required and locations are not preselected, locate each increment location for the replicate (duplicate and triplicate) IC samples using the following process:

   a. Refer to the DU map to determine the spacing between primary increments
   b. Divide the spacing by 3, this is the offset distance for the replicates
   c. Each duplicate IC increment will be collected directly north or south of the primary increment (use the same direction for all increments) at the specified offset distance. Place a flag labeled with the Location ID at the location.
   d. Each triplicate IC increment will be collected directly east or west (use the same direction for all increments) at the specified offset distance. Place a flag labeled with the Location ID at the location.

   Flags marking primary, duplicate, and triplicate IC increment locations should be different colors and also be different from the color of flags used to mark discrete soil sample locations.
5. Label each IC sample bucket in accordance with labeling requirements described in FSP prior to filling. The primary, duplicate, and triplicate IC samples will be placed in separate buckets.

Incremental Sample Collection (to be performed at each subsample increment location)

1. Document surface conditions in the vicinity of the increment location in the field notebook. Take digital photographs of the increment location (record in the photo log).
2. Sample increments should be obtained from an accessible location within 2 feet of the flagged increment location for the DU. If an increment cannot be obtained at the actual sample location, to avoid sampler bias, the sampler will first attempt to move 2 feet north of the GPS location and collect a sample. If this location is inappropriate for sampling, the sampler will move 2 feet west of the GPS location and attempt a sample. If a sample is still unattainable, the sampler will attempt to move 2 feet in either of the other two cardinal directions (south or east) of the GPS location. It is not necessary to adjust the planned locations for replicate increments if a primary increment locations is changed.
3. Wearing a clean pair of nitrile gloves, clear large surface debris from the increment location. Surface debris includes all identifiable debris such as twigs, intact leaves, pine needles, woody debris, duff, vegetation (including grass and grass roots), and rocks. Retain topsoil overlying mineral soil.
4. Collect the sample from each increment location using a soil punch or equivalent sampling device. Per SOP 2, insulated lineman gloves and a spotter will be used when operating the soil probe to mitigate possible encounters with unidentified underground utilities. The appropriate sample interval for each increment within a DU is DU-specific and is listed on Table 2 of the FSP.

5. Place the increment into a quart-sized re-sealable plastic bag dedicated to the IC sample.
6. Allow the cultural resources representative to inspect the increment in the quart-sized bag(s).
    a. If the increment passes the cultural resources review, continue sampling procedures.
    b. If the increment does not pass the cultural resources review, STOP SAMPLE COLLECTION. Notify the field supervisor for management-of change procedures.
6. Transfer the increment from the quart-sized inspection bag into the plastic bucket containing any previously collected increments for the sample.
7. Once an increment is successfully collected, remove the flag for its location and place it on the ground.
8. Complete field documentation for the increment location (see Soil Sample Collection Form in Attachment 1) and note any deviations to the sampling program on the form and in the field book.
9. Brush off the sample collection equipment between increment locations within one DU.
10. Continue collecting increments until all of the flags marking increment locations for the individual IC sample have been removed.

Decontamination and Incremental Sample Management (to be performed after all increments are collected)

1. Place a custody seal on the bucket to ensure its integrity during transport to sample management area.
2. Fully decontaminate sampling equipment between DUs as described in the FSP. Decontamination fluids can be discarded onto the ground in the vicinity of where the samples were collected.
3. Discard DU-dedicated sampling equipment such as gloves and quart-sized inspection bags into plastic trash bags for later disposal as solid waste.
4. At the close of the field day, transfer the IC sample containers to the sample manager, who will label and ship the IC sample containers to the analytical chemistry laboratory along with all appropriate documentation.

Collection of Quality Assurance/Quality Control Samples

Other than the replicate samples described above, no additional sample volumes will be collected in the field for quality assurance/quality control purposes.

FIELD SOP 4

Discrete Soil Sample Collection

Scope and Applicability

This standard operating procedure (SOP) describes procedures used for collecting discrete soil samples during the Residential Soil Study being conducted for the United States Environmental Protection Agency (EPA) in the northern portion of the Upper Columbia River site in northeastern Washington. Please refer to the Phase 2 Residential Soil Study Quality Assurance Project Plan (QAPP) for more information about the objectives of the project and rationale for the data to be collected and Table 2 of the Field Sampling Plan (FSP) for the location of each discrete sample. The procedures listed below may be modified in the field by the field supervisor (in consultation with EPA) based on conditions encountered in the field. Such changes and the EPA representative authorizing the change should be noted in the field logbook and on field change forms.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Soil probes capable of collecting soil cores 2 to 4 cm in diameter and 1 to 18 inches deep
- Stainless steel shovel, trowel, or spoons
- Insulated lineman gloves
- Tape measure
- Survey flags (separate colors for primary, duplicate, and triplicate IC samples)
- Aerial photographs showing DU boundaries and increment locations
- Camera and digital storage card
- Field logbook (bound and paginated)
- Pens and pencils
- Chain-of-custody records and custody seals
- Field forms
- Sample labels
- Re-sealable plastic bags
- Plastic sheeting on which to work with collected samples
- Disposable nitrile gloves for handling soil samples
- Certified pre-cleaned sample bottles
- Decontamination supplies
-
- Radios (for communication)
- Project-specific FSP and health and safety plan (HSP).

Procedures for Soil Sample Collection

The steps below detail the soil collection procedures for this sampling effort.

Preparation for Sampling

1. Transport field personnel and sampling equipment to the decision unit (DU) selected for sampling.
2. Perform DU-specific utility location procedures (see SOP 2).
3. Locate each discrete sample location using a handheld GPS unit. Place a flag labeled with the Location ID at the location. Flags marking discrete sample locations should be a different color than flags marking incremental composite subsample locations.

Sample Collection

1. Document surface conditions and anthropogenic changes in the vicinity of the sample location in the field notebook. Take digital photographs of the sample location (record in the photo log).
2. The discrete sample should be collected from an accessible location within 2 feet of the GPS sample location specified for the DU. If a soil sample cannot be obtained at the actual sample location, to avoid sampler bias, the sampler will first attempt to move 2 feet north of the GPS location and collect a sample. If this location is inappropriate for sampling, the sampler will move 2 feet west of the GPS location and attempt a sample. If a sample is still unattainable, the sampler will attempt to move 2 feet in either of the other two cardinal directions (south or east) of the GPS location.
3. Wearing a clean pair of nitrile gloves, clear large surface debris from the sample location. Surface debris includes all identifiable debris such as twigs, intact leaves, pine needles, woody debris, duff, vegetation (including grass and grass roots), and rocks. Retain topsoil overlying mineral soil.
4. Collect the discrete sample using a soil punch or equivalent sampling device. Per SOP 2, insulated lineman gloves and a spotter will be used to mitigate possible encounters with unidentified underground utilities. Each discrete soil sample will be obtained from the 1 to 6-inch below ground surface interval, as listed on Table 2 of the FSP.
5. Place the sample into a quart-sized re-sealable plastic bag.
6. Allow the cultural resources representative to inspect the sample in the quart-sized bag.
    c. If the sample passes the cultural resources review, continue sampling procedures.
    d. If the sample does not pass the cultural resources review, STOP SAMPLE COLLECTION. Notify the field supervisor for management-of change procedures.
7. Transfer the sample into the laboratory-supplied sample bottle.
8. Apply custody seals to container and lid to maintain integrity of sample during transport to sample management area.
9. Complete field documentation for the sample location (see Soil Sample Collection Form in Attachment) and note any deviations to the sampling program on the form and in the field book.

Decontamination and Sample Management

1. Fully decontaminate sampling and homogenization equipment between discrete sample locations as described in the FSP. Decontamination fluids can be discarded onto the ground in the vicinity of where the sample was collected.
2. Discard dedicated sampling equipment such as gloves and quart-sized inspection bags.

At the close of the field day, transfer the sample containers to the sample manager, who will label and ship the IC sample containers to the analytical chemistry laboratory along with all appropriate documentation.

Collection of Quality Assurance/Quality Control Samples

Field duplicate (FD) samples will be collected for discrete samples at a rate of 15 percent (1 FD for every 15 discrete samples).

The FD samples will be obtained from the thoroughly mixed and homogenized soil collected from the locations designated for such samples. Enough soil should be collected from each discrete sample location to split between the primary and duplicate sample. In the event additional sample volume is required to fulfill the volume requirements, an additional sample will be collected immediately adjacent to the first sample location and homogenized with the sample collected from the first sample location in an aluminum foil lined stainless steel bowl and then split between the primary and FD sample containers.

FIELD SOP 5

Field Determination of Incremental Sample Locations

Scope and Applicability

This standard operating procedure (SOP) describes the procedures for creating decision unit (DU) boundaries and incremental composite (IC) sample locations in the field during the Residential Soil Study being conducted for the United States Environmental Protection Agency (EPA) in the northern portion of the Upper Columbia River site in northeastern Washington. This SOP is needed because the decision unit (DU) boundaries and incremental sample locations for certain roof drip line and beach DUs will not be pre-determined by SRC prior to the onset of field work, or because of poor GPS reception in some portions of the study area. The IC samples will be collected in accordance with SOP 3 (Incremental Composite Soil Sample Collection) after the DU boundaries and increment locations are established.

Please refer to the Phase 2 Residential Soil Study Quality Assurance Project Plan (QAPP) for more information about the objectives of the project and rationale for the data to be collected and Table 2 of the Field Sampling Plan (FSP) for the general locations and assigned sample depths for the DUs at each property. The procedures listed below may be modified in the field by the field supervisor (in consultation with EPA) based on conditions encountered in the field. Such changes and the EPA representative authorizing the change should be noted in the field logbook and on field change forms.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Handheld global positioning system (GPS) device
- 100 meter (300 ft) reel tape
- Tape measure
- Camera and digital storage card
- Survey flags (separate colors for primary, duplicate, and triplicate IC samples)
- Aerial photographs showing approximate DU boundaries
- Calculator
- Random number generator, or dice
- 5lb sledge hammer
- Twine/string
- Field logbook
- Pens and pencils
- Project-specific FSP and health and safety plan (HSP).

Procedures for Determining Decision Unit Boundaries and Incremental Sample Locations for Drip Lines

The steps below detail the procedure for marking the drip line DUs for sampling.

1. Locate the structure where the drip line DU needs to be established.

2. Conduct visual inspection of the structure to identify drip lines for the roof. The drip line DU will consist of an approximately 6-ft wide strip of land between the structure and the outer edge of the drip edge splash zone for the roof (Figure 1). Gabled sides of the structure will be excluded from the drip line DU. Note that drip-line DUs may encompass multiple sides of the structure, or only a portion of one side based on structure-specific considerations determined during visual reconnaissance (Step 4).

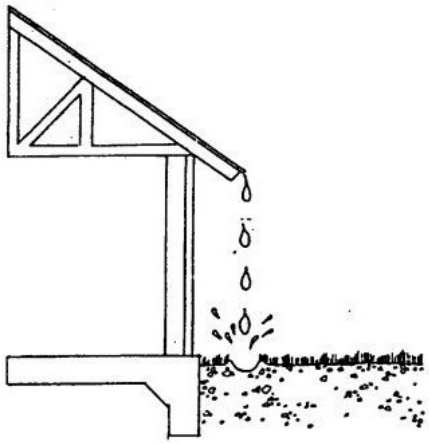


Figure 1. Drip Line and Splash Zone

3. Perform DU-specific utility location procedures (see SOP 2) and mark the locations of any underground utilities in the drip lines and mark any other locations that are unacceptable for sampling (e.g., recently placed backfill or construction), as these areas will be excluded from the drip line DU. Take multiple photographs of the DU and record all observations on the field sheets.
4. Once the location and extent of the DU is determined, install stakes or pin flags at the corners of each drip-line. Record the coordinates of each corner using a hand-help GPS unit with sub-meter accuracy. Draw a sketch of the DU on the site map.
5. Measure the entire length of the drip-line DU. Note that the drip-line DU may encompass multiple sides of the structure and may not be contiguous due to exclusions of areas observed during Step 4.
6. Calculate the overall area of the drip-line DU by multiplying the total length by the DU width. Divide the total DU area by 30 to get the size of each sampling grid cell (each grid cell should be the same size). Based on that area, determine the most practical dimensions for each grid cell.
7. Mark the corners of each grid cell with pin-flags, or use string tied to stakes to make a grid. Number the grid cells from 1 to 30 and conceptually split each cell into 4 quadrants.
8. Use a random number generator (or dice), determine which quadrant of the cells will be sampled. If using dice, re-roll any 5 or 6 until a 1, 2, 3 or 4 is rolled. The same quadrant will be sampled in all of the grid cells. Document the basis for selecting the quadrant in the field notes.
9. Each increment will be collected from the center of the determined quadrant for each cell. Mark the increment location and record its GPS coordinates.
10. Follow SOP #3: Incremental Composite Soil Sample Collection to collect the IC sample. Remove all stakes and pin flags upon completion of sampling.

Procedures for Determining Decision Unit Boundaries and Incremental Sample Locations for Beaches

The steps below detail the procedure for marking the beach DUs for sampling.

1. Locate the beach where the DU needs to be established.

2. Conduct visual inspection of the beach. The DU should extend throughout the beach area (i.e., area of un-vegetated, exposed sediment) to the water line.
3. Perform DU-specific utility location procedures (see SOP 2) and mark the locations of any underground utilities in beach area and mark any other locations that are unacceptable for sampling (e.g., cobbles or exposed bedrock), as these areas will be excluded from sampling. Take multiple photographs of the DU and record all observations on the field sheets.
4. Once the location and extent of the DU is determined, install stakes or pin flags at the corners of the beach. Record the coordinates of each corner using a hand-help GPS unit with sub-meter accuracy. Draw a sketch of the DU on the site map.
5. Measure the dimensions of the DU and calculate its area by multiplying the length by the width. Divide the total DU area by 30 to get the size of each sampling grid cell (each grid cell should be the same size). Based on that area, determine the most practical dimensions for each grid cell.
6. Mark the corners of each grid cell with pin-flags, or use string tied to stakes to make a grid. Number the grid cells from 1 to 30 and conceptually split each cell into 4 quadrants.
7. Use a random number generator (or dice), determine which quadrant of the cells will be sampled. If using dice, re-roll any 5 or 6 until a 1, 2, 3 or 4 is rolled. The same quadrant will be sampled in all of the grid cells. Document the basis for selecting the quadrant in the field notes.
8. Each increment will be collected from the center of the determined quadrant for each cell. Mark the increment location and record its GPS coordinates.
9. Follow SOP #3: Incremental Composite Soil Sample Collection to collect the IC sample. Remove all stakes and pin flags upon completion of sampling.

Procedures for Determining Incremental Sample Locations in Established DUs without GPS Reception

The steps below detail the procedure for determining IC sample locations within an established DU without GPS reception:

1. Locate the corners of the DU using GPS or landmarks.
2. Perform DU-specific utility location procedures (see SOP 2) and mark the locations of any underground utilities and mark any other locations that are unacceptable for sampling (e.g., cobbles or exposed bedrock), as these areas will be excluded from sampling. Take multiple photographs of the DU and record all observations on the field sheets.
3. Measure the dimensions of the DU and calculate its area by multiplying the length by the width. Divide the total DU area by 30 to get the size of each sampling grid cell (each grid cell should be the same size). Based on that area, determine the most practical dimensions for each grid cell.
4. Mark the corners of each grid cell with pin-flags, or use string tied to stakes to make a grid. Number the grid cells from 1 to 30 and conceptually split each cell into 4 quadrants.
5. Use a random number generator (or dice), determine which quadrant of the cells will be sampled. If using dice, re-roll any 5 or 6 until a 1, 2, 3 or 4 is rolled. The same quadrant will be sampled in all of the grid cells. Document the basis for selecting the quadrant in the field notes.
6. Each increment will be collected from the center of the determined quadrant for each cell. Mark the increment location and record its GPS coordinates.
7. Follow SOP #3: Incremental Composite Soil Sample Collection to collect the IC sample. Remove all stakes and pin flags upon completion of sampling.

Attachment 3
Health and Safety Plan

Health and Safety Plan

Upper Columbia River (UCR) RI/FS Oversight and Field Sampling

Prepared for

EPA Region 10; AES 10 Contract

August 14, 2014

Contents

Approval

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

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

Original Plan

RHSM Approval: **John Culley/SPK** **Date**: April 17, 2012

Field Operations Manager Approval: **Date:**

Revisions

Revisions Made By: Marilyn Gauthier/PDX **Date:** August 30, 2012

Description of Revisions to Plan: Added field activities associated with sediment sampling oversight and collection of split samples for metals analysis

Revisions Approved By: John Culley/SPK **Date: August 31, 2012**

Revisions

Revisions Made By: Craig Sauer/SPK **Date:** March 2014

Description of Revisions to Plan: Updated tasks, hazards/controls, SC-HW, emergency information, and air monitoring and PPE tables

Revisions Approved By: John Culley/SPK **Date: March 4, 2014**

Revisions

Revisions Made By: Rueben Greer/SPK **Date:** July 2014

Description of Revisions to Plan: Updated tasks, client contact, hazards/controls, SC-HW, and PPE table

Revisions Approved By: John Culley/SPK **Date: July 21, 2014**

Project HS&E Change Management Form

*This evaluation form should be reviewed on a **continuous** basis to determine if the current site health and safety plan adequately addresses ongoing project work, and should be completed whenever new tasks are contemplated or changed conditions are encountered..*

Project Task:	Sediment sampling oversight and split sample collection		
Project Number:	350521.FI.02	Project/Task Manager:	Marilyn Gauthier
Name:	Marilyn Gauthier	Employee #:	INC00014397

	Evaluation Checklist	Yes	No
1.	Have the CH2MHILL staff listed in the original HSP/FSI changed?	X	
2.	Has a new subcontractor been added to the project?	X	
3.	Is any chemical or product to be used that is not listed in Attachment 2 of the plan?		X
4.	Have additional tasks been added to the project which were not originally addressed in the plan?	X	
5.	Have new contaminants or higher than anticipated levels of original contaminants been encountered?		X
6.	Have other safety, equipment, activity or environmental hazards been encountered that are not addressed in the plan?	X	

If the answer is "YES" to Question 3, an HSP/FSI revision is NOT needed. Please take the following actions:

- Add the chemical to Attachment 2, and ensure employees handling the chemical are trained, and training documentation is added to Attachment 3.

If the answer is "YES" to Questions 1, 2 or 4-6, an HSP/FSI revision MAY BE NEEDED. Please contact HS&E directly.

Emergency Contacts

24-hour CH2M HILL Injury Reporting– 1-866-893-2514
24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911

Medical Emergency – 911 **Facility Medical Response #:** **Local Ambulance #:**	**CH2M HILL- Medical Consultant** WorkCare Dr. Peter Greaney M.D. 300 S. Harbor Blvd, Suite 600 Anaheim , CA 92805 800-455-6155 714-978-7488
Local Medical Clinic	**CH2M HILL Director – Health, Safety, Security & Environment** Andy Strickland/DEN (720) 480-0685 (cell) or (720) 286-2393 (office)
Fire/Spill Emergency – 911 **Facility Fire Response #:** **Local Fire Dept #:**	**Responsible Health and Safety Manager (RHSM)** Name: John Culley/SPK Phone: 206/660-3367
Security & Police – 911 **Facility Security #:** **Local Police #:**	**Human Resources Department** Employee Connect 720/286-4411
Utilities Emergency Phone Numbers Water: Gas: Electric:	**Worker's Compensation:** Contact Business Group HR dept. to have form completed or contact Jennifer Rindahl after hours: (720)891-5382
Safety Coordinator (SC-HW) Name: Rueben Greer/SPK Phone: 509/847-8819 Name: Steve Demus/SPK Phone: 509/ 944-1785 Name: Nathan Williams/PDX Phone: 509/ 999-2292	**Media Inquiries Corporate Strategic Communications** Name: John Corsi Phone: (720) 286-2087
Project Manager Name: Marilyn Gauthier/PDX Phone: 425/894-6464	**Automobile Accidents** Rental: Jennifer Rindahl/DEN (720) 286-2449 CH2M HILL owned vehicle: Teleplus Claim Reporting service – **1-800-753-6737**
Federal Express Dangerous Goods Shipping Phone: 800/238-5355	**CHEMTEL (hazardous material spills)** **Phone: 800/255-3924**

Hospital Name/Address: To be determined by the SC-HW once onsite; whether it is Northport or Colville, WA

Hospital Phone #:

Directions to Hospital

Take most direct route; SC-HW will develop hand-written map once onsite.

See map next page

Hospital Route Map

(SC-HW will develop hand-written map once onsite)

Incident Notification and Reporting

- Notify and submit reports to client as required in contract.
- Serious Incidents must be reported in accordance with CH2M HILL Standard of Practice, *Serious Incident Reporting Process*, immediately. Serious incidents are those that involve any of the following:
  - Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or public
  - Kidnap/missing person
  - Acts or threats of terrorism
  - Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage.
  - Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

In the event of an emergency, immediately call….. **911.**

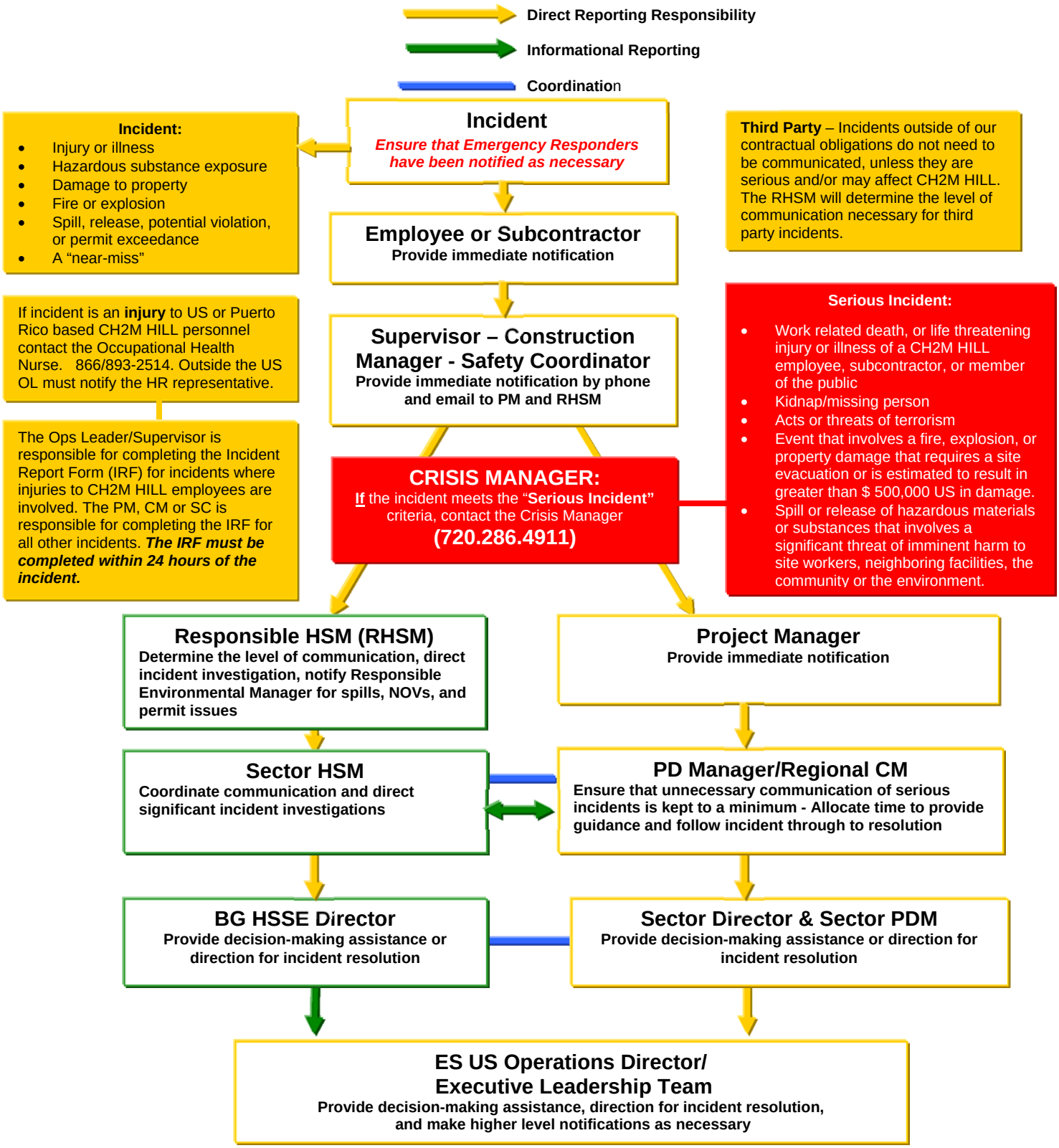
  - Severe Bleeding
  - Loss of consciousness
  - Chest Pain
  - Broken bones
- All other injuries or illness' (even those that are minor and may only require First Aid) which occur at work, while on business travel or commute must be reported to your supervisor immediately.
- **After informing their supervisor, 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).
- Appropriate treatment details are handled by the Occupational Injury Nurse, and HR Groups.
- Nurse communicates and troubleshoots with and for employee through full recovery.
- Complete a HITS report and notify the HSM.

ESBG Incident Reporting Flow Diagram

Individual Programs may have additional or alternate reporting procedures



Post-emergency incident communications regarding serious incidents at a CH2M HILL office or project (regardless of the party involved) shall be considered sensitive in nature and must be controlled in a confidential manner.

1.0 Introduction

1.1 CH2M HILL Policy and Commitment

1.1.1 Safe Work Policy

It is the policy of CH2M HILL to perform work in the safest manner possible. Safety must never be compromised. To fulfill the requirements of this policy, an organized and effective safety program must be carried out at each location where work is performed.

CH2M HILL believes that all injuries are preventable, and we are dedicated to the goal of a safe work environment. To achieve this goal, every employee on the project must assume responsibility for safety.

Every employee is empowered to:

- Conduct their work in a safe manner;
- Stop work immediately to correct any unsafe condition that is encountered; and
- Take corrective actions so that work may proceed in a safe manner.

Safety, occupational health, and environmental protection will not be sacrificed for production. These elements are integrated into quality control, cost reduction, and job performance, and are crucial to our success.

1.1.2 Health and Safety Commitment

CH2M HILL has embraced a philosophy for health and safety excellence. The primary driving force behind this commitment to health and safety is simple: employees are CH2M HILL's most significant asset and CH2M HILL management values their safety, health, and welfare. Also, top management believes that all injuries are preventable. CH2M HILL's safety culture empowers employees at all levels to accept ownership for safety and take whatever actions are necessary to eliminate injury. Our company is committed to world-class performance in health and safety and also understands that world-class performance in health and safety is a critical element in overall business success.

CH2M HILL is committed to the prevention of personal injuries, occupational illnesses, and damage to equipment and property in all of its operations; to the protection of the general public whenever it comes in contact with the Company's work; and to the prevention of pollution and environmental degradation.

Company management, field supervisors, and employees plan safety into each work task in order to prevent occupational injuries and illnesses. The ultimate success of CH2M HILL's safety program depends on the full cooperation and participation of each employee.

CH2M HILL management extends its full commitment to health and safety excellence.

1.1.3 Project-Specific Health, Safety, and the Environment Goals

All management and employees are to strive to meet the project-specific Health, Safety, and the Environment (HSE) goals outlined below. The team will be successful only if everyone makes a concerted effort to accomplish these goals. The goals allow the project to stay focused on optimizing the health and safety of all project personnel and, therefore, making the project a great success.

The Project has established eleven specific goals and objectives:

- Create an injury-free environment;
- Have zero injuries or incidents;

- Provide management leadership for HSE by communicating performance expectations, reviewing and tracking performance, and leading by example;
- Ensure effective implementation of the HSP through education, delegation, and team work;
- Ensure 100 percent participation in HSE compliance;
- Continuously improve our safety performance;
- Maintain free and open lines of communication;
- Make a personal commitment to safety as a value;
- Focus safety improvements on high-risk groups;
- Continue strong employee involvement initiatives; and
- Achieve health and safety excellence.

2.0 Applicability

This HSP applies to:

- All CH2M HILL staff, including subcontractors and tiered subcontractors of CH2M HILL working on the site; and
- All visitors to the construction site in the custody of CH2M HILL (including visitors from the Client, the Government, the public, and other staff of any CH2M HILL company).

This HSP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M HILL.

This HSP defines the procedures and requirements for the health and safety of CH2M HILL staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HSP will be kept onsite during field activities and will be reviewed as necessary. The HSP will be amended or revised as project activities or conditions change or when supplemental information becomes available. The HSP adopts, by reference, the Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, the HSP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HSP and any governing regulation, the more stringent and protective requirement shall apply.

All CH2M HILL staff and subcontractors must sign the employee sign-off form included in this document as Attachment 1 to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Coordinator (SC).

3.0 General Project Information

3.1 Project Information and Background

PROJECT NO: 350521

CLIENT: USEPA

PROJECT/SITE NAME: Upper Columbia River (UCR) RI/FS Oversight and Field Sampling

SITE ADDRESS: Kettle Falls, WA to the US/Canada border

CH2M HILL PROJECT MANAGER: Marilyn Gauthier/PDX

DATE HEALTH AND SAFETY PLAN REVISED: July 2014

Date(s) of Site Work: July 2014 through December 31, 2015

3.2 Site Background and Setting

Pending Superfund site; primarily concerned over mining/milling related impacts to WQ, sediment, and upland wind-blown effects. The largest concerns are the tailings discharges from Cominco smelter in Trail, BC

DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED: See Sections 3.3.1 and 3.3.2

3.3 Description of Tasks

Refer also to project documents (i.e., Work Plan) for detailed task information. Tasks other than those listed require an approved amendment or revision to this plan before tasks begin. All CH2M HILL and Subcontractor employees engaging in hazardous waste operations (HAZWOPER) or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65 (or if required by Subcontract). Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities. See the following tasks that fall under HAZWOPER requirements.

3.3.1 HAZWOPER-Regulated Tasks

- 3rd-party observation of fish, water, sediment, and soil sampling
- Collection of split samples for analysis by EPA laboratory
- Collection of upland sub-surface soil samples from residential properties (using trowels or Terra Core device)

3.3.2 Non-HAZWOPER-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. The following tasks do not involve exposure to safety or health hazards associated with the hazardous waste operations. Hazwoper training or medical requirements do not apply for the tasks listed below.

TASKS	CONTROLS
• Surveying • Site reconnaissance	• Brief on hazards, limits of access, and emergency procedures. • Post areas of contamination as appropriate. • Perform air sampling/monitoring as specified in Section 13.0. • Wear PPE as outlined in Section 14.0

SITE MAP

4.0 Project Organization and Responsibilities

4.1 Client

Contact Name: Laura Buelow
Phone: 509/376 5466

4.2 CH2M HILL

4.2.1 Project Manager

Name: Marilyn Gauthier/PDX
Phone: 425/894-6464

The project manager (PM) is responsible for providing adequate resources (budget and staff) for project-specific implementation of the HSE management process. The PM has overall management responsibility for the tasks listed below. The PM 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 document:

- Incorporate standard terms and conditions, and contract-specific HSE roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:
  - Choosing potential subcontractors based on technical ability and HSE performance;
  - Implementing the subcontractor prequalification process;
  - Ensuring that acceptable certificates of insurance, including CH2M HILL as named additional insured, are secured as a condition of subcontract award; and
  - Ensuring HSE submittals, subcontract agreements, and appropriate site-specific safety procedures are in place and accepted prior field mobilization.
- Ensure copies of training and medical monitoring records, and site-specific safety procedures are being maintained in the project file accessible to site personnel.
- Provide oversight of subcontractor HSE practices per the site-specific safety plans and procedures.
- Manage the site and interfacing with 3rd parties in a manner consistent with the contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented.
- Provide visible support and motivation for HSE programs, rules, procedures, processes, and training, leading by example and encouraging CH2M HILL employees to take ownership of HSE issues.
- Intervene or stop work when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition is encountered.
- Make available to and require CH2M HILL employees to complete required HSE training within established timelines and provide project numbers for such training.
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites.
- Promptly report all work-related HSE incidents or near misses.
- Wear any required personal protective equipment.
- Ensure CH2M HILL employees complete required HSE training within established timelines.

- Conduct, cooperate, or assist with HSE incident investigations.
- Consult with the Human Resources Delivery Partner before taking any disciplinary action (other than verbal counseling) associated with CH2M HILL Policy 203 and/or HSE programs rules, procedures, processes and training.

4.2.2 CH2M HILL Responsible Health and Safety Manager

RHSM Name: John Culley/SPK
Cellular Number: 206/660-3367

The RHSM is responsible for the following:

- Review and evaluate subcontractor HSE performance using the pre-qualification process;
- Approve HSP and its revisions as well as Activity Hazard Analyses (AHA);
- Review and evaluate subcontractor site-specific safety procedures for adequacy prior to start of subcontractor's field operations;
- Support the oversight (or SC's direct oversight) of subcontractor and tiered subcontractor HSE practices;
- Permit upgrades and downgrades in respiratory protection after reviewing analytical data;
- Conduct audits as determined by project schedule and coordination with PM; and
- Participate in incident investigations, lessons learned, loss and near loss reporting.

4.2.3 CH2M HILL Project Environmental Manager

EM Name: Nancy Ballantyne/DEN
Cellular Number: (303) 885-9954

The Project EM is responsible for the following:

- Provide environmental program support in areas such as training, auditing, planning, permit tracking, and subcontractor oversight as needed or as specified in the project environmental plan;
- Review and evaluate qualifications for subcontractors with a history of environmental non-compliance and for waste transportation and disposal subcontractors;
- Evaluate any spills, releases, or environmental permit incidents for appropriate follow-up actions, notifications, and recordkeeping requirements; and
- Provide environmental compliance and environmental management expertise and advice to the project team as needed during the course of the project.

4.2.4 CH2M HILL Safety Coordinator

Name: Rueben Greer/SPK
Phone: 509/847-8819
Name: Steve Demus/SPK
Phone: 509/ 944-1785
Name: Nathan Williams/PDX
Phone: 509/ 999-2292

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

- Verify this HSP is current and amended when project activities or conditions change;
- Verify CH2M HILL site personnel and subcontractor personnel read the HSP and sign the Employee Sign-Off Form, prior to commencing field activities;

- Verify CH2M HILL site personnel have completed any required specialty training (for example, fall protection, confined space entry, among others) and medical surveillance as identified in this HSP;
- Verify that project files include copies of subcontractor training and medical monitoring records, and accepted site-specific safety procedures prior to start of subcontractor's field operations;
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in the HSP;
- Act as the project "Emergency Response Coordinator" and perform the responsibilities outlined in the HSP;
- Hold and/or verify that safety meetings are conducted and documented in the project file initially and as needed throughout the course of the project (as tasks or hazards change);
- Verify that project health and safety forms and permits are being used as outlined this HSP;
- Perform oversight and assessments of subcontractor HSE practices per the site-specific safety plan and verify that project activity self-assessment checklists are being used as outlined this HSP;
- Coordinate with the RHSM regarding CH2M HILL and subcontractor operational performance, and 3rd party interfaces;
- Verify appropriate personal protective equipment (PPE) use, availability, and training;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Conduct accident investigations including root cause analysis;
- Calibrate and conduct air monitoring in accordance with the HSP; maintain all air monitoring records in project file;
- Maintain HSE records and documentation;
- Facilitate OSHA or other government agency inspections including accompanying inspector and providing all necessary documentation and follow-up;
- Deliver field HSE training as needed based on project-specific hazards and activities;
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites;
- Wear any required personal protective equipment;
- Conduct, cooperate, or assist with HSE incident investigations;
- Contact the PM and RHSM when standards of conduct or CH2M HILL Policy 203 has been violated by a CH2M HILL employee;
- Contact the RHSM and PM in the event of an incident;
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, stop affected work until adequate corrective measures are implemented, and notify the PM and RHSM as appropriate; and
- Document all oral health and safety-related communications in project field logbook, daily reports, or other records.

4.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HSE-215, *Contracts and Subcontracts)*

Subcontractor: E2 Consulting Engineers
Subcontractor Contact Name: Tracy Grant
Telephone: 510/918 7700
Subcontractor Tasks: Sample transportation, documentation, and shipping
Safety Procedures Required: Must fully comply with our HSP

Subcontractors must comply with the following activities, and are responsible to:

- Comply with all local, state, and federal safety standards;
- Comply with project and owner safety requirements;
- Actively participate in the project safety program and either hold or attend and participate in all required safety meetings;
- Provide a qualified safety representative to interface with CH2M HILL;
- Maintain safety equipment and PPE for their employees;
- Maintain and replace safety protection systems damaged or removed by the subcontractor's operations;
- Notify the SC of any accident, injury, or incident (including spills or releases) immediately and submit reports to CH2M HILL within 24 hours;
- Install contractually required general conditions for safety (for example, handrail, fencing, fall protection systems, floor opening covers);
- Conduct and document weekly safety inspections of project-specific tasks and associated work areas;
- Conduct site-specific and job-specific training for all subcontractor employees, including review of the CH2M HILL HSP, subcontractor HSPs, and subcontractor AHAs and sign appropriate sign-off forms; and
- Determine and implement necessary controls and corrective actions to correct unsafe conditions.

The subcontractors listed above may be required to submit their own site-specific HSP and other plans such as lead or asbestos abatement compliance plans. Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit their plans to CH2M HILL for review and acceptance before the start of field work.

Subcontractors are also required to prepare AHAs before beginning each activity posing hazards to their personnel. The AHA shall identify the principle steps of the activity, potential health and safety hazards for each step and recommended control measures for each identified hazard. 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.

4.4 Employee Responsibilities

All personnel are assigned responsibility for safe and healthy operations. This concept is the foundation for involving all employees in identifying hazards and providing solutions. For any operation, individuals have full authority to stop work and initiate immediate corrective action or control. In addition, each worker has a right and responsibility to report unsafe conditions or practices. This right represents a significant facet of worker empowerment and program ownership. Through shared values and a belief that all accidents are preventable, our employees accept personal responsibility for working safely.

Each employee is responsible for the following performance objectives:

- Understanding and abiding by CH2M HILL and client HSE programs, rules, procedures, processes, and training, including any that are project-specific;
- Completing all required HSE training made available and accessible within established timelines;
- Always wearing any required personal protective equipment;
- Intervening or stopping work for you or other CH2M HILL employees when an unsafe condition or behavior is encountered or observed, and/or when an environmentally compromising condition exists;
- Promptly notifying a supervisor, PM, SC, or RHSM when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition exists;
- Promptly reporting a supervisor, PM, SC, or RHSM all work-related health, safety , and environmental incidents or near misses;
- Attending required project HSE pre-task briefings and meeting prior to performing work; and
- Cooperating or assisting with HSE incident investigations.

4.4.1 Employee Authority

Each employee on the project has the obligation and authority to shut down any perceived unsafe work and during employee orientation, each employee will be informed of their authority to do so.

4.5 Client Contractors

(Reference CH2M HILL SOP HSE-215, *Contracts, Subcontracts and HSE Management Practices*)

Contractor: National Park Service
Contractor Contact Name: Keith Holiday
Telephone: 509/536 1222
Contractor Tasks: Watercraft operations

This HSP does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues). In addition to these instructions, CH2M HILL team members should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Self-assessment checklists are to be used by the SC and CH2M HILL team members to review the contractor's performance only as it pertains to evaluating CH2M HILL exposure and safety. The RHSM is the only person who is authorized to comment on or approve contractor safety procedures.

Health and safety-related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL team members on the precautions related to the contractor's work;
- When an apparent contractor non-compliance or unsafe condition or practice poses a risk to CH2M HILL team members:
  - Notify the contractor safety representative;
  - Request that the contractor determine and implement corrective actions;
  - If necessary, stop affected CH2M HILL work until contractor corrects the condition or practice; and
  - Notify the client, PM, and RHSM as appropriate.

If apparent contractor non-compliance or unsafe conditions or practices are observed, inform the contractor safety representative (CH2M HILL's obligation is limited strictly to informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative (CH2M HILL's obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

All verbal health and safety-related communications will be documented in project field logbook, daily reports, or other records.

5.0 Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the following standards of conduct, the HSP, and the safety requirements of CH2M HILL. Commonly accepted standards of conduct help maintain good relationships between people. They promote responsibility and self-development. Misunderstandings, frictions, and disciplinary action can be avoided by refraining from thoughtless or wrongful acts.

5.1 Standards of Conduct Violations

All individuals associated with this project are expected to behave in a professional manner. Violations of the standards of conduct would include, but not be limited to:

- Failure to perform work;
- Inefficient performance, incompetence, or neglect of work;
- Willful refusal to perform work as directed (insubordination);
- Negligence in observing safety regulations, poor housekeeping, or failure to report on-the-job injuries or unsafe conditions;
- Unexcused or excessive absence or tardiness;
- Unwillingness or inability to work in harmony with others;
- Discourtesy, irritation, friction, or other conduct that creates disharmony;
- Harassment or discrimination against another individual;
- Failure to be prepared for work by wearing the appropriate construction clothing or bringing the necessary tools; or
- Violation of any other commonly accepted reasonable rule of responsible personal conduct.

5.2 Disciplinary Actions

The Environmental Services (ES) business group employees, employees working on ES business group projects, and subcontractor employees are subject to disciplinary action for not following HSE rules and requirements. Potential disciplinary action is equally applicable to all employees including management and supervision. Disciplinary action may include denial of access to the worksite, warnings, reprimands, and other actions up to and including termination depending on the specific circumstances.

5.3 Subcontractor Safety Performance

CH2M HILL should continuously endeavor to observe subcontractors' safety performance and adherence to their plans and AHAs. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

5.3.1 Observed Hazard Form

When apparent non-compliance or unsafe conditions or practices are observed, notify the subcontractor's supervisor or safety representative verbally, and document using the Observed Hazard Form, included as an attachment to this HSP, and require corrective action.

If necessary, stop subcontractor's work using the Stop Work Order Form until corrective actions is implemented for observed serious hazards or conditions. Update the Observed Hazard Form to document corrective actions have been taken. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.

5.3.2 Stop Work Order

CH2M HILL has the authority, as specified in the contract, and the responsibility to stop work in the event any CH2M HILL employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the subcontractor of its responsibilities for the means and methods of the work or, therefore, of any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, immediately stop work and alert all affected individuals. Remove all affected CH2M HILL employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM, Contract Administrator (KA) and RHSM.

When repeated non-compliance or unsafe conditions are observed, notify the subcontractor's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (attached to this HSP) until adequate corrective measures are implemented. Consult the KA to determine what the contract dictates for actions to pursue in event of subcontractor non-compliance including work stoppage, back charges, progress payments, removal of subcontractor manager, monetary penalties, or termination of subcontractor for cause.

5.4 Incentive Program

Each project is encouraged to implement a safety incentive program that rewards workers for exhibiting exemplary safety behaviors. Actions that qualify are those that go above and beyond what is expected. Actions that will be rewarded include spotting and correcting a hazard, bringing a hazard to the attention of your foreman, telling your foreman about an incident, coming up with a safer way to get the work done, or stopping a crew member from doing something unsafe. The program will operate throughout the project, covering all workers. The incentive program will be communicated to all employees during the project employee orientation and project safety meetings.

5.5 Reporting Unsafe Conditions/Practices

Responsibility for effective health and safety management extends to all levels of the project and requires good communication between employees, supervisors, and management. Accident prevention requires a pro-active policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the

safety of our projects. All unsafe conditions or unsafe practices will be corrected immediately. CH2M HILL has zero tolerance of unsafe conditions or unsafe practices.

No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition;
- The unsafe condition or practice will be brought to the attention of the worker's direct supervisor, unless the unsafe condition or practice involves the employee's direct supervisor. If so, the SC needs to be notified at once by the responsible employee;
- Either the responsible employee or responsible employee's direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SC;
- The SC will act promptly to correct the unsafe condition or practice; and
- Details of the incident or situation will be recorded by the SC in the field logbook or use the Observed Hazard Form if subcontractor was involved.

6.0 Safety Planning and Change Management

6.1 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings are to be held with all project personnel in attendance to review the hazards posed and required HSE procedures and AHAs that apply for each day's project activities. The Pre-Task Safety Plans (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 as an attachment to this HSP, 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 HSE procedures, as identified in the HSP and AHA. The use of PTSPs promotes worker participation in the hazard recognition and control process while reinforcing the task-specific hazard and required HSE procedures with the crew each day.

6.2 Change Management

This HSP addresses all known activities and associated hazards. As work progresses, if significant changes are identified which could affect health and safety at the site, coordinate with the RHSM to determine whether a HSP update is necessary.

The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in this HSP.

6.3 Agency Inspection Guidance

(Reference CH2M HILL SOP HSE-201, *Agency Inspections and Communications*)

Agency inspections (e.g., OSHA, EPA, other regulatory agencies) are on the rise. CH2M HILL implements safety and environmental programs in order to ensure safety to workers, the public, and the environment. This plan addresses things like labeling containers, completing the hazard communication training using the attachments to this HSP, listing training requirements and PPE requirements, and addressing project-specific hazards. Field personnel need to contact the RHSM to update this plan if hazards are encountered that are not addressed.

SOP HSE-201 addresses agency inspections in detail, and the attached **Target Zero Bulletin on Agency Inspections** provides a good summary of the inspection process and what to do if an agency such as OSHA or EPA shows up at the site. It is critical to make immediate notification to the RHSM if an inspector arrives (and EM if it is environmental-related); they can help facilitate and make additional notifications.

Review the Target Zero Bulletin and keep it with your Health and Safety Plan/Environmental Plan. Make it a topic at a safety meeting and keep it readily available in the event of an inspection.

7.0 Project Hazard Analysis

A health and safety risk analysis (Table 1) has been performed for each task. In the order listed below, the RHSM considers the various methods for mitigating the hazards. Employees are trained on this hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects:

- Elimination of the hazards (use remote sampling methodology to avoid going into a confined space);
- Substitution (reduce exposure to vapors by using of a geoprobe instead of test pitting);
- Engineering controls (ventilate a confined space to improve air quality);
- Warnings (establish exclusion zones to keep untrained people away from hazardous waste work);
- Administrative controls (implement a work-rest schedule to reduce chance of heat stress); or
- Use of PPE (use of respirators when action levels are exceeded).

The hazard controls and safe work practices are summarized in the following sections of this HSP:

- General hazards and controls;
- Project-specific hazards and controls;
- Physical hazards and controls;
- Biological hazards and controls; and
- Contaminants of concern.

7.1 Activity Hazard Analysis

An AHA must be developed for each CH2M HILL job activity. The AHA shall define the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements to be performed and training requirements for the safe operation of the equipment listed must be identified. Workers are briefed on the AHA before performing the work and their input is solicited prior, during, and after the performance of work to further identify the hazards posed and control measures required. The AHA shall identify the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard.

The following hazard controls and applicable CH2M HILL core standards and SOPs should be used as a basis for preparing AHAs.

AHAs prepared for CH2M HILL activities are included as an attachment to this HSP.

7.2 Subcontractor Activity Hazard Analysis

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

Table 1 – General Activity Hazard Analysis

Project Activity / Potential Hazard	3rd-party Observation of Fish, Water, Sediment, and Soil Sampling	Surveying, Site Reconnaissance	Collection of Split Samples	Collection of Sub-Surface Soil Samples
Biological Hazards	X	X	X	X
Blood Borne Pathogens	X	X	X	X
Chemical Hazard	X		X	X
Driving	X	X	X	X
Electrical Safety	X	X	X	
Field Vehicles	X	X	X	X
Fire Prevention	X	X	X	
Hand & Power Tools	X	X	X	X
Hazard Communication	X		X	X
Ladder Safety	X	X	X	
Lighting	X	X	X	X
Manual Lifting	X	X	X	X
Noise	X	X	X	
Boating Safety	X	X	X	
Temperature Extremes	X	X	X	X
Ultraviolet Light exposure (sunburn)	X	X	X	X
Underground utilities				X

8.0 General Hazards and Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. It is a summarized list of requirements. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented.

8.1 Bloodborne Pathogens

(Reference CH2M HILL SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material (PIM).

Employees trained in first-aid/CPR or those exposed to PIM must complete CH2M HILL's 1-hour bloodborne pathogens computer-based training module annually. When performing first-aid/CPR the following shall apply:

- Observe universal precautions to prevent contact with blood or other PIMs. Where differentiation between body fluid types is difficult or impossible, consider all body fluids to be potentially infectious materials;
- Always wash your hands and face with soap and running water after contacting PIMs. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes; and

- If necessary, decontaminate all potentially contaminated equipment and surfaces with chlorine bleach as soon as possible. Use one part chlorine bleach (5.25 percent sodium hypochlorite solution) diluted with 10 parts water for decontaminating equipment or surfaces after initially removing blood or other PIMs. Remove contaminated PPE as soon as possible before leaving a work area.
    - CH2M HILL will provide exposed employees with a confidential medical examination should an exposure to PIM occur. This examination includes the following procedures:
- Documenting the exposure;
- Testing the exposed employee's and the source individual's blood (with consent); and
- Administering post-exposure prophylaxis.

8.2 Driving Safety

Follow the guidelines below when operating a vehicle:

- Refrain from using a cellular phone while driving. Pull off the road, put the vehicle in park and turn on flashers before talking on a cellular phone;
- Never operate a personal digital assistant (PDA), or other device with e-mail, internet, or text messaging function while driving a vehicle;
- Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you;
- Do no drive while drowsy. Drowsiness can occur at any time, but is most likely after 18 hours or more without sleep;
- Maintain focus on driving. Eating, drinking, smoking, adjusting controls can divert attention from the road. Take the time to park and perform these tasks when parked rather than while driving; and
- Ensure vehicle drivers are familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles.

8.3 Electrical Safety

(Reference CH2M HILL SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed:

- Only qualified personnel are permitted to work on unprotected energized electrical systems;
- Only authorized personnel are permitted to enter high-voltage areas;
- CH2M HILL employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M HILL VO;
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented;
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service;

- CH2M HILL has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock;
    - GFCIs shall be used on all 120-volt, single phase 15 and 20-amphere receptacle outlets which are not part of the permanent wiring of the building or structure.
- An assured equipment grounding conductor program may be required under the following scenarios:
    - GFCIs cannot be utilized;
    - Client requires such a program to be implemented; or
    - Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be 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;
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage; and
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

8.4 Field Vehicles

- Field vehicles may be personal vehicles, rental vehicles, fleet vehicles, or project vehicles.
- Maintain a first aid kit, bloodborne pathogen kit, and fire extinguisher in the field vehicle at all times.
- Utilize a rotary beacon on vehicle if working adjacent to active roadway.
- Familiarize yourself with rental vehicle features prior to operating the vehicle:
    - Vision Fields and Blind Spots
    - Vehicle Size
    - Mirror adjustments
    - Seat adjustments
    - Cruise control features, if offered
    - Pre-program radio stations and Global Positioning System (GPS), if equipped
- Always wear seatbelt while operating vehicle.
- Adjust headrest to proper position.
- Tie down loose items if utilizing a van or pick-up truck.
- Close car doors slowly and carefully. Fingers can get pinched in doors.
- Park vehicle in a location easily accessed in the event of an emergency. If not possible, carry a phone.
- Have a designated place for storing the field vehicle keys when not in use.

- Ensure back-up alarms are functioning, if equipped. Before backing a vehicle, take a walk around the vehicle to identify obstructions or hazards. Use a spotter when necessary to back into or out of an area.
- See the Vehicle Accident Guidance attached to this HSP, if a vehicle incident is experienced in a rental or fleet vehicle.

8.5 Fire Prevention

(Reference CH2M HILL SOP HSE-403, *Hazardous Material Handling*)

Follow the fire prevention and control procedures listed below.

8.5.1 Fire Extinguishers and General Fire Prevention Practices

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet (30.5 meters). When 5 gallons (19 liters) or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet (15.2 meters). Extinguishers must:
  - be maintained in a fully charged and operable condition;
  - be visually inspected each month; and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Combustible materials stored outside should be at least 10 feet (3 meters) from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Keep areas neat. Housekeeping is important.

8.5.2 Dispensing of Flammable/Combustible Liquids

- Areas in which flammable or combustible liquids are dispensed in quantities greater than 5 gallons (22.7 liters) (shall be separated from other operations by at least 25 feet (7.6 meters).
- Drainage away from storm drains or surface waters or other means of containment shall be provided to control spills.
- Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.
- Dispensing of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).
- Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks is prohibited.
- Dispensing devices and nozzles for flammable liquids shall be of an approved type.

8.6 General Practices and Housekeeping

The following are general requirements applicable to all portions of the work:

- Site work should be performed during daylight hours whenever possible;
- Good housekeeping must be maintained at all times in all project work areas;
- Common paths of travel should be established and kept 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, or other devices to be used;

- Specific areas should be designated for the proper storage of materials;
- Tools, equipment, materials, and supplies shall be stored in an orderly manner;
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area;
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals;
- All spills shall be quickly cleaned up; oil and grease shall be cleaned from walking and working surfaces;
- Review the safety requirements of each job you are assigned to with your supervisor. You are not expected to perform a job that may result in injury or illness to yourself or to others;
- Familiarize yourself with, understand, and follow jobsite emergency procedures;
- Do not fight or horseplay while conducting the firm's business;
- Do not use or possess firearms or other weapons while conducting the firm's business;
- Report unsafe conditions or unsafe acts to your supervisor immediately;
- Report emergencies, occupational illnesses, injuries, vehicle accidents, and near misses immediately;
- Do not remove or make ineffective safeguards or safety devices attached to any piece of equipment;
- Report unsafe equipment, defective or frayed electrical cords, and unguarded machinery to your supervisor;
- Shut down and lock out machinery and equipment before cleaning, adjustment, or repair. Do not lubricate or repair moving parts of machinery while the parts are in motion;
- Do not run in the workplace;
- When ascending or descending stairways, use the handrail and take one step at a time;
- Do not apply compressed air to any person or clothing;
- Do not wear steel taps or shoes with metal exposed to the sole at any CH2M HILL project location;
- Do not wear finger rings, loose clothing, wristwatches, and other loose accessories when within arm's reach of moving machinery;
- Remove waste and debris from workplace and dispose in accordance with federal, state, and local regulations;
- Note the correct way to lift heavy objects (secure footing, firm grip, straight back, lift with legs), and get help if needed. Use mechanical lifting devices whenever possible; and
- Check the work area to determine what problems or hazards may exist.

8.7 Hazard Communication

(Reference CH2M HILL SOPs HSE-107, *Hazard Communication* and HSE-403, *Hazardous Material Handling*)

The hazard communication coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available;
- Request or confirm locations of material safety data sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed;

- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical and include on the chemical inventory sheet (attached to this HSP) and add the MSDS to the MSDS attachment section of this HSP;
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly;
- Give employees required chemical-specific HAZCOM training using the chemical-specific training form included as an attachment to this HSP; and
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

8.8 Knife Use

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multi-purpose tools with fixed blades such as a Leatherman™) are prohibited at worksites except where the following three conditions are met:

- The open-bladed knife is determined to be the best tool for the job;
- An approved Activity Hazard Analysis (AHA) or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training); and
- Knife users have been trained and follow the AHA.

8.9 Lighting

Lighting shall be evaluated when conducting work inside buildings, confined spaces, or other areas/instances where supplemental light may be needed (e.g., work before sunrise or after sunset). A light meter can be used to evaluate the adequacy of lighting. The following are common requirements for lighting and the conditions/type of work being performed:

- While work is in progress outside construction areas shall have at least 33 lux (lx);
- Construction work conducted inside buildings should be provided with at least 55 lux light;
- The means of egress shall be illuminated with emergency and non-emergency lighting to provide a minimum 11 lx measured at the floor. Egress illumination shall be arranged so that the failure of any single lighting unit, including the burning out of an electric bulb will not leave any area in total darkness.

8.10 Personal Hygiene

Good hygiene is essential for personal health and to reduce the potential of cross-contamination when working on a hazardous waste site. Implement the following:

- Keep hands away from nose, mouth, and eyes during work;
- Keep areas of broken skin (chapped, burned, etc.) covered; and
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics.

8.11 Substance Abuse

(Reference CH2M HILL SOP HSE-105, *Drug-Free Workplace)*

Employees who work under the influence of controlled substances, drugs, or alcohol may prove to be dangerous or otherwise harmful to themselves, other employees, clients, the company, the company's assets and interests, or the public. CH2M HILL does not tolerate illegal drug use, or any use of drugs, controlled substances, or alcohol that impairs an employee's work performance or behavior.

Prohibitions onsite include:

- Use or possession of intoxicating beverages while performing CH2M HILL work;
- Abuse of prescription or nonprescription drugs;
- Use or possession of illegal drugs or drugs obtained illegally;
- Sale, purchase, or transfer of legal, illegal or illegally obtained drugs; and
- Arrival at work under the influence of legal or illegal drugs or alcohol.
    - Drug and/or alcohol testing is applicable under CH2M HILL Constructors, Inc. and munitions response projects performed in the United States. In addition, employees may be required to submit to drug and/or alcohol testing as required by clients. When required, this testing is performed in accordance with SOP HSE-105, Drug-Free Workplace. Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M HILL Virtual Office (VO).

8.12 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. CH2M HILL or subcontractor personnel encountering unknown or suspect objectsmaterials 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/HSM of the encountered condition and

4) not provide additional disturbance or otherwise handle the suspect object/material.

The site supervisor or SC shall contact the Project Manager and the HSM 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.

8.13 Field Ergonomics and Manual Lifting

(Reference CH2M HILL SOP HSE-112, *Manual Lifting*)

Some of the most common injuries during field work are the result of performing work in an awkward body position (poor ergonomics) or pushing the body beyond its natural limits. Workers who have to lift, stoop, kneel, twist, grip, stretch, reach overhead, or work in other awkward positions regularly are at risk of developing discomfort or even an injury. Additionally, back injuries are one of the leading causes of work disability and most back injuries are the result of improper lifting techniques or overexertion.

Contact the RHSM to determine hazard control measures if your task involves:

Repetitive motions;

Lifting and carrying items over long distances or on steep or sloped terrain;

Heavy lifting;

Use of vibrating tools or equipment; or

Being in a static position for extended periods of time;

There are a variety of ergonomically designed tools and work practices that can reduce the potential for discomfort and injury. Following are requirements ("must" or "shall") and recommendations ("should") to aid in the prevention of discomfort or injuries while working in the field.

Fitness for Duty

If manual lifting and repetitive activities are not part of your normal work duties, contact your PM and/or RHSM to help determine if you have the physical capability to perform the work. In many cases adding lifting or repetitive tasks to a subcontractor's scope of work is desirable to prevent injury. If the work task causes any pain or discomfort stop and get assistance.

Manual Lifting

All CH2M HILL workers must have training in proper manual lifting either through New Employee Orientation or through the Manual Lifting module located on the VO;

When possible, the task should be modified to minimize manual lifting hazards or awkward body positions;

Lifting loads weighing more than 40 pounds (18 kilograms) shall be evaluated by the SC using the Lifting Evaluation Form contained in SOP HSE-112;

Personnel shall seek assistance when performing manual lifting tasks that appear beyond physical capabilities.

Using mechanical lifting devices such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys; is the preferred means of lifting heavy objects;

Work in the Power Zone - The power zone for lifting or working is close to the body, between mid-thigh and mid-chest height. This zone is where arms and back can lift the most with the least amount of effort.

Work near elbow height to avoid bending excessive bending (avoid working above the shoulders and below the knees);

- Plan before carrying:
    - Wear appropriate shoes to avoid slips, trips or falls
    - If you wear gloves, wear gloves that fit. Tight-fitting gloves can put pressure on the hands, while loose-fitting gloves reduce grip strength and pose other safety hazards.
    - Avoid carrying large or bulky loads that limit or obstruct your vision
    - Slide, push, or roll instead of carrying when appropriate
    - When there is a choice, push instead of pull
    - Carry only as much as you can safely handle
    - Try to avoid slopes, stairs, or other obstacles that make carrying materials more difficult
    - Beware of and try to avoid slippery floors (e.g., liquids, ice, oil, and fine powders)
    - Use extra caution when moving loads that may be unstable
- In general, the following steps must be practiced when planning and performing manual lifts:
    - Examine the load and the surrounding area
    - Bend knees when lifting a load
    - Look forward to keep back straight
    - Position the load close to the body
    - Maintain a firm grip on the load
    - Test the load for stability and weight prior to lifting
    - Use smooth, controlled movements
    - Keep arms in front of body
    - Turn feet in direction of movement to avoid twisting

Ergonomic Work Practices

- Avoid repetitive motions, overhead reaching, and kneeling when possible;
- If prolonged awkward postures are unavoidable, use a "supported" posture to compensate; a supported posture uses part of your body to support the weight of another body segment that is in an awkward position;

- Watch your pace—attempting to do something faster can cause you to lose proper form;
- Use a table or move work to a location where you don't have to be in a bent-over position to do your work;
- Where awkward postures or repetitive motions are unavoidable, rotate with another worker, change tasks, stretch, and take short breaks frequently.

9.0 Project-Specific Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the work or the particular hazard. Each person onsite is required to abide by the hazard controls. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

9.1 Boat Safety

- Walk cautiously when wading in water. Always wear waders. Always check depth of water when wading. Avoid entering deep or fast moving water.
- When boating, always properly wear PFDs. Keep weight centered in boat. Avoid sudden shifts in position or weight. Enter and exit the boat cautiously and one at a time.
- When loading/unloading boat from vehicle, avoid carrying and loading in a way the might cause back strain. Walk slowly and carefully when carrying equipment or the canoe.
- Ensure all personnel entering area are briefed of potential hazards prior to entering work area (Safety Manager, Site Manager).
- Do not over-load the boat with personnel, equipment, and supplies.
- Plan path to avoid high angle entry and rock climbing; with the least amount of obstructions.
- Wear high traction safety footwear
- Plan steps before making them
- If stuck in mud, move slowly
- Ensure good grip on boat and balance. Do not stand in boat while boat is in motion.
- Vessel operations will be suspended if skippers judge that weather or current conditions become unsafe.
- Know obstructions and shallows, proceed slowly.
- Boats to be handled by experienced personnel only
- Moor or anchor boats securely when not in use
- Load small craft evenly to avoid listing.
- Counterbalance small craft when pulling equipment or debris out of the water. Keep the vessel as level as possible.
- Keep boat free from tripping hazards.
- Be aware of boat position and movement and communicate with the operator.
- Good Hygiene practices to be used at all times. No eating, drinking, smoking or chewing tobacco if contact with contaminated media is expected.

Boating Safety

Personnel who will operate a boat during the course of a project shall first demonstrate to the site manager that they are experienced in operating boats similar to those used for the project and that they are knowledgeable of the U.S. Coast Guard Boating Safety requirements (33 CFR Subchapter S). Project boats shall be operated by experienced boat operators only. Boat operators shall also possess basic mechanical knowledge necessary to troubleshoot common mechanical problems that can and do occur. The boat operator shall be responsible for the safety of all personnel on board the boat he or she is operating and for the integrity of all boat and safety equipment.

Each designated boat operator shall give a safety briefing to all occupants of the boat prior to leaving the shore. Boats are to be occupied during use by not less than one qualified operator plus one additional person.

The boat skipper has the final authority with regard to boat safety and navigational safety.

Use the attached boat safety checklist to evaluate and verify necessary equipment prior to leaving shore

9.1.1 Boat Requirements

All project boats will meet or exceed U.S. Coast Guard requirements for safety equipment, as applicable to the operation and type of boat. These requirements are summarized below for small craft (less than forty feet [12 meters] in length).

9.1.2 Flame Arresters

All gasoline engines, except outboard motors, installed in a boat must have an approved flame arrestor (backfire preventer) fitted to the carburetor.

9.1.3 Sound Signaling Devices

Boats shall carry at least one air horn or similar sound-signaling device. Radio or cell-phone communication must be in place as well.

9.1.4 Personal Flotation Devices

All personnel and passengers shall wear an approved personal flotation device (PFD) at all times when operating or being transported in a boat. A positively buoyant wet suit or dry suit may be substituted for a PFD. PFDs shall be Type II or higher (capable of turning its wearer in a vertical or slightly backward position in the water). In addition, each boat shall be equipped with at least one Type IV PFD, designed to be thrown to a person in the water and grasped and held by the user until rescued. A buoyant boat cushion equipped with straps and a float ring are two common examples of a Type IV PFD.

9.1.5 Fire Extinguishers

Each boat shall carry at least one Type B-I or B-II fire extinguisher (for use in gasoline, oil and grease fires) approved by Underwriters Laboratories (UL). Each fire extinguisher shall be inspected to ensure that it is sufficiently charged and that the nozzles are free and clear. Discharged fire extinguishers shall be replaced or recharged immediately.

9.1.6 Emergency Planning

As part of the project HSP and AHAs, emergencies and response actions must be addressed for potential emergencies such at fire, sinking, flooding, severe weather, man over-board, hazardous material incidents, etc.

9.1.7 Load Capacity

Boats shall not be loaded (passengers and gear) beyond the weight capacity printed on the U.S. Coast Guard information plate attached to the stern. In addition, several factors must be considered when loading a boat: distribute the load evenly, keep the load low, do not stand up in a small boat or canoe, and do not overload the boat.

9.1.8 Tool Kit

All motorized boats shall carry a tool kit sufficient for the boat operator to troubleshoot common mechanical problems such as fouled spark plugs, flooded carburetor, electrical shorts, etc. Boats operated in remote areas shall also carry appropriate spare parts (propellers, shear pins, patch kits, air pumps, etc). The tool kit shall be maintained by the boat operator and supplies used up shall be replaced immediately.

9.1.9 Communications

All boats operated shall carry a two-way radio or cellular telephone that enables communication back to the field camp or other pre-established location.

9.1.10 Good Housekeeping

Personnel using a boat shall properly stow and secure all gear and equipment against unexpected shifts when underway. Decks and open spaces must be kept clear and free from clutter and trash to minimize slip, trip, and fall hazards.

9.1.11 Fuel Management

Personnel shall utilize the "one-third rule" in boating fuel management. Use one-third of the fuel to get to the destination, one-third to return, and keep one-third in reserve.

No smoking is permitted on board vessels or during refueling operations.

9.1.12 Pollution Control

The Refuse Act of 1989 prohibits the throwing, discharging, or depositing of any refuse matter of any kind (including trash, garbage, oil, and other liquid pollutants) into the waters of the United States. The Federal Water Pollution Control Act prohibits the discharge of oil or hazardous substances in quantities that may be harmful into U.S. navigable waters. No person may intentionally drain oil or oily wastes from any source into the bilge of any vessel. Larger vessels equipped with toilet facilities must be equipped with a U.S. Coast Guard-approved marine sanitation device.

Employees shall report any significant oil spills to water to the _____ who must report the spill to the U.S. Coast Guard or other applicable regulatory agency. The procedure for incident reporting and investigation shall be followed when reporting the spill.

- Use the checklist below to evaluate vessel integrity.

Marine Vessel Checklist		
	Yes	**N/A**
Marine-band radio w/ Channel 16		
Personal Flotation Devices (PFDs)		
Visual Distress Signals		
Anchor and Anchor Line		
Sound-Producing Devices		
Navigation Lights and Shapes		
Fire Extinguishers		
Alternative Propulsion (for example, paddles)		
Overall Vessel Condition Satisfactory		
State Requirements		
Marine Sanitation Device		
Navigation Rules		
Ropes and Buoys		
First Aid Kit and Bloodborne Pathogen Kit		
Nonslip Deck		
Personnel Access Ladder		

9.2 Hand and Power Tools

(Reference CH2M HILL, SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed:

- Tools shall 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's instructions and design limitations;
- Maintain all hand and power tools in a safe condition;
- 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 Underwriters Laboratories (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.); and
- 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.

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points 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.

9.3 Inclement Weather

- This project may be conducted during months of the year in which severe storms occur at a higher frequency and develop rapidly; especially on the water. Personnel are to take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm.

Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed.

- Protective measures during a lightning storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop or stand under a lone tree; seek low areas); staying away from open water, metal equipment, wire fences, and metal pipes; and positioning people several yards apart.
- Remember that lightning may strike several miles from the parent cloud, so work should be stopped/restarted accordingly. If you feel your hair stand on end or smell ozone, lightning may be about to strike you. Immediately drop to your knees and bend forward—**do not** lie flat on the ground.
- Flash floods are also a concern with the high mountains. Pay close attention to thunderstorms in the mountains and be aware of flash flood potential. Look for signs of floodplains.

9.4 Outdoor Safety Tips

- When scheduling daily sampling events, always inform someone as to where you are going, your route, and when you expect to return. **Stick to your plan**.
- Carry enough water for each person, each day of your sampling trips (plastic gallon jugs are handy and portable).
- If caught in a storm, find shelter as soon as possible and report your situation to the Project Manager.
- If your vehicle breaks down:
- Stay near the vehicle. Your emergency supplies are there. A vehicle can be seen for miles, but a person on foot is very difficult to find.
- Keep clothing on and dress in layers.
- If you have water, **drink it**. Do not ration it.
- If water is limited, keep your mouth shut. Do not talk, do not eat, do not smoke, do not drink alcohol, do not take salt.
- A roadway is a sign of civilization. If you find a road, **stay on it**.
- Report all incidents, no matter how minor, to your crew chief/lead, task manager, design manager, or Project Manager as appropriate.
- Incident reports are required for all incidents.
- Two-track roads are inherently difficult; use caution.
- Park the vehicle in a location where it can be accessed easily in the event of an emergency.
- Pay attention, constantly observe the work area for hazards, and implement every effort needed to protect CH2M HILL personnel from onsite hazards.
- Field work will be done during the daylight hours.
- Wear high-visibility orange vests if in areas where hunters may be.

9.5 Traffic Hazards

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established by a contractor.

- 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.
- 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, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.

- Always remain aware of an escape route -- behind an established barrier, parked vehicle, guardrail, etc.
- Always pay attention to moving traffic – never assume drivers are looking out for you
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a "buddy system" should be used, where one worker is looking towards traffic.
- When working on highway projects, obtain a copy of the contractor's traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.
- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices are dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.
- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped according to (TMCC) guidelines. All vehicles within 40 feet of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- When it is not possible to position work zone flaggers so they are not exposed to traffic or equipment approaching them from behind, the employer, responsible contractor and/or project owner must develop and use a method to ensure that flaggers have adequate warning of such traffic and equipment approaching from behind the flagger.
- The employer, responsible contractor and/or project owner must conduct an orientation that familiarizes the flagger with the job site each time the flagger is assigned to a new project or when job site conditions change significantly. The orientation must include, but is not limited to, the flagger's role and location on the job site, motor vehicle and equipment in operation at the site, job site traffic patterns, communications and signals to be used between flaggers and equipment operators, on-foot escape route, and other hazards specific to the job site.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers. Vehicles should be parked at least 40 feet away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.
- When flaggers are used on a job, the flaggers' employer, responsible contractor and/or project owner must keep on-site, a current site specific traffic control plan.

9.6 Uneven walking surfaces

- Employees walking in ditches, swales and other drainage structures adjacent to roads or across undeveloped land must use caution to prevent slips and falls which can result in twisted or sprained ankles, knees, and backs.
- Whenever possible observe the conditions from a flat surface and do not enter a steep ditch or side of a steep road bed.
- If steep terrain must be negotiated, sturdy shoes or boots that provide ankle support should be used. The need for ladders or ropes to provide stability should be evaluated.
- Wear sturdy footwear appropriate for site walk activities (i.e., hiking boots or work boots).
- Watch for icy conditions, and be aware of slips, trips and falls.

9.7 Soil Sampling

- Tie down loose items
- Utilize a spotter if backing vehicles or equipment towards the sampling location
- Inspect the sampling area for obstructions and poison ivy and poison oak, or other physical hazards
- If sample locations are located in dense tall grassy areas consider utilizing a "Bug-Out" suit or DuPont™ Tyvek® to mitigate the potential for tick bites
- If lifting heavy equipment from a vehicle, move items to the rear and get assistance when lifting
- Be alert for bees, wasps, and other insects when sampling
- Log calibration of the Direct Reading Instrument in either a field log book or on the attached form
- Notify others in the area that the task is going to be performed; delineate an exclusion zone, as applicable
- Don personal protective equipment (PPE) as specified in Section 4 of this site-specific HSP
- Position yourself upwind prior to sampling, if possible
- Do not handle sample jars without nitrile gloves

9.8 Utilities (Underground)

Name: One Call
Phone: 811

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during intrusive activities. Intrusive activities include excavation, trenching, drilling, hand augering, soil sampling, or similar activities.

The assessment must be conducted before any intrusive subsurface activity and must include at least the following elements:

1. A background and records assessment of known utilities or other subsurface obstructions. ***Specifically ask the resident if they buried any lines on their property (e.g. water, gas, electric), and follow the avoidance techniques in 9.8.5 and 9.8.6.***

2. Contacting and using the designated local utility locating service (e.g. 811).

3. Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. *Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above.* ***NOTE: This requirement has been removed for this project only, if all of the other three provisions are followed, and the employee using the Terra Core instrument is wearing insulated "lineman" gloves when pushing the instrument into the ground (no exceptions)***

4. A visual survey of the area to validate the chosen location (Refer to Section 9.8.4).

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility before a drill rig, backhoe, excavator or other aggressive method is used.

Aggressive methods are never allowed within 2 feet of an identified high risk utility (see paragraph below).

Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

9.8.1 Background and Records Assessment of Known Utilities

Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Obtain available utility diagrams and/or as-built drawings for the facility.

Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.

Request that a facility contact with knowledge of utility locations review and approve proposed locations of intrusive work.

9.8.2 Designated Local Utility Locating Service

Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call) to identify and mark the location of utilities. Call 811 in the US or go to www.call811.com to identify the appropriate local service group. Contacting the local utility locating service is a legal requirement in most jurisdictions.

9.8.3 Independent Field Survey (Utility Locate)

The organization conducting the intrusive work (CH2M HILL or subcontractor) shall arrange for an independent field survey to identify, locate, and mark any potential subsurface utilities in the work area. This survey is in addition to any utility survey conducted by the designated local utility locating service.

The independent field survey provider shall determine the most appropriate instrumentation/technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions.

A CH2M HILL or subcontractor representative must be present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. If there is any question that the survey was not performed adequately or the individual was not qualified, then arrangements must be made to obtain a qualified utility locate service to re-survey the area. Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.

If the site owner (military installation or client) can provide the independent field survey, CH2M HILL or the subcontractor shall ensure that the survey includes:

- Physically walking the area to verify the work location and identify, locate, and mark underground utility locations:
- Having qualified staff available and instrumentation to conduct the locate;
- Agreeing to document the survey and clearances in writing.
- Should any of the above criteria not be met, CH2M HILL or subcontractor must arrange for an alternate independent utility locate service to perform the survey.
- The markings from utility surveys must be protected and preserved until the markings are no longer required. If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or designee must notify the independent utility locate service or the designated local utility locating service to resurvey and remark the area.

9.8.4 Visual Assessment before and during Intrusive Activities

Perform a "360 degree" assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the dig area.

The visual survey shall include all surface landmarks; **sheds or shops with power running to them, partially day-lighted lines**, manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

9.8.5 Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty

When aggressive intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing or hand digging. Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

9.8.6 Intrusive Activities within 2 feet of a "day-lighted" Underground Utility

Use non-aggressive methods (hand digging, vacuum excavation, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.

9.8.7 Spotter

- A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

10.0 Physical Hazards and Controls

Physical hazards include exposure to temperature extremes, sun, noise, and radiation. If you encounter a physical hazard that has not been identified in this plan, contact the RHSM so that a revision to this plan can be made.

10.1 Noise

(Reference CH2M HILL SOP HSE-108, *Hearing Conservation*)

CH2M HILL is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted, (dBA) and above by implementing a hearing conservation program that meets the requirements of the OSHA Occupational Noise Exposure standard, 29 CFR 1910.95. A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task.

- Areas or equipment emitting noise at or above 90dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- Areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 85 dBA or a noise dose of 50% must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.
- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M HILL's virtual office.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner and a copy of the OSHA standard 29 CFR 1910.95 shall be posted in the workplace.

10.2 Ultraviolet Radiation (sun exposure)

Health effects regarding ultraviolet (UV) radiation are confined to the skin and eyes. Overexposure can result in many skin conditions, including erythema (redness or sunburn), photoallergy (skin rash), phototoxicity (extreme sunburn acquired during short exposures to UV radiation while on certain medications), premature skin aging, and numerous types of skin cancer. Implement the following controls to avoid sunburn.

Limit Exposure Time

- Rotate staff so the same personnel are not exposed all of the time.
- Limit exposure time when UV radiation is at peak levels (approximately 2 hours before and after the sun is at its highest point in the sky).

- Avoid exposure to the sun, or take extra precautions when the UV index rating is high.

Provide Shade

- Take lunch and breaks in shaded areas.
- Create shade or shelter through the use of umbrellas, tents, and canopies.
- Fabrics such as canvas, sailcloth, awning material and synthetic shade cloth create good UV radiation protection.
- Check the UV protection of the materials before buying them. Seek protection levels of 95 percent or greater, and check the protection levels for different colors.

Clothing

- Reduce UV radiation damage by wearing proper clothing; for example, long sleeved shirts with collars, and long pants. The fabric should be closely woven and should not let light through.
- Head protection should be worn to protect the face, ears, and neck. Wide-brimmed hats with a neck flap or "Foreign Legion" style caps offer added protection.
- Wear UV-protective sunglasses or safety glasses. These should fit closely to the face. Wrap-around style glasses provide the best protection.

Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Re-apply sunscreen at least every 2 hours, and more frequently when sweating or performing activities where sunscreen may be wiped off.
- Choose a sunscreen with a high sun protection factor (SPF). Most dermatologists advocate SPF 30 or higher for significant sun exposure.
- Waterproof sunscreens should be selected for use in or near water, and by those who perspire sufficiently to wash off non-waterproof products.
- Check for expiration dates, because most sunscreens are only good for about 3 years. Store in a cool place out of the sun.
- No sunscreen provides 100 percent protection against UV radiation. Other precautions must be taken to avoid overexposure.

10.3 Temperature Extremes

(Reference CH2M HILL SOP HSE-211, *Heat and Cold Stress*)

Each employee is responsible for the following:

- Recognizing the symptoms of heat or cold stress;
- Taking appropriate precautionary measures to minimize their risk of exposure to temperature extremes (see following sections); and
- Communicating any concerns regarding heat and cold stress to their supervisor or SC.

10.3.1 Heat

Heat-related illnesses are caused by more than just temperature and humidity factors.

Physical fitness influences a person's ability to perform work under heat loads. At a given level of work, the more fit a person is, the less the physiological strain, the lower the heart rate, the lower the body temperature (indicates less retrained body heat—a rise in internal temperature precipitates heat injury), and the more efficient the sweating mechanism.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work. With a recent history of heat-stress exposures of at least two continuous hours per day for 5 of the last 7 days to 10 of the last 14 days, a worker can be considered acclimatized. Its loss begins when the activity under those heat-stress conditions is discontinued, and a noticeable loss occurs after 4 days and may be completely lost in three to four weeks. Because acclimatization is to the level of the heat-stress exposure, a person will not be fully acclimatized to a sudden higher level; such as during a heat wave.

Dehydration reduces body water volume. This reduces the body's sweating capacity and directly affects its ability to dissipate excess heat.

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). **Heat dissipation** is a function of surface area, while heat production depends on body mass. Therefore, overweight individuals (those with a low ratio) are more susceptible to heat-related illnesses because they produce more heat per unit of surface area than if they were thinner. Monitor these persons carefully if heat stress is likely.

When wearing **impermeable clothing**, the weight of an individual is not as important in determining the ability to dissipate excess heat because the primary heat dissipation mechanism, evaporation of sweat, is ineffective.

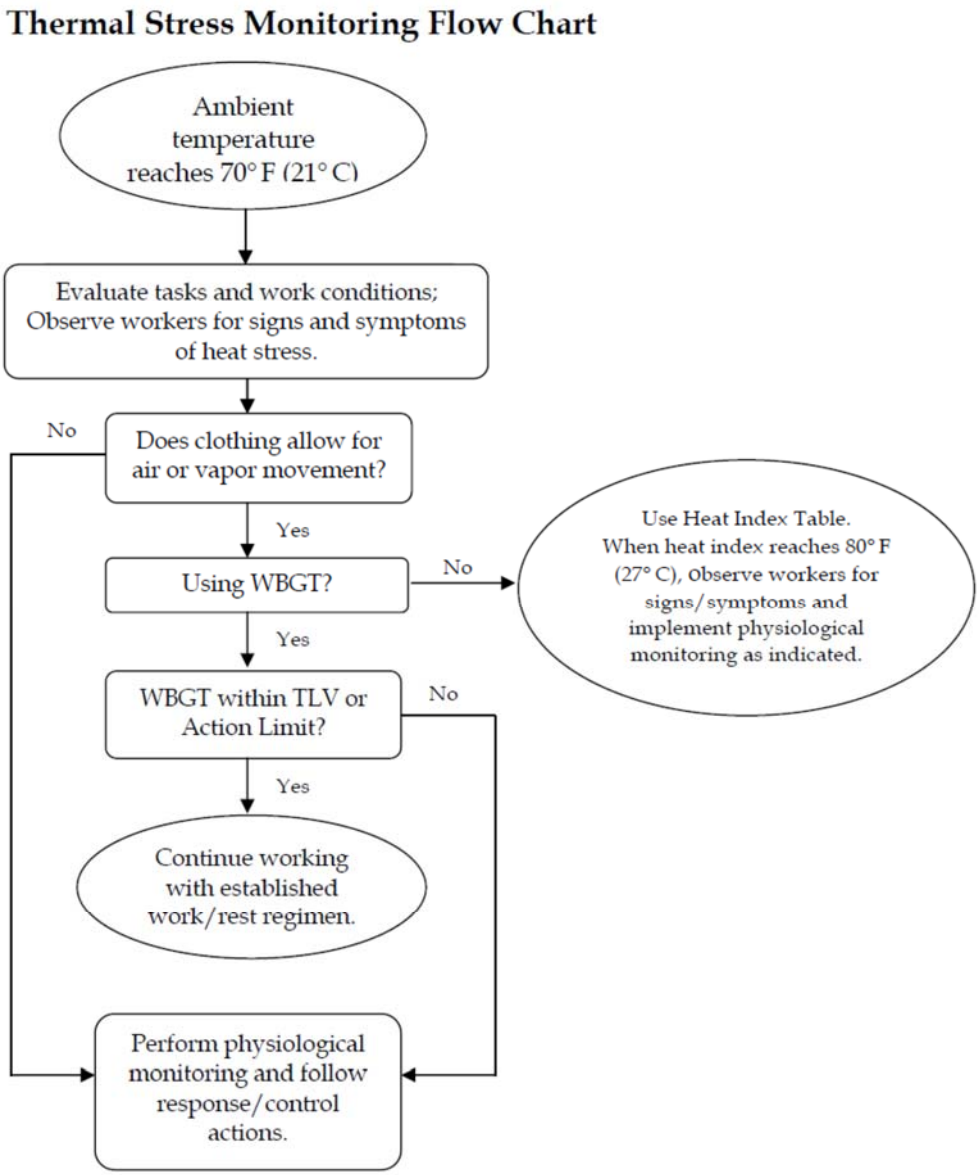
SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat 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 thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

Precautions

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°Fahrenheit (10 degrees Celsius [C]) to 60°Fahrenheit (F) (15.6 degrees C) should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons (7.5 liters) 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 (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.
- Avoid direct sun whenever possible, 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 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. PREVENTION and communication is key.

Thermal Stress Monitoring

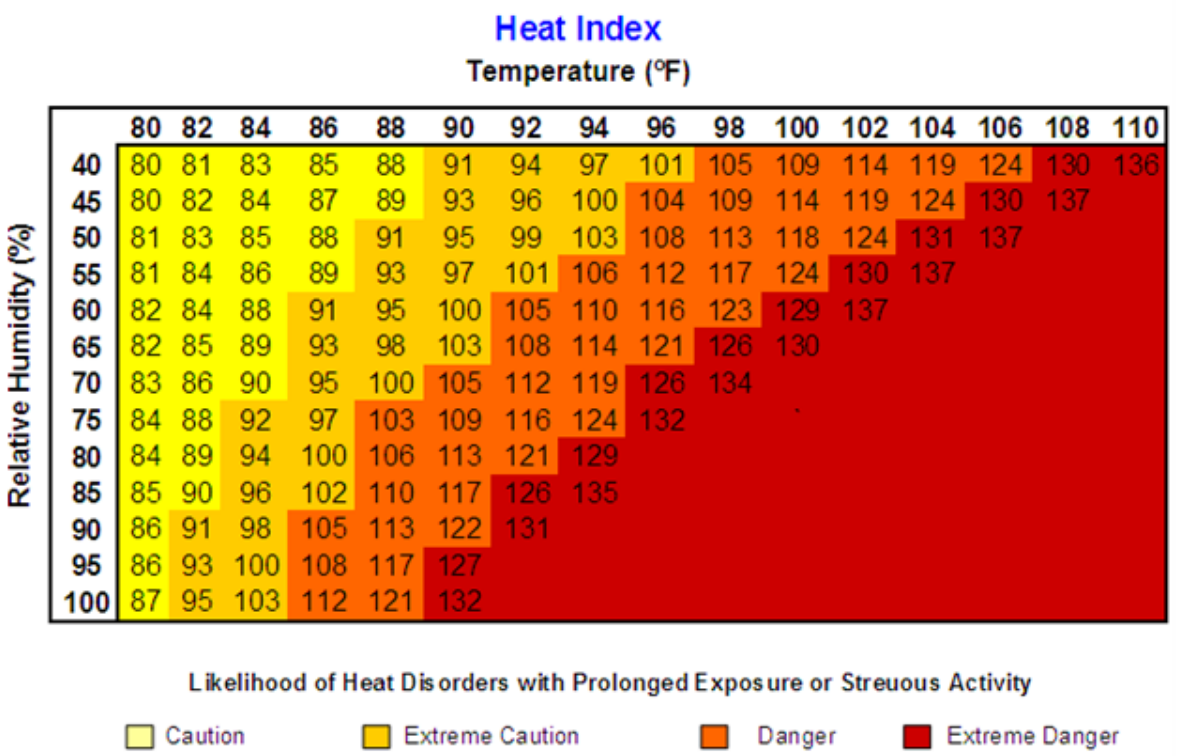


Thermal Stress Monitoring – Permeable or Impermeable Clothing

When permeable work clothes are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological

monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or at a lower temperature when workers begin to exhibit signs and symptoms of heat stress.



Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Observe Workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Every 2 hours, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Every 60 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Every 30 minutes or sooner if signs of heat stress are observed.
Source: National Weather Service		

Physiological Monitoring and Associated Actions

The following physiological monitoring protocol below, using either radial pulse or aural temperature, will occur when the heat index is 80 degrees F or greater (or when personnel exhibit signs of heat stress), the following will be performed:

- The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g. 180 – 35 year old person = 145 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.
- The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
- If the heart rate is higher than 120 bpm, 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 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent.
- Continue this procedure until the rate is maintained below 120 bpm.
- Alternately, the body temperature can be measured, either oral or aural (ear), before the workers have something to drink.
- If the oral or aural temperature exceeds 99.6° F (37.6 ° F) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral or aural (ear) temperature is maintained below 99.6 ° F (37.6° C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field, however, a digital aural (aural) thermometer is easy to obtain and inexpensive to purchase.

Procedures for when Heat Illness Symptoms are Experienced

- **Always** contact the RHSM when any heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.
- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M HILL worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.
- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow precautions under the emergency medical treatment of this HSP.

10.3.2 Cold

General

Low ambient temperatures increase the heat lost from the body to the environment by radiation and convection. In cases where the worker is standing on frozen ground, the heat loss is also due to conduction.

Wet skin and clothing, whether because of water or perspiration, may conduct heat away from the body through evaporative heat loss and conduction. Thus, the body cools suddenly when chemical protective clothing is removed if the clothing underneath is perspiration soaked.

Movement of air across the skin reduces the insulating layer of still air just at the skin's surface. Reducing this insulating layer of air increases heat loss by convection.

Non-insulating materials in contact or near-contact with the skin, such as boots constructed with a metal toe or shank, conduct heat rapidly away from the body.

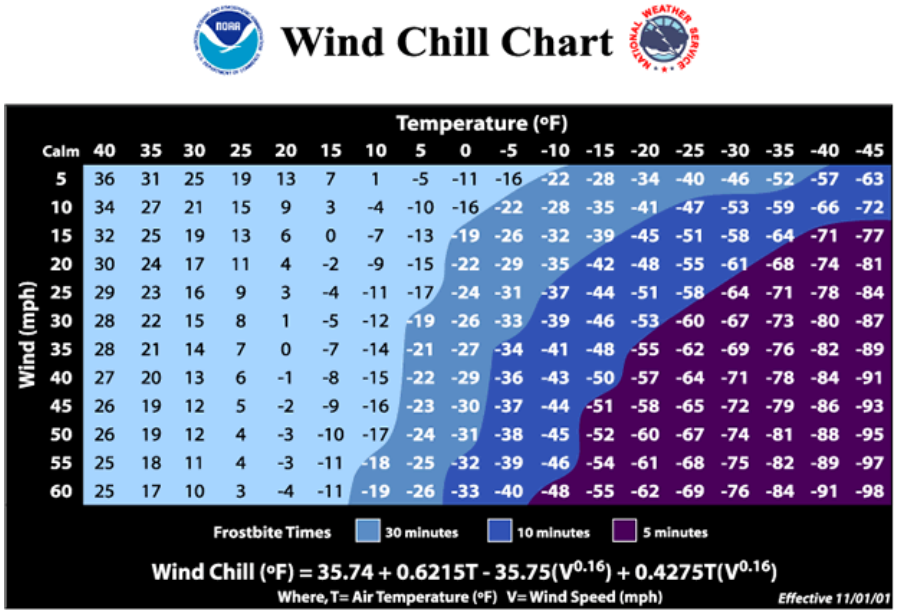
Certain common drugs, such as alcohol, caffeine, or nicotine, may exacerbate the effects of cold, especially on the extremities. These chemicals reduce the blood flow to peripheral parts of the body, which are already high-risk areas because of their large surface area to volume ratios. These substances may also aggravate an already hypothermic condition.

Precautions

- 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 wet weather.
- Wind-Chill Index (below) 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.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor/PM 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 immediately.	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 break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.



10.4 Radiological Hazards

Refer to CH2M HILL's Core Standard, Radiological Control and Radiological Controls Manual for additional requirements.

Hazards	Controls
None Known	None Required

11.0 Biological Hazards and Controls

Biological hazards are everywhere and change with the region and season. If you encounter a biological hazard that has not been identified in this plan, contact the RHSM so that a revision to this plan can be made. Whether it is contact with a poisonous plant, a poisonous snake, or a bug bite, do not take bites or stings lightly. If there is a chance of an allergic reaction or infection, or to seek medical advice on how to properly care for the injury, contact the occupational nurse at 1-866-893-2514.

11.1 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. If you are stung, contact the occupational nurse at 1-866-893-2514. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe.

11.2 Bird Droppings

Large amounts of bird droppings may present a disease risk. The best way to prevent exposure to fungus spores in bird droppings is to avoid disturbing it. A brief inhalation exposure to highly contaminated dust may be all that is needed to cause infection and subsequent development of fungal disease.

If disturbing the droppings or if removal is necessary to perform work, follow these controls:

- Use dust control measures (wetting with water or HEPA vacuuming) for all activities that may generate dust from the accumulated droppings.
- Wear Tyvek with hoods, disposable gloves and booties, and air-purifying respirators with a minimum N95 rating.
- Put droppings into plastic/poly bags and preferably into a 55-gallon drum to prevent bag from ripping.

11.3 Hantavirus

Hantavirus pulmonary syndrome (HPS) is a disease caused by a virus which can be transmitted from certain rodents to humans and is prevalent throughout the United States. Avoid disturbing rodent nests. Contact is most likely to occur when there is a current rodent infestation in things like control boxes, storage sheds, wellheads, remediation equipment, or trailers. Once excreted into the environment by the rodent, hantaviruses can survive in the environment and remain infectious for a period of 2-3 days. Ultraviolet rays in sunlight inactivate hantaviruses. Nesting material and droppings must be removed if work is necessary in a rodent-infested area. PPE for removal shall include:

- Tyvek coveralls;
- Rubber boots or disposable shoe covers;
- Rubber, latex, or vinyl gloves;
- Respiratory protection such as a full face or half-mask air-purifying respirator with a high-efficiency particulate air (HEPA) filter; and
- Protective goggles if wearing a half-mask respirator.

Spray any urine, droppings, and nesting materials with either a bleach and water solution (1 parts bleach to 9 parts water) or a household disinfectant prepared according to the label instructions for dilution and disinfection time. Soak well and let stand for 15 minutes. Use a paper towel or rag to pick up the materials and dispose of them.

Mop floors after spraying them using bleach and water solution or a disinfectant. Dirt floors can be sprayed with either bleach and water solution or a disinfectant. Personal protective gear shall be decontaminated upon removal at the end of the day. All potentially infective waste material (including respirator filters) from clean-up operations shall be double-bagged in plastic bags.

Symptoms of HPS

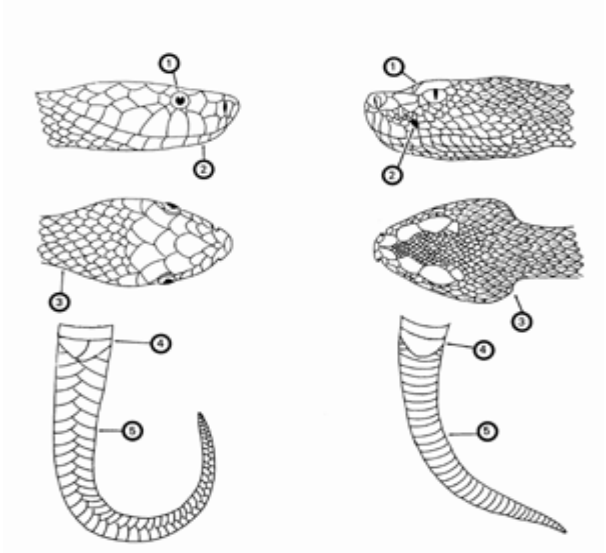
Symptoms develop between 14 and 31 days after exposure to infected rodents and include fatigue, fever, and muscle aches, especially the large muscle groups--thighs, hips, back and sometimes shoulders. About half of all HPS patients also experience headaches, dizziness, chills and/or abdominal pain. Four to 10 days after the initial phase of the illness, late symptoms of HPS may appear. These include coughing and shortness of breath. If you develop symptoms suggestive of HPS, call the occupational nurse at 1-866-893-2514.

11.4 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Call the occupational nurse at 1-866-893-2514 immediately. Do not apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings. Below is a guide to identifying poisonous snakes from non-poisonous snakes.

Identification of Poisonous Snakes

Major Identification Features Non-venomous Snake	Major Identification Features Venomous Snake
1. Round pupils 2. No sensing pit 3. Head slightly wider than neck 4. Divided anal plate 5. Double row of scales on the underside of the tail	1. Elliptical pupils 2. Sensing pit between eye and nostril 3. Head much wider than neck 4. Single anal plate 5. Single scales on the underside of the tail



11.5 Spiders - Brown Recluse and Widow

The Brown Recluse spider can be found most anywhere in the United States. It varies in size in shape, but the distinguishing mark is the violin shape on its body. They are typically non-aggressive. Keep an eye out for irregular, pattern-less webs that sometimes appear almost tubular built in a protected area such as in a crevice or between two rocks. The spider will retreat to this area of the web when threatened.

The Black Widow, Red Widow and the Brown Widow are all poisonous. Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale 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.

Hazard Controls

- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.
- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.
- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

If you think you have been bit by a poisonous spider, immediately call the occupational nurse at 1-866-893-2514 and follow the guidance below:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood;
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite;
- Elevate the bitten area, if possible;
- Do not apply a tourniquet, do not try to remove venom; and
- Try to positively identify the spider to confirm its type. If the spider has been killed, collect it in a plastic bag or jar for identification purposes. Do not try to capture a live spider—especially if you think it is a poisonous spider.

Black Widow

Red Widow

Brown Widow

Brown Recluse

If you are stung by a scorpion, call the occupational nurse 1-866-893-2514 and try to note the description of the scorpion. Cleanse the sting area and apply ice.

11.6 Black Bears

Bears may inhabit wooded areas where there is scarce continuous human presence. Make your presence known-especially when vegetation and terrain make it hard to see. Make noise, sing, or talk loudly. Avoid thick brush. Try to walk with the wind at your back so your scent will warn bears of your presence.

Give bears plenty of room. Every bear has a "personal space" - the distance within which a bear feels threatened – that can be from a few feet to a few hundred feet. If you stray within that zone, a bear may act aggressively. Never approach bears, even if only out of curiosity, and never attempt to feed bears.

If a bear cannot recognize you, he may come closer or stand on his hind legs for a better view. You may try to back away slowly diagonally, but if the bear follows, stop and stand your ground. If the bear moves closer or acts aggressively, stay close together and wave your arms and shout.

Do not climb a tree – black bears are good climbers.

Do not run. Bears have been clocked at speeds of up to 35 mph, and like dogs, will chase fleeing animals. Bears often make bluff charges, sometimes up to 10 feet away without making contact. Continue waving your arms and shouting. Never imitate bears sounds or use high-pitched squeals.

If attacked, do not run. Clasp your hands tightly over the back of your neck or if you are carrying a backpack use it to protect your head and neck and remain still. For Black bears, if the attack lasts for more than a few seconds, respond aggressively - use sticks, rocks, your fists or noise. Black bears will sometimes back off if they are challenged.

11.7 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. 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 (6.4 mm) in size. In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray only outside of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions (vegetation above knee height, tick endemic area) or when tasks (having to sit or kneel in vegetation) diminish the effectiveness of the other controls mentioned above, bug-out suits (check with your local or regional warehouse) or Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Avoid habitats where possible, reduce the abundance through habitat disruption or application of acracide. If these controls aren't feasible, contact your local or regional warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet (Attachment 5) for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet, and call the occupational nurse at 1-866-893-2514.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme disease is a rash that might appear that looks like a bull's eye with a small welt in the center. RMSF is a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact the occupational nurse at 1-866-893-2514.

Be sure to complete an Incident Report (either use the Hours and Incident Tracking System [HITS] system on the VO) if you do come in contact with a tick.

11.8 Feral Dogs

Avoid all dogs – both leashed and stray. Do not disturb a dog while it is sleeping, eating, or caring for puppies. If a dog approaches to sniff you, stay still. An aggressive dog has a tight mouth, flattened ears and a direct stare. If you are threatened by a dog, remain calm, do not scream and avoid eye contact. If you say anything, speak calmly and firmly. Do not turn and run, try to stay still until the dog leaves, or back away slowly until the dog is out of sight or you have reached safety (e.g. vehicle). If attacked, retreat to vehicle or attempt to place something between you and the dog. If you fall or are knocked to the ground, curl into a ball with your hands over your head and neck and protect your face. If bitten, wash the wound vigorously with soap and water, and contact the occupational nurse at 1-866-893-2514. Report the incident to the local authorities, and try to get as much information about the dog as possible (e.g. breed, size, color, owner, location, signs of sickness, erratic behavior other than the aggressiveness of the attack).

12.0 Contaminants of Concern

The table below summarizes the potential contaminants of concern (COC) and their occupational exposure limit and signs and symptoms of exposure.

Contaminants of Concern

Contaminant	Location and Maximum[a] Concentration	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Arsenic	Present in slag material; or as a result upland deposition	0.01 mg/m^3	5 Ca	Ulceration of nasal septum, respiratory irritation, dermatitis, gastrointestinal disturbances, peripheral neuropathy, hyper-pigmentation	NA
Barium		0.5 mg/m^3	50	Irritation to eyes, skin, upper resp; skin burns; gastroenteritis; slow pulse	NA
Cadmium		0.005 mg/m^3	9 Ca	Pulmonary edema, coughing, chest tightness/pain, headache; chills, muscle aches, nausea, vomiting, diarrhea; difficulty breathing; loss of sense of smell; emphysema; mild anemia	NA
Cobalt (Metal Dusts)		0.05 mg/m^3	20	Coughing; difficulty breathing; wheezing; decreased pulmonary function; diffuse nodule fibroses; dermatitis; respiratory hypersensitivity; asthma	NA
Copper		1 mg/m^3	100	Irritation to eyes, skin, nose, and pharynx; metallic taste; dermatitis	NA
Lead		0.05 mg/m^3	100	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
Manganese		1 mg/m^3	500	Insomnia; mental confusion; meta fume fever; dry throat; cough; flu-like fever; vomit; malaise	NA
Zinc		5 mg/m^3	500	Chills; aches; nausea; fever; cough; dry throat; headache; blurred vision; vomit; fatigue	NA

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of permissible exposure limit (PEL), recommended exposure limit (REL), or threshold limit value (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.

eV = electron volt; mg/kg = milligram per kilogram; mg/m^3 = milligrams per cubic meter

Potential Routes of Exposure

Dermal: Contact with contaminated media. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of PPE.	**Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of respiratory protection when other forms of control do not reduce the potential for exposure.	**Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

13.0 Site Monitoring

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

When performing site monitoring, record all the information, such as in a field logbook. Note date and time, describe monitoring location (for example, in breathing zone, at source and site location), and what the reading is. If any action levels are reached, note it in the field logbook and note the action taken.

Exposure records (air sampling) must be preserved for the duration of employment plus thirty years. Ensure that copies of the field log book are maintained in the project file.

Copies of all project exposure records (e.g., copies of field logbook pages where air monitoring readings are recorded and associated calibration) shall be sent to the regional SPA for retention and maintained in the project files.

13.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Frequency [b]	Calibration
Visual Dust Monitor	• Collection of upland surface soil samples • Split sampling collection	No Visual Dust → Level D Visual Dust → Implement dust control measures	Initially and continuously during tasks	None

[a] Action levels apply to **sustained** breathing-zone measurements above background **for more than 5 minutes**.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC-HW; generally, every 5 to 15 minutes if acceptable; it may be appropriate to do so more frequently. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (for example, "Breathing Zone/MW-3," "at surface/SB-2," etc.).

Note: Based on the COCs and scope of work, at this time there does not appear to be an inhalation exposure hazard. Employees should still use good personal hygiene, wash hands before meals, and wear chemical resistant gloves when conducting field activities listed in Section 3.3.1 and handling any potential contaminated media. If analytical data indicates an increase in contamination, or the scope of work changes, notify the Health and Safety Manager to reevaluate air monitoring for future tasks onsite.

13.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
Not Applicable at this time				

13.3 Air Sampling

Method Description: Based on current site conditions, recent analytical data, and the tasks planned in this work order, air sampling will not be required at this time. If site conditions or tasks change, notify the Health and Safety Manager to reevaluate the need for air sampling.

14.0 Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, *Personal Protective Equipment*)

14.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards. A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Below are items that need to be followed when using any form of PPE:

- Employees must be trained to properly wear, limitations, and maintain of the PPE;
- In work areas where actual or potential hazards are present at any time, PPE must be worn by employees working or walking through the area;
- PPE must be inspected prior to use and after any occurrence to identify any deterioration or damage;
- PPE must be maintained in a clean and reliable condition;
- Damaged PPE shall not be used and must either be repaired or discarded; and
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
• Site reconnaissance • Surveying		**Coveralls:** Standard field attire (i.e. long pants and shirts w/ sleeves) **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots **Gloves:** Leather gloves (if necessary based on hazards).	Hardhat [c] Safety glasses Ear protection [d]	
	N/A	**Personal Flotation Device**: A coast guard approved PFD required when onboard a boat, tumbling into swift-moving water, or wading in water exceeding 3 feet in depth. **Waders**: Waders will be used when wading in water above the boot line.		None required.
• 3rd-party observation of fish, water, sediment, and/or soil sampling • Collection of upland surface soil samples • Split sample collection		**Coveralls:** Cotton coveralls, or uncoated Tyvek® if cotton cannot be kept clean. **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots **Gloves:** Leather gloves (if necessary based on hazards).	Hardhat [c] Splash shield [c] Safety glasses Ear protection [d]	
	Modified D	**Gloves:** Insulated "line-man" gloves when using the Terra-Core instrument **Personal Flotation Device**: A coast guard approved PFD required when onboard a boat, tumbling into swift-moving water, or wading in water exceeding 3 feet in depth. **Waders**: Waders will be used when wading in water above the boot line.		None required.

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

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

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

[b] No facial hair that would interfere with respirator fit is permitted.

[c] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

15.0 Worker Training and Qualification

15.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, *Training*)

15.1.1 Hazardous Waste Operations Training

All employees engaging in hazardous waste operations or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65. At a minimum, the training shall have consisted of instruction in the topics outlined in 29 CFR 1910.120 and 29 CFR 1926.65. Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities.

15.1.1.1 Initial Training

General site workers engaged in hazardous waste operations shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations, unless otherwise noted in the above-referenced standards.

Employees who may be exposed to health hazards or hazardous substances at treatment, storage, and disposal (TSD) operations shall receive a minimum of 24 hours of initial training to enable the employee to perform their assigned duties and functions in a safe and healthful manner.

Employees engaged in emergency response operations shall be trained to the level of required competence in accordance with 29 CFR 1910.120.

15.1.1.2 Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received three days of actual experience (on-the-job training) under the direct supervision of a trained, qualified supervisor and shall be documented. If the field experience has not already been received and documented at a similar site, this supervised experience shall be accomplished and documented at the beginning of the assignment of the project.

15.1.1.3 Refresher Training

General site workers and TSD workers shall receive 8-hours of refresher training annually (within the previous 12-month period) to maintain qualifications for fieldwork. Employees engaged in

emergency response operations shall receive annual refresher training of sufficient content and duration to maintain their competencies or shall demonstrate competency in those areas at least annually.

15.1.1.4 Eight-Hour Supervisory Training

On site management or supervisors who will be directly responsible for, or supervise employees engaged in hazardous waste site operations, will have received at least 8 hours of additional specialized training on managing such operations. Employees designated as Safety Coordinator – Hazardous Waste are considered 8-hour HAZWOPER Site Safety Supervisor trained.

15.1.2 First Aid/Cardiopulmonary Resuscitation

First aid and CPR training consistent with the requirements of a nationally recognized organization such as the American Red Cross Association or National Safety Council shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M HILL's Virtual Office is also required for those designated as first aid/CPR trained.

15.1.3 Safety Coordinator Training

SCs are trained to implement the HSE program on CH2M HILL field projects. A qualified SC is required to be identified in the site-specific HSP for CH2M HILL field projects. SCs must also meet the requirements of the worker category appropriate to the type of field project (construction or hazardous waste). In addition, the SCs shall have completed additional safety training required by the specific work activity on the project that qualifies them to implement the HSE program (for example, fall protection, excavation).

15.1.4 Site-Specific Training

Prior to commencement of field activities, all field personnel assigned to the project will have completed site-specific training that will address the contents of applicable HSPs, including the activities, procedures, monitoring, and equipment used in the site operations. Site-specific training will also include site and facility layout, potential hazards, risks associated with identified emergency response actions, and available emergency services. This training allows field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and work operations for their particular activity.

15.1.5 Project-Specific Training Requirements

Project-specific training for this project includes:

- Safety Coordinator Training – CH2M HILL SC-HW must have current SC- Haz Waste
- FA/CPR - The assigned SC-HW onsite must have current FA/CPR training.
- Fire Extinguisher - The assigned SC-HW onsite must take the on-line fire extinguisher training course.
- Waste Management - The assigned SC-HW onsite must take the on-line waste management training course.
- Blood-borne Pathogen - The assigned SC-HW must take the CH2M HILL on-line BBP training course.
- Behavior-based Loss Prevention - The SC-HW must take the CH2M HILL on-line BBLPS training course.
- Dangerous Goods Shipping Training - The SC-HW onsite must take the on-line DG training course

16.0 Medical Surveillance and Qualification

(Reference CH2M HILL SOP HSE-113, *Medical Surveillance*

All site workers participating in hazardous waste operations or emergency response (HAZWOPER) will maintain an adequate medical surveillance program in accordance with 29 CFR 1910.120 or 29 CFR 1926.65 and other applicable OSHA standards. Documentation of employee medical qualification (e.g., physician's written opinion) will be maintained in the project files and made available for inspection.

16.1 Hazardous Waste Operations and Emergency Response

CH2M HILL personnel expected to participate in on site HAZWOPER tasks are required to have a current medical qualification for performing this work. Medical qualification shall consist of a qualified physician's written opinion regarding fitness for duty at a hazardous waste site, including any recommended limitations on the employee's assigned work. The physician's written opinion shall state whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

16.2 Job or Site-Specific Medical Surveillance

Due to the nature of hazards for a particular job or work site, specialized medical surveillance may be necessary. This surveillance could include biological monitoring for specific compounds, or specialized medical examinations.

16.3 Respirator User Qualification

Personnel required to wear respirators must have a current medical qualification to wear respirators. Medical qualification shall consist of a qualified physician's written opinion regarding the employee's ability to safely wear a respirator in accordance with 29 CFR 1910.134.

16.4 Hearing Conservation

Personnel working in hazardous waste operations or operations that fall under 29 CFR 1910.95 and exposed to noise levels in excess of the 85dBA time-weighted average shall be included in a hearing conservation program that includes annual audiometric testing.

17.0 Site-Control Plan

17.1 Site-Control Procedures

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations)*

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas.

The SC will implement site control procedures including the following bulleted items.

- Establish support, contamination reduction, 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.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals;
  - Air horn; and
  - Two-way radio or cellular telephone if available.
- Establish offsite communication.
- Establish and maintain the "buddy system."

17.2 Remediation Work Area Zones

(Reference CH2M HILL SOP HSE-218 Hazardous Waste Operations)

A three-zone approach will be used to control areas where site contaminants exist. Access will be allowed only after verification of appropriate training and medical qualification. The three-zone approach shall include an EZ, Contamination Reduction Zone (CRZ) and a Support Zone (SZ). The three-zone approach is not required for construction work performed outside contaminated areas where control of site contamination is not a concern.

Specific work control zones shall be established as necessary during task planning. Site work zones should be modified in the field as necessary, based on such factors as equipment used, air monitoring results, environmental conditions, or alteration of work plans. The following guidelines shall be used for establishing and revising these preliminary zone designations.

17.2.1 Support Zone

The SZ is an uncontaminated area (trailers, offices, field vehicles, etc.) that will serve as the field support area for most operations. The SZ provides field team communications and staging for emergency response. Appropriate sanitary facilities and safety and emergency response equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged and decontaminated materials, or personnel with medical emergencies that cannot be decontaminated.

17.2.2 Contamination Reduction Zone

The CRZ is established between the EZ and the SZ, upwind of the contaminated area where possible. The CRZ provides an area for decontamination of personnel, portable handheld equipment and tools, and heavy equipment. In addition, the CRZ serves as access for heavy equipment and emergency support services.

17.2.3 Exclusion Zone

The EZ is where activities take place that may involve exposure to site contaminants and/or hazardous materials or conditions. This zone shall be demarcated to prevent unauthorized entry. More than one EZ may be established if there are different levels of protection to be employed or different hazards that exist in the same work area. The EZ shall be large enough to allow adequate space for the activity to be completed, including field personnel and equipment, as well as necessary emergency equipment.

The EZ shall be demarcated with some form of physical barrier or signage. The physical barrier or signage shall be placed so that they are visible to personnel approaching or working in the area. Barriers and boundary markers shall be removed when no longer needed.

17.2.4 Other Controlled Areas

Other work areas may need to be controlled due to the presence of an uncontrolled hazard, to warn workers of requirements, or to prevent unauthorized entry. Examples include general construction work areas, open excavations, high noise areas, vehicle access areas, and similar activities or limited access locations. These areas shall be clearly demarcated with physical barriers (fencing, cones, reinforced caution tape or rope) as necessary and posted with appropriate signage.

18.0 Decontamination

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations*)

Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. The SC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC. The SC must ensure that procedures are established for disposing of materials generated on the site.

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC should establish areas for eating, drinking, and smoking.

18.1 Contamination Prevention

Preventing or avoiding contamination of personnel, tools, and equipment will be considered in planning work activities at all field locations. Good contamination prevention and avoidance practices will assist in preventing worker exposure and result in a more efficient decontamination process. Procedures for contamination prevention and avoidance include the following:

- Do not walk through areas of obvious or known contamination;
- Do not directly handle or touch contaminated materials;
- Make sure there are no cuts or tears in PPE;
- Fasten all closures in suits and cover them with duct tape, if appropriate;
- Take particular care to protect any skin injuries;
- Stay upwind of airborne contamination, where possible;
- Do not eat or drink in contaminated work areas;
- Do not carry food, beverages, tobacco, or flame-producing equipment into contaminated work areas;
- Minimize the number of personnel and amount of equipment in contaminated areas to that necessary for accomplishing the work;
- Choose tools and equipment with nonporous exterior surfaces that can be easily cleaned and decontaminated;
- Cover monitoring and sampling equipment with clear plastic, leaving openings for the sampling ports, as necessary; and
- Minimize the amount of tools and equipment necessary in contaminated areas.

18.2 Personnel and Equipment Decontamination

Personnel exiting an EZ must ensure that they are not spreading potential contamination into clean areas or increasing their potential for ingesting or inhaling potential contaminants. Personal decontamination may range from removing outer gloves as exiting the EZ, to proceeding through an outer layer doffing station including a boot and glove wash and rinse, washing equipment, etc. Equipment that has come into contact with contaminated media must also be cleaned/decontaminated when it is brought out of the EZ.

18.3 Decontamination During Medical Emergencies

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

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

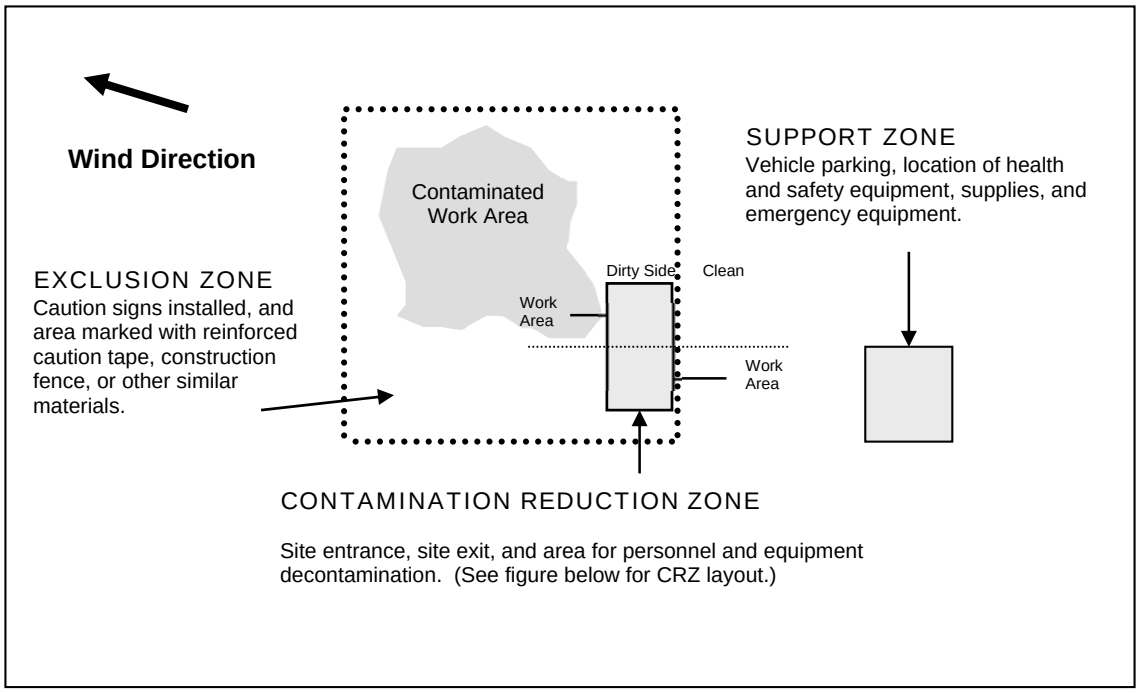
18.4 Waste Collection and Disposal

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

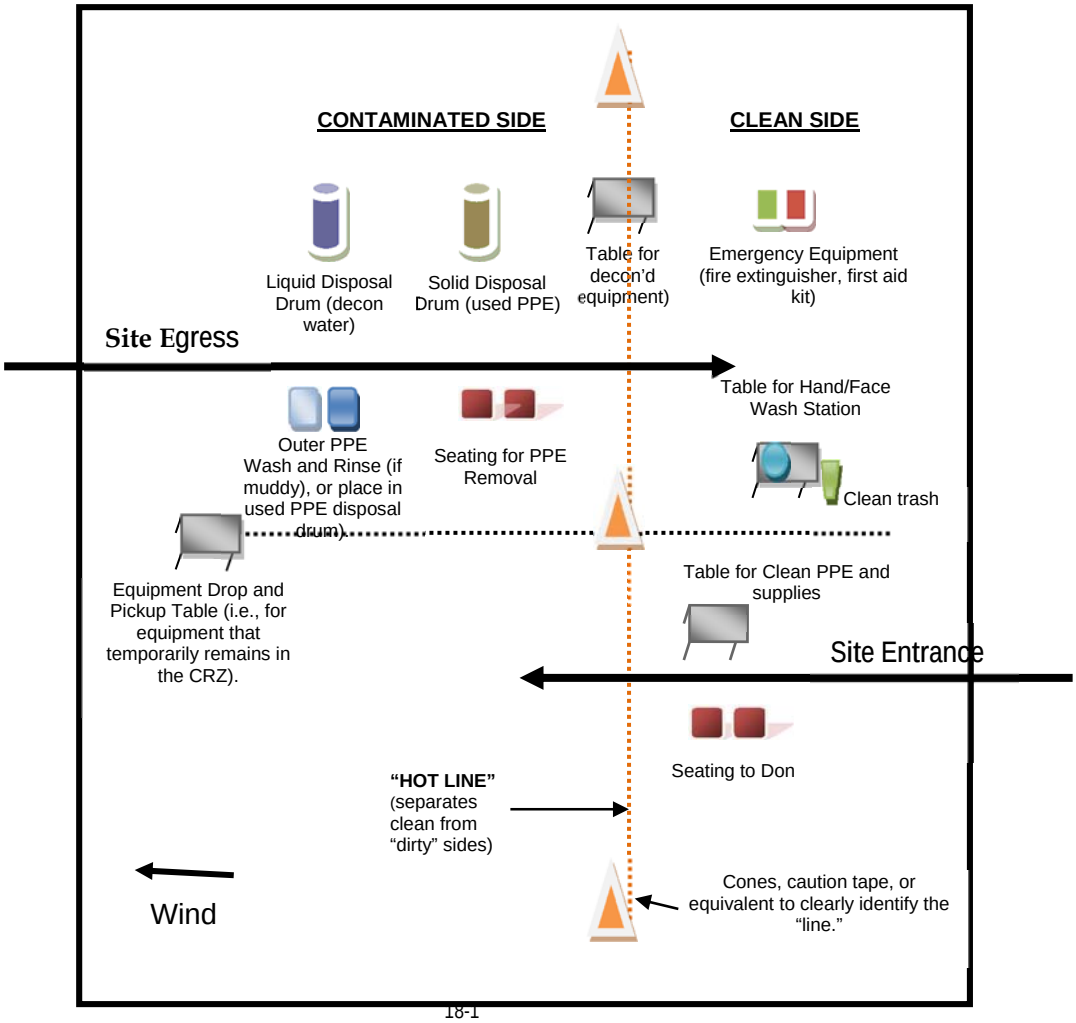
18.5 Diagram of Personnel-Decontamination Line

The following figure illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC to accommodate task-specific requirements.

Work Area - Set up appropriately based on wind direction



Typical Contamination Reduction Zone



19.0 Emergency Response Plan

(Reference CH2M HILL SOP HSE-106, *Emergency Planning*)

19.1 Pre-Emergency Planning

The Emergency Response Coordinator (ERC), typically the SC or designee, performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate. Pre-Emergency Planning activities performed by the ERC include:

- Review the facility emergency and contingency plans where applicable;
- Determine what onsite communication equipment is available (two-way radio, air horn);
- Determine what offsite communication equipment is needed (nearest telephone, cell phone);
- Confirm and post the "Emergency Contacts" page and route to the hospital located in this section in project trailer(s) and keep a copy in field vehicles along with evacuation routes and assembly areas. Communicate the information to onsite personnel and keep it updated;
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear;
- 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;
- 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. This may include a "tabletop" exercise or an actual drill depending on the nature and complexity of the project. Drills should take place periodically but no less than once a year;
- Brief new workers on the emergency response plan; and
- The ERC will evaluate emergency response actions and initiate appropriate follow-up actions.

19.2 Emergency Equipment and Supplies

The ERC shall ensure the following emergency equipment is on the site. Verify and update the locations of this equipment as needed. The equipment will be inspected in accordance with manufacturer's recommendations. The inspection shall be documented in a field logbook or similar means to be kept in the project files.

Emergency Equipment and Supplies	Location
20 (or two 10) class A,B,C fire extinguisher	Field vehicle/Boat
First aid kit	Field vehicle/Boat
Potable water	Field vehicle/Boat
Bloodborne-pathogen kit	Field vehicle/Boat
Marine-band Radio	Boat
Satellite phone	Field Vehicle/Boat (if cell coverage is not expected)
Additional equipment (specify): Cellular phone	Field vehicle/Boat

19.3 Incident Response

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

- Notify appropriate response personnel;
- Shut down CH2M HILL operations and evacuate the immediate work area;
- Account for personnel at the designated assembly area(s);
- Assess the need for site evacuation, and evacuate the site as warranted;
- Implement HSE-111, Incident Notification, Reporting and Investigation; and
- Notify and submit reports to clients as required in contract.
    - Small fires or spills posing minimal safety or health hazards may be controlled with onsite spill kits or fire extinguishers without evacuating the site. When in doubt evacuate. Follow the incident reporting procedures in the "Incident Notification, Reporting, and Investigation" section of this HSP.

19.4 Emergency Medical Treatment

Emergency medical treatment is needed when there is a life-threatening injury (such as severe bleeding, loss of consciousness, breathing or heart has stopped). When in doubt if an injury is life-threatening or not, treat it as needing emergency medical treatment.

- Notify 911 or other appropriate emergency response authorities as listed in the "Emergency Contacts" page located in this section.
- The ERC 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, perform decontamination (if applicable) where feasible; lifesaving and first aid or medical treatment takes priority.
- Initiate first aid and CPR where feasible.
- Notify supervisor and if the injured person is a CH2M HILL employee, the supervisor will call the occupational nurse at 1-866-893-2514 and make other notifications as required by HSE SOP-111, *Incident Notification, Reporting and Investigation*.
- Make certain that the injured person is accompanied to the emergency room.
- Follow the Serious Incident Reporting process in HSE SOP-111, Incident Notification, Reporting and Investigation, and complete incident report using the HITS system on the VO or if not feasible, use the hard copy forms provided as an attachment to this HSP.
- Notify and submit reports to client as required in contract.

19.5 Evacuation

- Evacuation routes, assembly areas, and severe weather shelters (and alternative routes and assembly areas) are to be specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the ERC or designee before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The ERC 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 ERC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The ERC will follow the incident reporting procedures in the "Incident Notification, Reporting and Investigation" section of this HSP.

19.6 Evacuation Signals

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.

20.0 Spill Containment Procedures

CH2M HILL and subcontractor personnel working at the project site shall be knowledgeable of the potential health, safety and environmental concerns associated with petroleum and other substances that could potentially be released at the project site.

The following is a list of criteria that must be addressed in CH2M HILL's or the subcontractor's plans in the event of a spill or release. In the event of a large quantity spill notify emergency services. Personnel discovering a spill shall (only if safe to do so):

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

21.0 Inspections

21.1 Safe Behavior Observations

Safe Behavior Observations (SBOs) 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 SC or designee shall perform at least one SBO each week for any field work performed by subcontractors or when there are at least two CH2M HILL personnel performing field work.

The SC or designee shall complete the SBO form (attached to this HSP) for the task/operation being observed and submit them weekly.

For commercial projects, SBOs may be submitted electronically by e-mailing them to the address, "CH2MHILL ES COM Safe Behavior Observations" when connected to the network or at SafeBehaviorObservations@ch2m.com. For Federal projects, SBOs may be submitted electronically by e-mailing them to the address, "CH2M HILL ES FED Safe Behavior Observations" when connected to the network or at CH2MHILLESFEDSafeBehaviorObservation@ch2m.com.

22.0 Incident Notification, Reporting, and Investigation

(Reference CH2M HILL SOP HSE-111, *Incident Notification, Reporting and Investigation*)

22.1 General Information

This section applies to the following:

- All injuries involving employees, third parties, or members of the public;
- Damage to property or equipment;
- Interruptions to work or public service (hitting a utility);
- Incidents which attract negative media coverage;
- Near misses;
- Spills, leaks, or regulatory violations; and
- Motor vehicle accidents.

Documentation, including incident reports, investigation, analysis and corrective measure taken, shall be kept by the SC and maintained onsite for the duration of the project.

22.2 Section Definitions

Incident: An incident is an event that causes or could have caused undesired consequences. An incident may be caused by natural forces, employees, subcontractors, or third parties in any location associated with CH2M HILL operations, including offices, warehouses, project sites, private property, or public spaces. Incidents include:

- Injury or illness to a CH2M HILL employee or subcontractor employee, or member of the public;
- Property damage;
- Spill or release;
- Environmental requirement or permit violation;
- A "near-miss"; or
- Other (e.g., fire, explosion, bomb threat, workplace violence, threats)
- **Accident**: an incident involving actual loss through injury, damage to assets, or environmental harm.

Near Miss: A near-miss occurs when an intervening factor prevented an injury or illness, property damage, spill or release, permit violation or other event from occurring. Examples of near-miss situations include: a hard hat or other personal protective equipment (PPE) prevented an injury; secondary containment or emergency shutoff prevented a spill; or an alert co-worker prevented an incident.

Serious Incident:

A Serious Incident must be immediately reported to senior management includes:

- Work related death, or life threatening injury or illness of a CH2M HILL employee;
- subcontractor, or member of the public;
- Kidnap/missing person;
- Acts or threats of terrorism;

- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.3 Reporting Requirements

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

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC.

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

- Project Name and Site Manager;
- Date and time of incident;
- Description of incident;
- Extent of known injuries or damage;
- Level of medical attention; and
- Preliminary root cause/corrective actions

The RHSM shall immediately inform the EM (or available alternate) of spills, potential environmental permit compliance, or any environmental situation that could result in a notice of violation from an agency.

The CH2M HILL team shall comply with all applicable statutory incident reporting requirements such as those to OSHA, the police, or state or Federal environmental agency.

22.4 HITS System and Incident Report Form

CH2M HILL maintains a HITS entry and/or Incident Report Form (IRF) for all work-related injuries and illnesses sustained by its employees in accordance with recordkeeping and insurance requirements. A HITS entry and/or IRF will also be maintained for other incidents (property damage, fire or explosion, spill, release, potential violation, and near misses) as part of our loss prevention and risk reduction initiative.

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M HILL's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

22.5 Injury Management/Return-to-Work (for US/Puerto Rico based CH2M HILL Staff Only)

(Reference CH2M HILL, SOP HSSE-124, Injury Management/Return-to-Work)

22.5.1 Background

The Injury Management Program has been established to provide orderly, effective and timely medical treatment and return-to-work transition for an employee who sustains a work-related injury or illness. It also provides guidance and assistance with obtaining appropriate treatment to aid recovery, keep supervisors informed of employee status, and to quickly report and investigate work-related injury/illnesses to prevent recurrence.

To implement the Injury Management/Return-to-Work Program successfully, supervisors and/or SC should:

- Ensure employees are informed of the Injury Management/Return-to-Work Program;
- Become familiar with the Notification Process (detailed below); and
- Post the Injury Management/Return-to-Work Notification Poster.

22.5.2 The Injury Management/Return-to-Work Notification Process:

- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week.
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.
- Nurse notifies appropriate CH2M HILL staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

22.6 Serious Incident Reporting Requirements

(Reference CH2M HILL SOP HSE-111, *Incident Reporting, Notification and Investigation*)

The serious incident reporting requirements ensures timely notification and allows for positive control over flow of information so that the incident is handled effectively, efficiently, and in conjunction with appropriate corporate entities. This standard notification process integrates Health, Safety, Security and Environment and Firm Wide Security Operations requirements for the consistent reporting of and managing of serious events throughout our operations.

22.6.1 Serious Incident Determination

The following are general criteria for determining whether an incident on CH2M HILL owned or managed facilities or program sites is considered serious and must be immediately reported up to Group President level through the reporting/notification process:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;

- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.6.2 Serious Incident Reporting

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

For all serious incidents this standard reporting process is implemented immediately so as to ultimately achieve notification to the Business Group President within 2 hours of incident onset or discovery, and notification to appropriate corporate Crisis Management Support Team.

22.7 Incident Root Cause Analysis

The accident analysis is essential if all causes of the incident are to be identified for the correct remedial actions to be taken to prevent the same and similar type of incident from recurring. Root Cause Analysis (RCA) shall be completed for all recordable injuries, property damage incidents in excess of $5000.00 (US), environmental permit violations, spills and releases which are required to be reported to regulatory agencies, and any other incident, including near misses where they RHSM or PM determines an RCA is appropriate. The RHSM/REM is responsible for ensuring it is completed and results entered in the incident report form in HITS. RCA's must be completed using a Team that includes, at least the RHSM or designee, the involved party(ies), a responsible operations representative (e.g. PM, construction manager, crew supervisor, etc.) and an independent management representative not associated with the incident.

The Root Cause Analysis Form must be completed for all Loss Incidents and Near Loss Incidents. This form must be submitted to the investigation team for review.

For minor losses or near losses, the information may be gathered by the supervisor or other personnel immediately following the 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, determine the root cause, and 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 follow the Root Cause Analysis Flow Chart (see Attachment 4 of the SOP) 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."

Personal factors include:

- Lack of skill or knowledge;
- Correct way takes more time and/or requires more effort;

- Short-cutting standard procedures is positively reinforced or tolerated; or
- Person thinks there is no personal benefit to always doing the job according to standards.

Job Factors include:

- Lack of or inadequate operational procedures or work standards;
- Inadequate communication of expectations regarding procedures or standards; or
- Inadequate tools or equipment.

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.

22.7.1 Corrective Actions

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 timeframe for completion. Be sure the corrective actions address the causes.

Once the investigation report has been completed, the PM shall hold a review meeting to discuss the incident and provide recommendations. The responsible supervisors shall be assigned to carry out the recommendations, and shall inform the SC upon successful implementation of all recommended actions.

- Evaluation and follow-up of the IRF will be completed by the type of incident by the RHSM, EM, or FWSO.
- Incident investigations must be initiated and completed as soon as possible but no later than 72 hours after the incident.

23.0 Records and Reports

An organized project filing system is essential for good documentation and recordkeeping. There are many benefits to an organized filing system:

- Other CH2M HILL employees can easily and quickly find documents;
- Records are readily available for review;
- Records may be needed during OSHA investigations, audits, or other legal matters;
- Records may be needed on short notice in case of an accident, illness or other emergency; and
- Systematic recordkeeping aids in overall project organization.

The project filing system shall be established at the beginning of the project and maintained throughout all phases of construction and archived in accordance with CH2M HILL's Records Retention Policy. The information contained in the filing system shall be updated regularly and/or as specified in this document. The PM and SC are responsible for collecting documentation, including subcontractor documentation, and maintaining a complete and organized filing system.

Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), MSDSs, exposure modeling results;
- Physical hazard exposure records include noise, ionizing radiation, non-ionizing radiation, vibration, and lasers exposure assessments and measurements;
- Respiratory fit test records;
- Training records;
- Incident reports, investigations and associated back-up information such as agency notifications, calculations, and corrective actions taken;
- Federal or state agency inspection records;
- Other Records:
  - HSE audits and assessments;
  - Project-specific HSE plans;
  - SBOs;
- The RHSM shall coordinate with the PM or designee to ensure that final project-specific HSE records described in this section, including negative exposure determinations, are maintained with the project files in accordance with the CH2M HILL records retention schedule, or forwarded to the Medical Surveillance Program Administrator, as appropriate. Records retention requirements are detailed in the Recordkeeping and Access to Records SOP, HSE-119.

CH2M HILL Health and Safety Plan

Attachment 1

Health and Safety Plan Employee Sign-off Form

EMPLOYEE SIGNOFF FORM
Health and Safety Plan

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

Project Name: **Project Number:**

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

CH2M HILL Health and Safety Plan

Attachment 2

Chemical Inventory/Register Form

CH2MHILL

CHEMICAL INVENTORY/REGISTER FORM

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

Location:

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☐ Project:

Project No.:

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

MSDS for the listed products will be maintained at:

CH2M HILL Health and Safety Plan

Attachment 3

Chemical-Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

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

Location: Project # :

HCC: Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

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

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

CH2M HILL Health and Safety Plan

Attachment 4

Key Target Zero Program Elements

(blank forms for field use)

Activity Hazard Analysis

Pre-Task Safety Plans

Safe Behavior Observation

ACTIVITY HAZARD ANALYSIS

Activity:	**Date**:
	Project Name:
Description of the work:	**Site Supervisor**:
	Site Safety Officer:
	Review for latest use: Before the job is performed

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	Potential Health and Safety Hazards (Analyze each principal step for potential hazards)	Hazard Controls (Develop specific controls for each potential hazard)

ACTIVITY HAZARD ANALYSIS

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	Potential Health and Safety Hazards (Analyze each principal step for potential hazards)	Hazard Controls (Develop specific controls for each potential hazard)

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)

ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:** _____
Safety Officer Name:	_____	_____	**Date/Time:** _____
Employee Name(s):	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____
	_____	_____	**Date/Time:** _____

CH2MHILL

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

Project:_____ Location: _____ Date:_____

Supervisor: _____ Job Activity:_____

_____

Attendees: Print Name Sign Name

_____

_____

_____

_____

_____

_____

_____

List Tasks and verify that applicable AHAs have been reviewed:

_____

_____

_____

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

_____

_____

_____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

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

Other Potential Hazards (Describe):

_____

_____

_____

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

Name (Print): _____
Signature:_____ Date:_____

CH2MHILL

Safe Behavior Observation Form		
☐Federal or ☐Commercial Sector (check one)	☐Construction or ☐Consulting (check one)	
Project Number:	Client/Program:	
Project Name:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- ❖ 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 support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

For ES Commercial Sector projects please email completed forms to: CH2M HILL ES COM Safe Behavior Observation

CH2M HILL Health and Safety Plan

Attachment 5

Fact Sheets

Vehicle Accident Guidance

Ticks

2011 Vehicle Accident Guidance—ESBG

Remember that if you a **renting** a non-CH2M HILL owned vehicle (short-term rental) in the U.S., you should carry the insurance card from the state where your driver's license is issued.

If you operate a **fleet vehicle**, carry the insurance card where the vehicle is registered.

For ALL Vehicles if you are in an accident:

1. If you are injured, call 911 for emergency medical treatment or 1-866-893-2514 to contact the CH2M HILL Occupational Nurse/Physician for minor injuries. If you feel you have not been injured, contact the RHSM for guidance on whether calling the CH2M HILL Occupation Nurse/Physician is applicable.

2. **Call the Police--**For any vehicle accident/damage, it is recommended that the local police (or site security/emergency services if working on a client site that provides such services) be called to determine if a report needs to be filed. In some instances, a report may not be required (during accident alerts, or in public parking lots). Document that the authorities were called and follow up with any guidance they give you. State requirements vary. If a report is filed, obtain a copy.

3. Notify Supervisor, (and PM/RHSM if working on a project site)

4. Complete a HITS report on the VO.

Additional Steps

To report an auto accident, and before a claim can be taken by telephonic reporting, have available your name (the company name alone is no longer accepted, a driver's name must be provided even for fender benders), location of accident and your office address if different than the accident location, business group and project number. A claim cannot be taken without your name, address, business group and your project number. By location the state where the accident occurred, and which office you are aligned to, i.e., accident occurs in Idaho, but you are out of the Denver office. Advise the claim recorder the accident occurred in ID, but that your office location is Denver. This will assist the claim intake person in identifying location coding for the claims.

Auto accidents involve two different sections of an Auto policy:

1) Liability to others due to Bodily Injury and Property Damage

2) Physical Damage - Comprehensive and Collision - damage to the vehicle CH employee is driving

CH2M Hill has Liability coverage for any auto - our policy will respond on either a primary or excess basis.

Refer to the table below for additional notifications to make based on the type of accident experienced and type of vehicle being used.

Liability - Bodily Injury or Property Damage to Others

Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill - Primary	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill - Primary	Contact Jennifer Rindahl/DEN (720-286-2449)
Client vehicle driven by CH2M Hill employee	Client's auto policy unless client has made CH2M Hill responsible for vehicle	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindahl/DEN (720-286-2449); contact client;
Short term lease (30 days or less)	Rental car company if rented through Enterprise, Budget or Hertz; CH2M Hill excess	Contact Broadspire (1-800-753-6737); Contact local branch of rental car company where vehicle leased (ERAC includes 24 hour roadside assistance) and Jennifer Rindahl/DEN (720-286-2449)
Short term lease (30 days or less)	CH2M Hill - Primary if rented through company other than our national agreements; $100,000 deductible	Contact Broadspire (1-800-753-6737); Contact rental car company and Jennifer Rindahl/DEN (720-286-2449)
Personal vehicle used on business	Employee's personal auto policy; CH2M Hill on an excess basis	Contact personal auto insurance company; contact Jennifer Rindahl/DEN (720-286-2449)

Physical Damage - damage to vehicle CH employee was driving

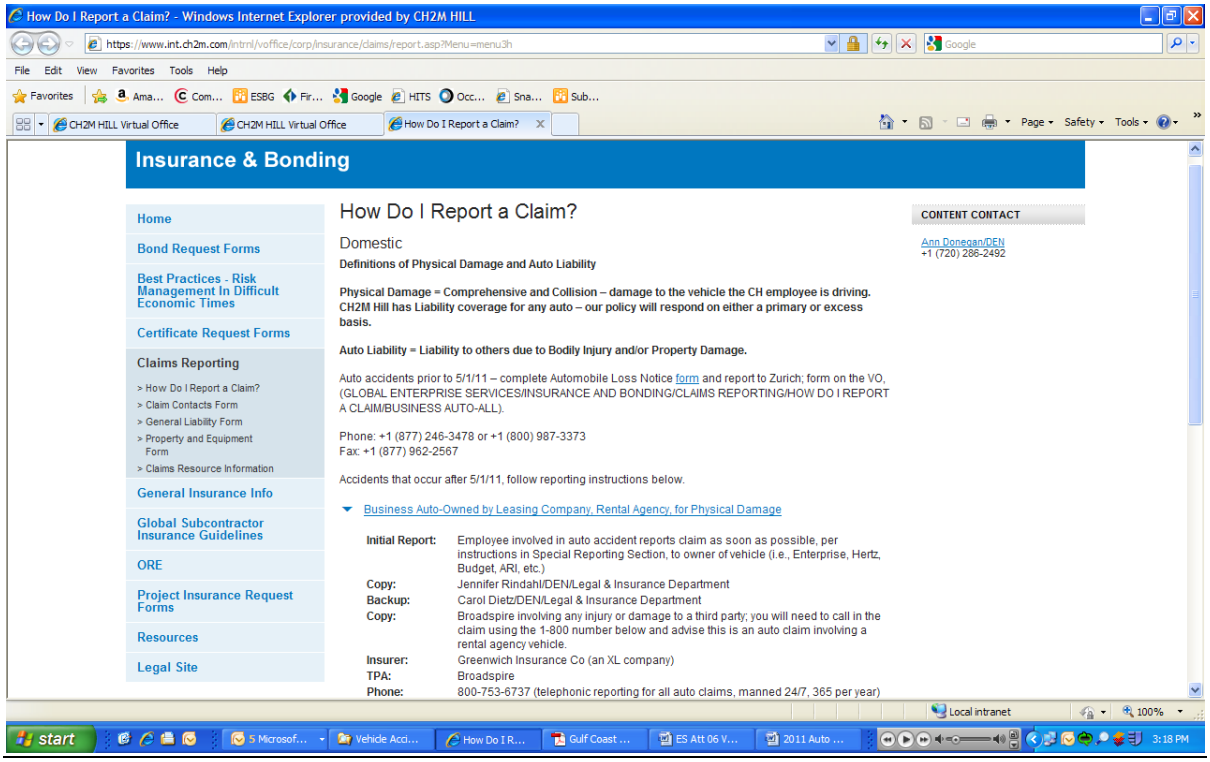
Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill ONLY if vehicle is scheduled on policy - $5,000 deductible	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill Equipment Schedule if scheduled on policy	Contact Jennifer Rindahl/DEN (720-286-2449)
CH2M Hill fleet, pool or project vehicle - long term lease	ARI if physical damage coverage purchased - $500 deductible	Contact Jennifer Rindahl/DEN 720.286.2449; call ARI at 1-800-221-1645 give them Client Code and ARI fleet vehicle number; and notify Linda George/DEN - Fleet Coordinator - 720-286-2057
Client vehicle CH2M Hill Employee is driving	Client's auto policy unless client has made CH2M Hill contractually responsible for vehicle	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)
Short term lease (30 days or less) using corporate VISA	VISA if corporate credit card used and vehicle is not a pickup, truck, cargo van or used off-road	Contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Short term lease (30 days or less) through Enterprise (ERAC) and vehicle is used off-road and physical damage coverage included when vehicle leased	ERAC up to $3,000 in damage; CH2M Hill's coverage is excess	Notify Rental Car Company; contact Jennifer Rindahl/DEN (720-286-2449) if damage over $5,000
Short term lease (30 days or less) did **not** use corporate VISA	CH2M Hill - $5,000 deductible (project responsibility)	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindhal/DEN 720-286-2449; contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Personal vehicle used on business	CH will reimburse the amount of the deductible carried on the employee's policy up to $500 whichever is less	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)

Details for reporting a claim on the CH2M Hill VO are accessed by going to the VO home page and clicking:

GLOBAL ENTERPRISE SERVICES/INSURANCE & BONDING/CLAIMS REPORTING

HOW DO I REPORT A CLAIM TAB or access the following URL:

https://www.int.ch2m.com/intrnl/voffice/corp/insurance/claims/report.asp?Menu=menu3h



For Personally Owned Vehicles (POVs):

CH2M HILL does not provide auto insurance for POVs, it is responsibility of the owner. If you are in a vehicle accident conducting company business, contact the police as above, supervisor, and 911 or CH2M HILL's occupational nurse/physician as stated above. Complete a HITS report. Contact Jennifer Rindahl/DEN for assistance for meeting personal insurance deductibles (up to $500) with proof of insurance and deductible.

If using your POV for extended project use, notify the PM to make sure a rental car is not needed. Check your insurance policy for guidance on using the POV for business use.

Additional Resources:

Claims Resource Manual

Tick-Borne Pathogens — A Fact Sheet

Most of us have heard of Lyme disease or Rocky Mountain Spotted Fever (RMSF), but there are actually six notifiable tick-borne pathogens that present a significant field hazard. In some areas, these account for more than half of our serious field incidents. The following procedures should be applied during any field activity—even in places that are predominantly paved with bordering vegetation.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs and symptoms of tick-borne illnesses.

Tick Identification

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

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Tick Habitat

In eastern states, ticks are associated with deciduous forest and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture.

On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. For this region, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

Illnesses and Signs & Symptoms

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

- Lyme (bacteria)
- RMSF (bacteria)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

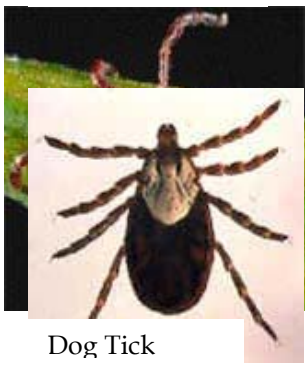
Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These

illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. For Lyme disease, the bite area will sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

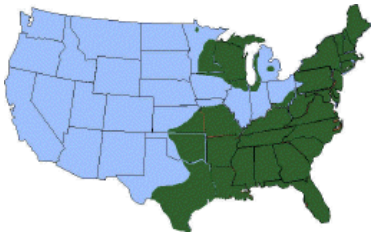
Deer Tick

From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)

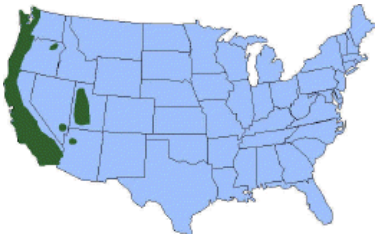
Lone Star Tick



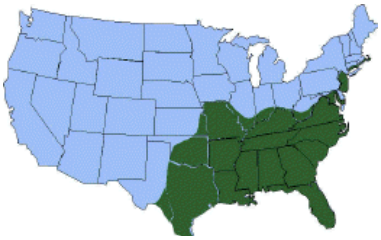
Dog Tick



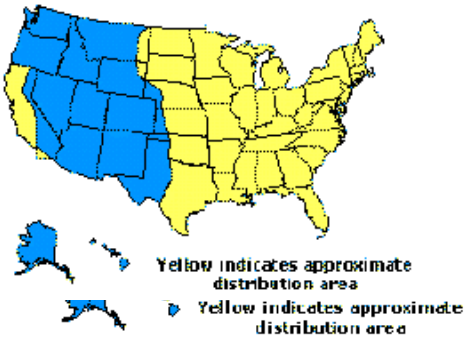
Distribution of Deer Tick (dark green)



Distribution of Pacific Deer Tick (dark green)



Distribution of Lone Star Tick (Green)



Hazard Control

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

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

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

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants—tick-borne pathogens present risk of serious illness!

In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and/or direct population reduction through the use of tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative maintenance such as removing leaf litter and trimming grass and brush. Tick populations can be reduced by between 72 and 100 percent when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant or to a licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary to control exposure to ticks. Personal protection must include all of the following steps:

- So that ticks may be easily seen, wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used
- To prevent ticks from getting underneath clothing tuck pant legs into socks or tape to boots
- Wear long-sleeved shirts, a hat, and high boots
- Apply DEET repellent to exposed skin or clothing per product label
- Apply permethrin repellent to the outside of boots and clothing before wearing, per product label
- Frequently check for ticks and remove from clothing
- At the end of the day, search your entire body for ticks (particularly groin, armpits, neck, and head) and shower
- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves any time ticks are handled

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid situations such as hand-to-face contact, eating, drinking, and smoking when applying or using repellents.

Remove and wash clothes per repellent product label. Chemical repellents should not be used on infants and children.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ Lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician.

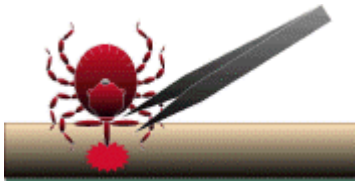
Tick Check

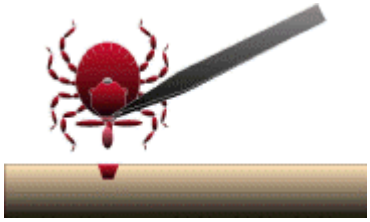
A tick check should be performed after field survey before entering the field vehicle (you do not want to infest your field vehicle with ticks). Have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thorough as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self check.

If a tick has embedded itself into the skin, remove the tick as described below.

Tick Removal

1. Use the tick removal kit obtained through the CH2M HILL Milwaukee warehouse, or a fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.
Error! Objects cannot be created from editing field codes.
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. Avoid squeezing, crushing or puncturing the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

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

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

6. Should you wish to save the tick for identification, place it in a plastic bag, with the date of the tick bite, and place in your freezer. It may be used at a later date to assist a physician with making an accurate diagnosis (if you become ill).

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

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Individuals previously infected with Lyme disease does not confer immunity—re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

The employee should contact the Injury Management/Return To Work provider (IMRTW), WorkCare using the toll-free number 866-893-2514 to report the tick bite. WorkCare will follow-up with each CH2M Hill employee who reports a tick bite and is at risk of developing Lyme disease by monitoring for symptoms up to 45 days, and will refer the employee to a medical provider for evaluation and treatment as necessary.

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 6

Agency Inspection Target Zero Bulletin

Environmental Services Business Group

TARGET ZERO BULLETIN

Subject: HSSE Agency Inspections (OSHA, EPA, DOT, State Health Department)

Do you know what YOU would do if an agency inspector arrived at your site unannounced?

Recently, a State Occupational Safety and Health Administration (OSHA) inspector made an unannounced visit to one of our Federal project sites. OSHA, U.S. Environmental Protection Agency (EPA), and authorized state or local agencies have authority to inspect any facility that is subject to health, safety, and environmental legislation. Inspections may be announced or unannounced. This particular inspector indicated that the project was targeted for an inspection because the work was funded by the American Recovery and Reinvestment Act (ARRA).

Enterprise Standard Operating Procedure (SOP) HSE-201, *Agency Inspections and Communications,* describes the responsibilities, procedures, and requirements associated with inspections conducted by external regulatory agencies, as well as the methods for communicating information to key individuals. This Target Zero Bulletin is a brief summary of what to do in the event of an agency inspection at your site. Refer to the SOP for more specific guidance.

Notification of Inspections

- If the inspection is an announced regulatory agency inspection, the Project Manager (PM) should notify the Responsible Health and Safety Manager (RHSM) and Responsible Environmental Manager (REM) well in advance of the inspection.
- If an unannounced agency inspector visits one of our projects, Field personnel must immediately notify the project Emergency Response Coordinator (ERC). Typically the ERC is the Safety Coordinator (SC).
- The ERC must immediately notify the RHSM/REM, as appropriate, of unannounced inspections, or designate someone to call the RHSM/REM. The RHSM/REMs can provide guidance to the field staff and PM.

Inspector Credential Verification

- Upon arrival, the ERC must request the inspector to provide official credentials. Record the inspector's name and office phone number or obtain the inspector's business card.
- The inspector shall sign the visitors log and be given a site-specific health, safety, and environmental protection briefing.
- The inspector shall meet any site access requirements associated with security clearances, specialized training, and medical monitoring. The CH2M HILL representative shall verify that the inspector possesses these requirements; access will only be granted to those areas where appropriate access requirements are met. Some inspectors have the authority to gain access to any work area at any time, such as an inspector with a search warrant. In these cases, we can stop work operations as necessary to protect the safety of the inspector(s).

Opening Conference

- The CH2M HILL Project Manager, ERC, RHSM, or REM, and the inspector shall determine attendees for the opening conference. The RHSM (for OSHA and other worker health and safety inspections) or REM (for environmental inspections) shall join the opening conference via conference call.
- The inspector shall inform CH2M HILL of the purpose of the inspection and provide a copy of the complaint, if applicable.
- The inspector shall outline the scope of the inspection, including employee interviews conducted in private, physical inspection of the workplace and records, possible referrals, discrimination complaints, and the closing conference(s).

Requests for OSHA Logs

- An OSHA inspector may request to review the project OSHA Injury/Illness log, better known as the OSHA 300 Log. Contact your RHSM for assistance in obtaining the OSHA 300 Log.

- Field projects with a continuous duration of one year or longer are considered to be separate establishments and are required to maintain an OSHA 300 log specific to the project. The project OSHA 300 log should be maintained onsite and kept current.
- Recordable injuries and illnesses sustained on field projects less than one year in duration are maintained on the CH2M HILL office log where the injured employee is based.

The Inspection

- The scope of the inspection shall be limited to that indicated by the inspector in the opening conference. The inspector shall be escorted to relevant areas only. The ERC or other designated by the RHSM or REM must accompany the inspector during the inspection.
- Ensure that the inspection is limited to the scope that the inspector disclosed during the opening conference. The ERC should always take notes which identify: areas inspected, machinery or equipment and materials examined, employees or other persons interviewed, and photographs taken by the inspector.
- The inspector will observe safety, health, and environmental conditions and practices and document the inspection process. The inspector may also take photos and instrument readings, examine records, collect air samples, measure noise levels, survey existing engineering controls, and monitor employee exposure to toxic vapors, gases, and dusts.
- CH2M HILL should gather duplicate information (photographs, readings, samples) in the same manner and condition as the inspector. If the equipment needed to take duplicate samples is not onsite, ask the inspector if the sampling can wait until the equipment is available. If samples are taken, request a description of the tests that the agency intends to perform on the samples and request results as soon as they are available.
- Employees may be questioned during the inspection tour. The employee can refuse to speak to an inspector, can speak to the inspector with a company representative (including management) present, or can speak to the inspector privately. It is CH2M HILL policy that employees who wish to speak to the inspector are not discriminated against, intimidated, or otherwise mistreated for exercising their rights during compliance inspections.
- Copies of documents should not be provided to the inspector without the approval of the RHSM or REM or Legal Insurance Department (LID). **DO NOT** voluntarily release documents. Respond only to inspection team requests.
- During the course of the inspection, the inspector may point out violations. For each violation, the CH2M HILL representative should ask the inspector to discuss possible corrective action. Where possible, violations detected by the inspector should be corrected immediately and noted by the inspector as corrected.
- For those items which cannot be corrected immediately, an action plan shall be formulated for timely correction. In any instance, employees exposed to hazards shall be removed from the area.

Closing Conference

After the inspection, a closing conference is normally held as follows:

- The CH2M HILL PM, ERC, RHSM or REM shall be involved via conference call in the closing conference, at a minimum;
- The inspector shall describe the apparent violations found during the inspection and other pertinent issues as deemed necessary by the inspector. CH2M HILL shall be advised of their rights to participate in any subsequent conferences, meetings or discussions. Any unusual circumstances noted during the closing conference shall be documented by the ERC;
- The inspector shall discuss violations observed during the inspection and indicate for which violations a citation and a proposed penalty may be issued or recommended;
- The ERC shall request receipts for all samples and approved documents photocopied by the inspector, request a photocopy of the inspector's photograph log, and request a copy of the final inspection report; and
- Any documentation from an agency inspection must be transmitted immediately to the RHSM or REM, and LID.

Unannounced regulatory agency inspections may happen at any time on our projects -

Get your RHSM/REM and PM involved immediately if an Inspector arrives.

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 7

Completed CH2M HILL AHAs

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 8

Material Safety Data Sheets

ATTACHMENT D: RISK-BASED CONCENTRATIONS FOR TAL METALS

Table D-1. Residential Risk-Based Concentrations (RBCs) for Soil using the EPA Regional Screening Level Calculator.

Analyte	CASRN	Residential Risk-Based Concentrations Soil Screening Levels[a]		
		Carcinogenic SSL TR=1.0E-6 (mg/kg)	Noncarcinogenic SSL HI=1 (mg/kg)	Final RSL (mg/kg)
Aluminum	7429-90-5	–	77,400	77,400
Antimony	11071-15-1	–	31.3	31.3[b]
Arsenic (inorganic)	7440-38-2	0.39	21.6	9.39[c]
Barium	7440-39-3	–	15,300	15,300
Beryllium	7440-41-7	1,380	156	156
Cadmium	7440-43-9	1,840	70.3	70.3
Calcium	7440-70-2	–	–	–
Chromium (VI)	18540-29-9	0.301	234	0.301[d]
Cobalt	7440-48-4	368	23.4	23.4
Copper	7440-50-8	–	3,130	3,130
Iron	7439-89-6	–	54,800	54,800
Lead	7439-92-1	–	400	400
Magnesium	7439-95-4	–	–	–
Manganese	7439-96-5	–	1,830	1,830
Nickel (soluble salts)	7440-02-0	12,700	1,550	1,550
Potassium	7440-09-7	–	–	–
Selenium	7782-49-2	–	391	391
Silver	7440-22-4	–	391	391
Sodium	7440-23-5	–	–	–
Thallium	7440-28-0	–	0.782	0.782
Vanadium	7440-62-2	–	5.47	5.472[f]
Zinc	7440-66-6	–	23,500	23,500

HI = hazard index; RSL = residential screening level; SSL = soil screening level; TR = total risk

[a]Residential soil screening levels were calculated using U.S. EPA's Regional Screening Levels (RSLs) (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) with default values for exposure factors.
[b]Values are for antimony potassium tartrate based on Diamond and Thayer (2011a). Antimony potassium tartrate is the most common form of antimony found in the environment.
[c]Values were adjusted using the following equation: final RSL = 0.67 (1E-6) + 9 (natural background).
[d]Values are for chromium VI and are based on a conservative estimate. Adjustments will be made to take into account ratio III:VI in soil for actual risk calculations.
[f]Value is from Diamond and Thayer (2011b), Bacom, et al. (2012), and not by the RSL RAIS calculator.

ATTACHMENT E1: CULTURAL RESOURCES COORDINATION PLAN

TABLE OF CONTENTS

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
APE	Area of potential effects
ARPA	Archeological Resources Protection Act of 1979
CCT	Confederated Tribes of the Colville Reservation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CRCP	Cultural resources coordination plan
DOJ	U.S. Department of Justice
DAHP	Washington State Department of Archaeology & Historic Preservation
FOIA	Freedom of Information Act
Lake Roosevelt	Franklin D. Roosevelt Lake
MOA	Memorandum of Agreement
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
QAPP	Quality assurance project plan
RCW	Revised Code of Washington
RI/FS	Remedial investigation and feasibility study
RM	River mile
SHPO	State Historic Preservation Officer
Site	Upper Columbia River site
STI	Spokane Tribe of Indians
TAI	Teck American, Incorporated
THPO	Tribal Historic Preservation Officer
UCR	Upper Columbia River
USBR	U.S. Bureau of Reclamation
U.S. EPA	U.S. Environmental Protection Agency
WA	Washington
WAC	Washington Administrative Code

1. INTRODUCTION

This document presents the cultural resources coordination plan (CRCP) for the Upper Columbia River (UCR) site (herein the 'Site') remedial investigation and feasibility study (RI/FS) with emphasis placed on sampling activities associated with the residential soil study to be conducted within the UCR Study Area as defined by the QAPP (EPA, 2014).

1.1 Background

As specified in the Statement of Work associated with the June 2, 2006 Settlement Agreement (U.S. EPA, 2006), "For all RI/FS activities at the Site involving sediment collection or ground penetration/disturbance, the Company shall work with the potentially affected parties to assess the effects of the planned work and seek ways to avoid, minimize or mitigate any adverse effects on historic properties." The purpose of this CRCP is to describe known or likely physical impacts of proposed sediment/soil sampling, provide relevant background information, define measures for protecting resources, and define procedures for consulting with the appropriate state, federal, and Tribal parties with interests in the cultural resources of the Site and surrounding areas for this study.

The Site is located wholly within Washington (WA) state and includes approximately 150 river miles of the Columbia River extending from the U.S.-Canada border to the Grand Coulee Dam. The Colville Indian Reservation borders the UCR from approximately river mile (RM) 690 to the Grand Coulee Dam. The Spokane Indian Reservation borders the UCR to the east from approximately RM 650 to RM 640. Franklin D. Roosevelt Lake (Lake Roosevelt) and associated lands are administered by the U.S. Bureau of Reclamation (USBR) and the National Park Service (NPS) of the U.S. Department of the Interior.

The U.S. Environmental Protection Agency (EPA) has responsibilities under the National Historic Preservation Act (NHPA) to consider how its undertakings would affect historic properties. As defined in the NHPA, "historic properties" include archaeological resources, historic-period buildings and structures, and traditional cultural places listed in or determined eligible for listing in the National Register of Historic Places. To meet the NHPA requirements, EPA must ensure that sampling and other activities would avoid, minimize, or mitigate any adverse effects to any historic properties.

The CRCP is organized into six sections, as follows: (1) this introductory section, which includes summary information on the archaeology, prehistory, Native peoples, and Euroamerican historical development of the project area; (2) an overview of the relevant federal, state, and tribal laws and regulations, and other appropriate procedures and requirements; (3) a description of the proposed sampling program; and (4) a plan for coordination and consultation with all affected parties to address known and likely impacts to cultural resources in implementing the proposed work.

1.2 Cultural Setting

The broader context of the cultural development of the upper Columbia region provides the critical framework for understanding the importance of the cultural resources in the area. Archaeological and historical resources reflect broad patterns of cultural use and development, just as ongoing traditional use of areas and natural resources represents cultural continuity that can be important to individual and social identities. This section of the CRCP serves as a brief introduction to the cultural history of the upper Columbia region.

Archaeological research contributes significantly to our understanding of the prehistoric past. In the upper Columbia region, systematic archaeological research began in the late 1930s and has continued to the present. Almost 500 archaeological resources have been recorded in and along Lake Roosevelt, representing prehistoric, protohistoric, ethnohistoric, and historic-period human use and occupation. Research at some of these resources has provided the outlines of prehistoric cultural development in the upper Columbia region. Human presence in the region extends back at least 11,000 years. These first humans lived in small groups and were mobile foragers, hunting and gathering plants. The presence of the Columbia River led to an early focus on the abundance of riverine sources. Beginning about 8,000 years ago, populations appear to have increased and led to a gradual trend to less mobility and more permanent settlements. The growing population also led to use of a greater diversity of resources and increasing reliance on fish.

Permanent settlements increased in size and became concentrated in the river valleys beginning about 6,000 years ago, probably in response to continued population growth. Use of resources in upland areas expanded to meet the needs of the burgeoning populations and settlements. These trends continued until about 1,000 years ago, when there is evidence for a decline in population size. There were fewer settlements, villages were smaller, and there was less use of upland areas.

Cultural patterns of the late prehistoric period were reflected in the lives of the Native peoples at the time of Euroamerican contact. At the time of contact, the UCR was the homeland of the Lakes, Colville, Spokane, and Sanpoil peoples. The Lakes people occupied the Columbia River valley from the vicinity of modern Northport, WA, north into the Arrow Lakes area of modern BC. The Colville lived along the river downstream of the Lakes as far as around the mouth of the Spokane River. Downriver of the Colville were the Spokane, in the Spokane River drainage, and the Sanpoil, who lived along the Columbia River from around the mouth of the Spokane River to the near the modern location of the Grand Coulee Dam.

All of these groups spoke Interior Salish languages and shared many cultural features. Their cultural differences largely reflected differences in the local environments in which they lived. The social, political, and economic foundation of these groups was historically the winter village. The villages were concentrated in the river valleys, and each village was politically independent. Residents of the villages relied on provisions gathered, dried, and stored during the summer to survive through the winter. With the coming of spring, families began moving out of the winter village and shifting among the warm-season camps near resource locations. Gathering of plants and hunting game in upland areas were important subsistence activities during this season, but salmon constituted the most important food staple. Kettle Falls was a major aboriginal fishery, attracting people from throughout the region.

Native life began to change with the introduction of elements of Euroamerican culture. Horses reached the region in the 1700s and significantly changed Native travel and transportation. European diseases such as smallpox appeared in the late 1700s and had disastrous consequences for Native groups. Populations may have declined as much as 80% between the 1780s and 1840s. Direct contact with Euroamericans came in the early 1800s, when fur-trade posts were established on the Spokane River and at Kettle Falls.

When American settlement began in the 1840s, it bypassed the upper Columbia region. The discovery of gold in the region in the 1850s led to a major influx of Americans and growing conflict between the new settlers and Indian groups. A series of treaties with Indian groups were signed in 1855 but did not include the peoples of the upper Columbia region. As American settlement continued, the federal government responded by Presidential Executive Order creating the Colville Reservation in 1872 for the Colville,

Spokane, Methow, Okanogan, Sanpoil, Lakes, Calispel, Coeur d'Alene and scatterings bands. Separate reservations were later set aside for the Spokane, Calispel and Coeur d'Alene tribes. Both the Colville and Spokane reservations have subsequently lost lands to the allotment process in the late 1800s and early 1900s and inundation from the waters of Lake Roosevelt. The Colville Reservation is now the home to the twelve tribes that comprise the Confederated Tribes of the Colville Reservation (CCT); the Spokane Reservation is the home of the Spokane Tribe of Indians (STI).

As already noted, the direct Euroamerican presence in the upper Columbia region began with the establishment of fur-trade posts on the Spokane River and at Kettle Falls. These posts were constructed between 1810 and 1825. The fur traders were followed by Christian missionaries in the 1830s and 1840s. A more substantial Euroamerican presence in the region developed in the 1850s, with the discovery of gold near Fort Colville. Conflicts between miners and Indians led to a military campaign in the Spokane River valley in 1858 and the establishment of an army post (Fort Colville) near Kettle Falls in 1859.

American settlement in the UCR drainage accelerated in the 1860s, initially spurred by mining. Farmers eventually followed the miners, but agricultural activity was limited until the construction of the Spokane Falls and Northern Railway through the region in 1890. With improved access to markets, farming—especially orchard crops—developed as one of the economic mainstays of the area, although mining has continued to play an important role.

The growing demands for agriculture led to plans to construct a dam at Grand Coulee. The dam would provide water for irrigation and inexpensive hydroelectric power. Construction of the dam began in 1934 and was completed in 1942. More than 82,000 acres above the dam was flooded, resulting in the relocation of 11 towns and about 3,000 residents. Since its creation, Lake Roosevelt has provided a growing number of recreational and tourist activities, which have become increasingly important to local economies.

2. OVERVIEW OF LAWS AND REGULATIONS

Implementation of the residential soil sampling plan will require activities on privately owned lands and tribal allotments. This overview therefore includes a brief description of relevant state law and executive orders, and Tribal laws and regulations.

2.1 Federal Legislation and Regulations

An overview of federal legislation and regulations is provided below. There are three key laws relevant to Site RI/FS activities. The NHPA guides all federal agency actions that could affect cultural resources. Implementation of the RI/FS constitutes an "undertaking" as defined in the NHPA and therefore complying with the NHPA requirements is the responsibility of EPA. The Archeological Resources Protection Act (ARPA) of 1979 and the Native American Graves Protection and Repatriation Act (NAGPRA) apply to activities that could affect archaeological resources and Indian burials on federal and tribal lands. These laws and their implementing regulations would therefore apply to RI/FS activities conducted on federal and tribal lands.

2.1.1 National Historic Preservation Act of 1966, as Amended through 1992 (16 USC 470-470w)

The NHPA is the centerpiece of federal legislation protecting cultural resources. In the Act, Congress states that the federal government will "provide leadership in the preservation of the prehistoric and historic resources of the U.S.," including resources that are federally owned, administered, or controlled. For

federal agencies, Sections 106 and 110 of the Act provide the foundation for how federal agencies are to manage cultural resources, but other sections provide further guidance. The implementing regulations for the NHPA are in 36 Code of Federal Regulations (CFR) Part 800. These regulations are summarized below.

2.1.1.1 Section 106

Similar to the National Environmental Policy Act of 1969 (NEPA), Section 106 of the NHPA requires federal agencies to take into account the effects of their actions or programs specifically on historic and archeological properties, prior to implementation. This is accomplished through consultation with the State Historic Preservation Officer (SHPO) and/or the Advisory Council on Historic Preservation (ACHP). On lands held by a Tribe with a Tribal Historic Preservation Officer (THPO), the THPO has the same duties and responsibilities as the SHPO. If an undertaking on federal lands may affect properties having historic value to a federally recognized Indian Tribe, such Tribe shall be afforded the opportunity to participate as interested persons during the consultation process defined in 36 CFR 800. Compliance can also be accomplished using agreed-upon streamlined methods and agreement documents such as programmatic Agreements.

The Section 106 process is designed to identify possible conflicts between historic preservation objectives and the proposed activity, and to resolve those conflicts in the public's interest through consultation. Neither the NHPA nor the ACHP's regulations require that all historic properties be preserved. Rather, they only require the agency proposing the undertaking to consider the effects of the proposed undertaking prior to implementation.

Failure to take into account the effects of an undertaking on historic or cultural properties can result in formal notification from the ACHP to the head of the federal agency of foreclosure of the ACHP's opportunity to comment on the undertaking pursuant to NHPA. A notice of foreclosure can be used by litigants against the federal agency in a manner that can halt or delay critical activities or programs.

The process for compliance with Section 106 consists of the following steps:

1. **Identification of Historic Properties**—Identification of historic properties located within the area of potential effects (APE) is accomplished through review of existing documentation and/or field surveys.
2. **Property Evaluation**—Evaluation of the identified historic properties using National Register criteria (36 CFR Part 63) in consultation with the SHPO and, if necessary, the ACHP. Properties that meet the criteria will be considered "Eligible" for listing in the National Register, and will be subject to further review under Section 106. Properties that do not meet the criteria will be considered "Not Eligible" for listing in the National Register, and will not be subject to further Section 106 review.
3. **Determination of Effect**—An assessment is made of the effects of the proposed project on properties that were determined to meet the National Register criteria, in consultation with the SHPO and if necessary, the ACHP. One of the following effect findings will be made:
    - No Historic Properties Affected—If no historic properties are found or no effects on historic properties are found, the agency official provides appropriate documentation to the SHPO/THPO and notifies consulting parties. However, the federal agency must proceed to the assessment of adverse effects when it finds that historic properties may be affected or

the SHPO/THPO or Council objects to a "No Historic Properties Affected" finding. The agency must notify all consulting parties and invite their views.

- No Historic Properties Adversely Affected—When the Criteria of Adverse Effect are applied (36 CFR 800.5(a)), and it is found that historic properties will not be adversely affected by the undertaking, the agency may make a finding of "No Historic Properties Adversely Affected." This finding is submitted to the SHPO for concurrence. Typically, the Council will not review "No Adverse Effect" determinations. However, the Council will intervene and review "No Historic Properties Adversely Affected" determinations if it deems it appropriate, or if the SHPO/THPO or another consulting party and the federal agency disagree on the finding and the agency cannot resolve the disagreement. If Indian Tribes disagree with the finding, they can request the Council's review directly, but this must be done within the 30-day review period. Agencies must retain records of their findings of "No Historic Properties Adversely Affected" and make them available to the public. The public should be given access to the information when they so request, subject to Freedom of Information Act (FOIA) and other statutory limits on disclosure, including the confidentiality provisions in Section 304 of the NHPA. Failure of the agency to carry out the undertaking in accordance with the finding requires the agency official to reopen the Section 106 process and determine whether the altered course of action constitutes an adverse effect.

- Historic Properties Adversely Affected—Adverse effects occur when an undertaking may directly or indirectly alter characteristics of a historic property that qualify it for inclusion in the Register. Reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative also need to be considered. The finding of "Historic Properties Adversely Affected" is submitted to the SHPO for concurrence. The SHPO/THPO may suggest changes in a project or impose conditions so that adverse effects can be avoided and thus result in a "No Historic Properties Adversely Affected" determination.

4. **Resolution of Adverse Effects/Mitigation**—When adverse effects are found, the consultation must continue among the federal agency, SHPO/THPO, and consulting parties to attempt to resolve them. The agency official must notify the Council when adverse effects are found and should invite the Council to participate in the consultation when circumstances as outlined within 36 CFR 15 800.6(a)(1)(i)(A)-(C) exist. A consulting party may also request the Council to join the consultation.

   When resolving adverse effects without the Council, the agency official consults with the SHPO/THPO and other consulting parties to develop a Memorandum of Agreement (MOA). The MOA will outline the steps or actions to be taken prior to implementation of the project, in order to mitigate the adverse effects on the historic property. Stipulations included in an MOA may include (but are not limited to) documentation, modification of the project to lessen the adverse effects on the property, efforts to sell or relocate the resource, or step-by-step consultation with interested parties throughout the process to ensure it is carried out according to plan.

The MOA is executed between the agency official and the SHPO/THPO and filed with required documentation with the Council. This filing is the formal conclusion of the Section 106 process and must occur before the undertaking is approved.

In some cases, streamlining of the Section 106 process can be accomplished through the use of programmatic agreements. The ACHP and the agency official may negotiate a programmatic agreement to govern the implementation of a particular program or the resolution of effects from complex projects or multiple undertakings. Programmatic agreements are particularly useful when programs or projects affecting historic properties are similar and repetitive, and have known effects, such as routine maintenance or a series of similar rehabilitation projects.

2.1.1.2 Section 101(d)(2)

This section of the NHPA provides for the assumption by federally recognized Indian Tribes of all or any part of the functions of a SHPO with respect to tribal lands (e.g., all lands within the exterior boundaries of any Indian reservation and all dependent Indian communities). Section 101(d)(2) requires federal agencies, in carrying out their Section 106 responsibilities, to consult with federally recognized Indian Tribes that attach religious or cultural significance to a historic property. The agency will consult with federally recognized Indian Tribes in the Section 106 process to identify, evaluate, and treat historic properties that have religious or cultural importance to those groups.

2.1.1.3 Section 110

Section 110 of the NHPA is intended to ensure that historic preservation is integrated into the ongoing programs of Federal agencies. This section of the Act requires agencies to identify, evaluate, and nominate for listing in the National Register, historic properties owned or controlled by the agency; use historic properties to the maximum extent feasible; ensure documentation of historic properties that are to be altered or damaged; carry out programs and projects that further the purpose of the Act; and undertake such planning and actions as may be necessary to minimize harm to any formally designated National Historic Landmark properties.

2.1.1.4 Section 111

Section 111 of the NHPA requires agency officials, to the extent practicable, to establish and implement alternatives for historic properties, including adaptive use, that are not needed for current or projected agency uses or requirements. Further, Section 111 allows the proceeds from any lease to be retained by the agency to defray the cost of administration, maintenance, repair, and related expenses of historic properties.

2.1.1.5 Section 112

Section 112 of the NHPA requires that agency officials who are responsible for protection of historic properties pursuant to the NHPA ensure that all actions taken by employees or contractors meet professional historic preservation standards established by the Secretary of the Interior (Professional Qualifications Standards of the Secretary of the Interior’s Standards and Guidelines in Archaeology and Historic Preservation [NPS 1983]).

2.1.1.6 Section 304

Section 304 of the NHPA requires that information about the location, character, or ownership of a historic property be withheld from public disclosure when the federal agency head or other public official

determines that disclosure may cause a significant invasion of privacy, risk and/or harm to the historic property, or impede the use of a traditional religious site by practitioners.

2.1.1.7 CERCLA and the NHPA

EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements (U.S. EPA, 1989) outlines how "substantive compliance" with the NHPA is to be achieved in CERCLA actions. The initial step is determining if cultural resources are known or are likely to be present "in or near the area under study in the RI." This step may require conducting a survey of both the location of the proposed remedial action and any associated actions that would occur off-site. The CERCLA manual referenced above defines three stages of a survey: Stage IA, literature search and sensitivity study; Stage IB, field investigation; and Stage II, site definition and evaluation. All studies should include Stage IA but implementation of Stage IB is contingent on the results of Stage IA, and the need for Stage II is contingent on the results of Stage IB. If results of the survey identify significant cultural resources (i.e., resources listed or considered eligible for listing on the National Register), effects of the proposed remedial action and associated actions to the significant resources must be evaluated. Adverse effects to significant resources must be either avoided or mitigated. Any proposed mitigation measures must be incorporated into the remedial design process.

2.1.2 Archeological Resources Protection Act of 1979 (16 USC 470aa-470ll)

ARPA is essentially an update to the 1906 Antiquities Act. It expands and strengthens the activities prohibited under the Antiquities Act, increases the criminal penalties for violation, establishes civil penalties, and provides further guidelines for the issuance of permits. This Act continues to apply only to federal and Indian lands (the definition of "Indian lands" in ARPA differs very slightly from the definition of "tribal lands" in the NHPA). Most archaeological excavations and collection of artifacts on these lands are allowed only with an ARPA permit. Trafficking in illegally obtained archeological resources from federal and Indian lands is also prohibited. Individuals convicted of violating the Act are liable for the value of the archaeological resource itself, and the cost of restoration or repair of the damage caused by illegal excavation or collection.

The implementing regulations are 43 CFR Part 7 (Department of the Interior), which applies to Federal lands that are not within military reservations or national forests. The regulations include detailed definitions of "archaeological resource" and "Indian lands" (lands held in trust by the U.S. on behalf of a federally recognized Tribe or individual members of a federally recognized Tribe).

2.1.3 Native American Graves Protection and Repatriation Act (25 USC 3001-3013)

NAGPRA establishes that Native American human remains and associated funerary objects found on federal or tribal lands belong to the lineal descendants of the Native American. When the lineal descendants cannot be determined, the remains belong to the Tribe on whose land the remains were found (when found on tribal lands), or to the Indian Tribe with the "closest cultural affiliation." This latter rule also applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony (all defined in the Act) NAGPRA applies to both human remains intentionally excavated (which would require an ARPA permit) and those accidentally discovered.

NAGPRA also requires all federal agencies and museums to inventory their holdings of Native American human remains and funerary objects. Once the inventories are completed, the agencies and museums are to

notify the appropriate Tribes of the remains and other objects in their collections. The remains and associated funerary objects are to be returned (repatriated) at the request of the lineal descendant(s) or Tribe. The same requirement applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony for which a cultural affiliation can be demonstrated. Exceptions to the repatriation requirement are objects that are "indispensable for completion of a specific scientific study, the outcome of which would be of major benefit to the U.S."

The implementing regulations are 43 CFR Part 10, which largely expand on the elements of the statute. The regulations detail: (1) the process of consultation with Indian Tribes to address either intentional excavation of human remains or inadvertent discovery of human remains; (2) how agencies and museums are to inventory their collections; and (3) the repatriation process. When human remains, funerary objects, sacred objects, and objects of cultural patrimony are inadvertently discovered on federal lands the following steps are to be followed: (1) ongoing activity in the area of the find must cease and a reasonable effort made to protect the find; and (2) the federal land agency (i.e., the federal agency on whose lands the remains or objects have been found) must be immediately notified by telephone, with written confirmation. The federal land agency must then notify the appropriate Tribe(s) and further secure and protect the discovery. The activity may be halted for up to days while an appropriate response to the find is negotiated by the federal agency and the appropriate Tribe(s).

2.1.4 American Indian Religious Freedom Act (42 USC 1996)

This act states that it is the policy of the U.S. to protect and preserve the rights of American Indians to practice traditional religions. That policy includes rights of access to sacred sites and to the use and possession of sacred objects. There are no implementing regulations.

2.2 Presidential Executive Orders

Presidential executive orders define policies and procedures for federal agencies to facilitate their execution of laws passed by the U.S. Congress or clarify how specific laws are to be implemented. Presidential executive orders can be considered instructions or directives from the President to federal agencies on how to carry out specific laws. The executive orders listed below are either directly related to cultural resources or define relationships between federal agencies and tribes.

2.2.1 Executive Order 11593. Protection and Enhancement of the Cultural Environment

Issued in 1971, Executive Order 11593 states that the federal government would provide leadership in "preserving, restoring, and maintaining the historic and cultural environment of the Nation." Federal agencies were directed to inventory cultural resources under their jurisdiction and nominate National Register-eligible properties to the National Register. Properties that have been determined eligible are not to be transferred, sold, demolished, or altered without providing the ACHP on Historic Preservation with an opportunity to comment. Properties to be demolished or substantially altered were to be documented prior to demolition or alteration. National Register properties or National Register-eligible properties under federal control were to be maintained following standards set by the Secretary of the Interior. Executive Order 11593 also assigns specific responsibilities to the Secretary of the Interior, including managing the National Register of Historic Places and assisting and advising other federal agencies in the management of cultural resources.

2.2.2 Executive Order 13007. Indian Sacred Sites

Issued in 1996, Executive Order 13007 directs federal agencies to provide access and ceremonial use of Indian sacred sites, where practicable, legal, and not inconsistent with essential agency functions. Agencies are also directed to avoid adversely impacting sacred sites and maintain the confidentiality of such sites. A "sacred site" as defined by this executive order is a specific location that is sacred because of its religious significance to or ceremonial use in an Indian religion.

2.2.3 Executive Order 13175. Consultation and Coordination with Indian Tribal Governments

Issued in 2000, Executive Order 13175 directs federal agencies to consult with Tribal officials in the development of policies and regulations that have "tribal implications" or that preempt tribal law. Executive Order 13175 also emphasizes the importance of government-to-government relationships between the U.S. government and tribes. Agencies must designate an official responsible for implementing the Executive Order and must document Tribal consultation in the development of the relevant policies and regulations.

2.3 Tribal Legislation and Regulations

Tribal laws and regulations addressing cultural resources would apply to lands on the reservations and off-reservation trust lands. The CCT and the STI are the two Tribes whose laws and regulations would be potentially applicable to the Site. The legal code of the CCT addresses cultural resources, as summarized below. This code applies to both on-reservation actions and off-reservation actions by federal agencies that could affect cultural resources. STI does not currently have laws that specifically address cultural resources. Both Tribes have THPOs, who have the same authority and responsibilities as the SHPO on their respective reservations and on off-reservation trust lands.

2.3.1 Confederated Tribes of the Colville Reservation. Colville Tribal Law and Order Code Chapter 4-4, Cultural Resources Protection

This Colville Tribal Code establishes the Colville Cultural Resources Board, which has the responsibility of developing policies and procedures to protect cultural resources of interest and concern to the Colville Tribes, both on and off the Colville Reservation. The Board reviews proposed federal agency actions off the reservation and is responsible for reviewing all proposed on-reservation actions that could affect significant cultural resources. The code also establishes a Colville Register of Historic and Archaeological Properties for listing of historic properties on the Colville Reservation.

This code defines the roles and responsibilities of the Colville History and Archaeology Department, which include identifying significant cultural resources on the reservation, nominating properties to the National Register and the Colville Register, and promoting efforts to protect cultural resources on the reservation.

Chapter 4-4 of Colville Tribal Code prohibits the excavation, disturbance, or other adverse effects to archaeological resources and historic properties on the reservation without a permit issued by the History and Archaeology Department. The code defines the procedure for the issuance of permits and the duties of permittees.

2.4 State Legislation and Regulations

WA state laws and regulations regarding archaeological and historical resources, as well as the law protecting Indian graves, are not applicable on federal lands or on tribal trust lands. These laws would

apply, however, to any RI/FS-related activities that would affect private lands or non-federal or non-tribal public lands.

2.4.1 Revised Code of Washington (RCW) Chapter 27.44, Indian Graves and Records

This legislation prohibits the removal or other disturbance of Indian burials, cairns, and "glyptic or painted records." "Burials" and "graves" are not defined in the statute. Excavation or removal of burials is permitted only under provisions of a permit issued by the WA Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in Washington Administrative Code (WAC) Chapter 25-48.

2.4.2 RCW Chapter 27.53, Archaeological Sites and Resources

This legislation prohibits the excavation or disturbance of archaeological sites on public and private lands in WA except under provisions of a permit issued by the WA Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in WAC Chapter 25-48.

2.4.3 RCW Chapter 68.60, Abandoned and Historic Cemeteries and Historic Graves

This legislation prohibits the destruction, alteration, or other disturbance of historical land abandoned cemeteries and historic graves (Indian graves and burials are protected in RCW Chapter 27.44). A historic cemetery is defined in the statute as one established before November 1889. A historic grave is a grave or graves outside of a cemetery placed prior to June 1990.

2.4.4 RCW Chapter 43.21C, State Environmental Policy Act

This legislation directs state and local agencies in WA to address environmental impacts of proposed projects. The implementing rules (WAC Chapter 197-11) require that impacts to historic and cultural resources are to be addressed in the State Environmental Policy Act process.

3. PROPOSED SAMPLING PROGRAM

Residential properties in the Columbia River valley north of Northport, WA and extending south of the U.S.-Canada border are the focus of this investigation (UCR Study Area; see Figure 1). Sampling locations are provided in Attachment B. Properties to be sampled were identified through voluntary participation. In January of 2014, the EPA sent fliers to property owners in the area to seek voluntary participation in this residential soil sampling study. The EPA visited each of the volunteered properties in the spring of 2014, interviewed property owners, and defined and mapped exposure areas. No soil was disturbed during the site visit. The EPA will convene a meeting with the UCR Cultural Resources Working Group to consult and review the mapped information as soon as it is available.

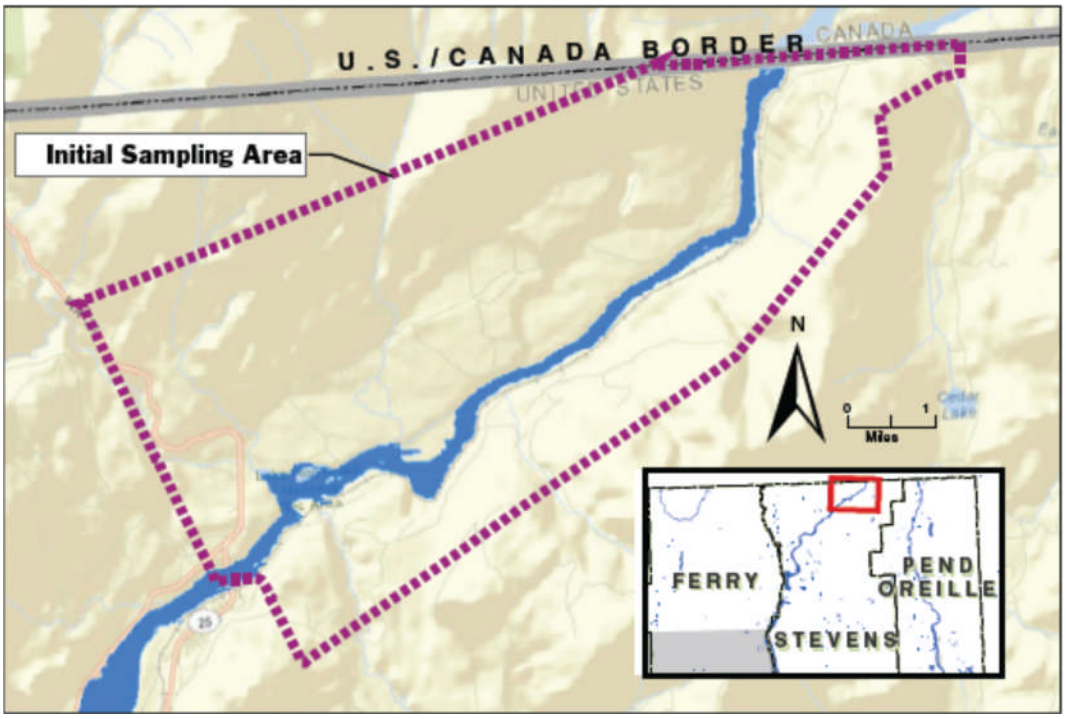


Figure 1. Residential property owners within the initial UCR Study Area.

Given that the goal of the study is to sample metals in surface soils in areas with high human exposure potential, the investigation places emphasis on the utilized portions of each parcel (i.e., the areas around each house where residents are most likely to come into contact with surface soils). Children's play areas and gardens were targeted for soil sampling. Gardens were targeted because intermittent exposure may occur in these areas during digging in the surface for tilling and weeding, planting, and moving plants. Animal pens or riding areas will also be sampled because of the potential exposure to surface soils. Drip lines of residences and other large painted structures (e.g., barns) will be sampled. Areas near roadways and railways (with a 50-foot buffer in either direction from the center line) will be avoided to prevent sampling soil that may be contaminated by non-air sources. Soil samples will be collected using an IC sampling design (see Figure 2). IC sampling entails the collection of multiple individual volumes of soil (termed "increments") from a target area (SU or DU) that are composited and subsampled according to a detailed standard operating procedure prior to laboratory analysis (ITRC, 2012).

Method for Collecting Increment Soil Samples

Individual soil increments will be collected using a cylindrical or core-shaped sampler to ensure that each increment contains a proportionate amount of soil particles over the entire depth of interest, with an equal volume of soil particles from the top of the sample as the bottom. The diameter of the cylindrical or core-shaped sampler will be between 2 to 4 inches but will remain constant within a DU.

Care will be taken to collect an IC sample that contains the same amount of soil particles from the top of the sample as the bottom. This will be achieved by scraping the length of the core using a decontaminated trowel or disposable scoop to remove the increment sample from the corer into a bucket. Each increment across a DU will be collected in this manner, with the increments for one IC sample placed in the same large bucket, taking care to ensure that equal volumes of soil are collected from each increment location.

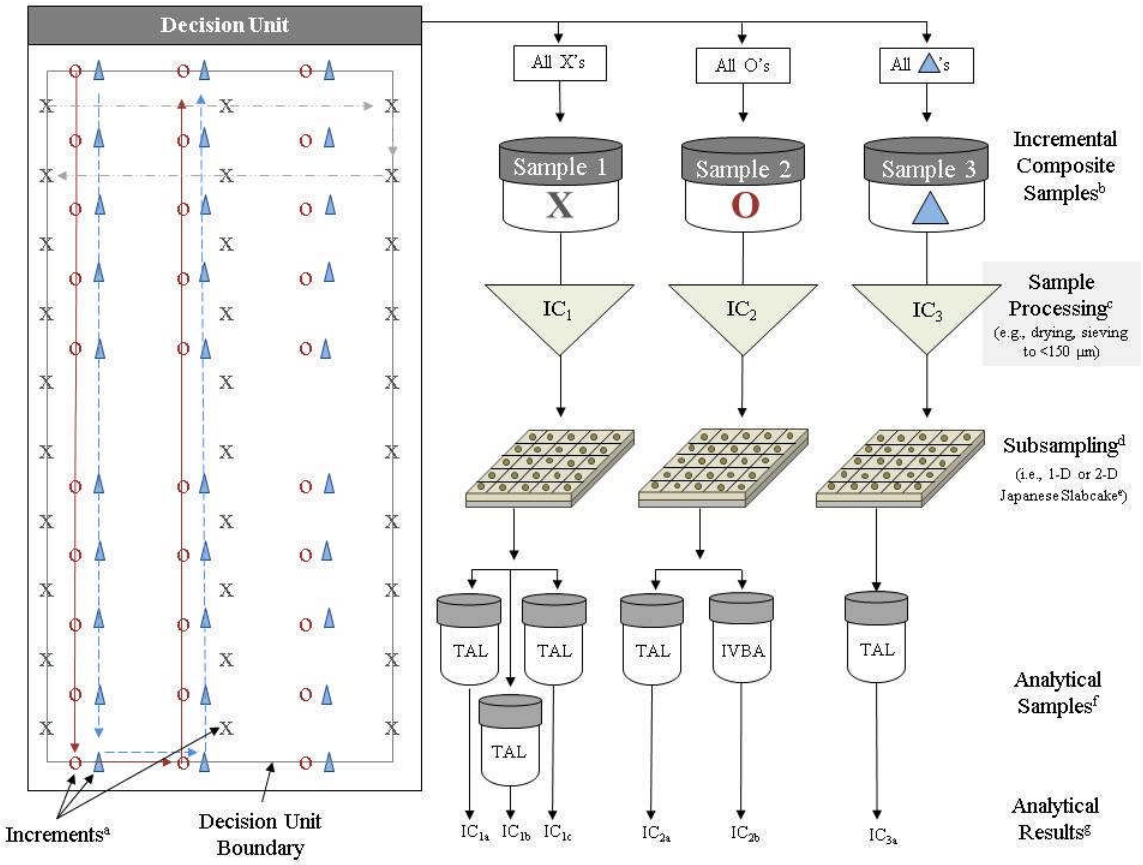


Figure 2. Overview of the IC sampling design for use in the UCR Residential Soil Study.

[a]Increments will be located by using systematic random sampling and a square grid.
[b]Thirty increments will be collected during the same field sampling event for each of the three IC samples. Equal volumes from each increment will be combined to create one IC sample (as shown). Additional information is available in the FSP.
[c]Sample processing will take place in the laboratory, by pre-sieving the sample to 2 mm and then passing the entire IC sample through a 150 micron sieve (see text for additional information on laboratory procedures).
[d] Laboratory subsampling will consist of 30 increments; all remaining sieved soil will be archived after analytical samples are obtained.
[d d] No additional subsampling will be done once the laboratory subsample (2 grams of < 150 µm soil) is placed in the jar. If laboratory replicate samples or split samples are required from a particular sample, additional jars will be required and 2 g of soil will be placed in each jar. Two g is the minimum mass required to control fundamental error (FE) at 5% for both <150 µm and <250 µm grain size fractions (latter applies to beach DUs only). Two g is also the minimum mass required to collect a representative subsample using incremental subsampling methods (Crumbling, 2014).
[e]As described in ITRC (2012).
[f]Each of the IC samples will be analyzed for TAL metals (no Hg). IVBA analyses will be run for IC samples with Pb concentrations greater or equal to 100 ppm and As concentrations greater than or equal to 20 ppm. If all of the IC sample results for a given property are less than 100 ppm Pb and less than 20 ppm As, IVBA analyses will not be done for that property. If one of the concentration criteria (Pb ≥100 ppm, As ≥20 ppm) is met, both Pb and As IVBA assays will be done. On a property basis: If more than one IC sample for a given DU type (e.g., house, play area DU) exceeds one of the concentration criteria, the IVBA assay will be run with using the one sample that has the maximum Pb concentration for that type of DU. To be clear, a maximum of one IVBA analysis for Pb and As will be done for each type of DU on a property. The 100 ppm criteria for Pb bioaccessibility is expected to be protective of both the current 10 µg/dL blood Pb level as well as the Center for Disease Control's value of 5 µg/dL. The 20 ppm criteria is based on the WA State Department of Ecology's unrestricted land use value (ECY, 2007).
[g]At least 10% of the IC samples will include the preparation and analysis of three laboratory replicate subsamples for the purpose of estimating variance due to sample processing and analytical error (combined).

Figure adapted from ITRC (2012) and Hathaway et al. (2008).

Sample Depth

The sampling depth will depend on the land use and will vary by DU. Surface soil will be collected from the top 0-1" depth interval (top 2 cm, U.S. EPA, 2003) in house, dripline, agriculture, and "other-not specified" DUs . For gardens (vegetable and ornamental), the depth will be the typical tilling depth (typically 0-12"). Sampling depth for play areas will generally be 0-1". For utilized areas where observed soil disturbance is greater than 1", the sampling depth will be 0-3" (e.g., animal activity areas). Within each DU, 30 increments will be collected for each IC sample from each designated sample depth to support the HHRA. Details of the sampling design are provided in the QAPP and FSP (see Attachment D of the QAPP).

4. COORDINATION PLAN

The objective of the CRCP is to ensure that implementation of the RI/FS and associated sampling activities does not adversely affect any cultural resources. The plan therefore defines a general process and more specific procedures to meet this objective.

Few of the surveys conducted prior to about 1975 are likely to have met current regulatory and professional standards. In addition, many of the previous surveys focused on archaeological resources to the exclusion of other types of cultural resources (and older archaeological surveys documented only evidence of prehistoric use or occupation). Finally, it is likely that there are some locations previously surveyed at which burials or buried archaeological resources are present but not evident and therefore not recorded at the time of the survey (many surveys both in the past and in the present rely entirely or primarily on surface evidence of archaeological resources or burials).

This plan therefore defines procedures that address sampling at both known locations of cultural resources and locations where no cultural resources are presently recorded.

4.1 General Consultation Framework

Successful implementation of the RI/FS and of this CRCP, given the issues defined above, will require ongoing consultation and coordination with the CCT, the STI, and the WA State Department of Archaeology & Historic Preservation (DAHP) (i.e., the consulting parties). Other consulting parties (as defined in 36 CFR 800.2(c)) may be recognized in the future whose participation would be important for general consultation or coordination in the RI/FS process or for specific sampling locations. For the purposes of cultural resources coordination activities, the "consulting parties" referred to in this plan are distinguished from other "participating parties" to the RI/FS process.

4.2 Cultural Resource Procedures in the Sampling Process

This section defines general procedures to be followed in the sampling process to minimize the potential for inadvertent disturbance of cultural resources. More specific protocols to respond to discoveries are defined in the following sections.

A Tribal cultural resources monitor or a professional archaeologist will be present on-site to monitor sampling. The protocol for this monitoring is defined below.

4.2.1 Archaeological Monitoring in the Sampling Program

To assure compliance with the NHPA and the applicable requirements, procedures, and standards of the CCT, and STI, the following procedures have been developed to address potential discoveries, including inadvertent discoveries, of cultural materials and deposits (including sacred objects, funerary objects, and

objects of cultural patrimony as defined in NAGPRA) and Indian burials and human remains (as defined in NAGPRA) during sediment and soil sampling and associated activity that could result in ground disturbance.

4.2.1.1 Professional Archaeologist and/or Tribal Representative On-Site

An archeological monitor and/or Tribal representative will be present on-site when ground disturbing sampling or sampling-related activity occurs. The archaeological monitor and/or Tribal representative will visually examine all samples to determine if evident or likely artifacts are present or if other deposits are present that are likely to be cultural in origin. The archaeological monitor and/or Tribal representative will not make physical contact with the sample unless artifacts or other cultural deposits are present. If artifacts or likely archaeological deposits are present, the archaeologist or Tribal representative will record the location of the materials and photograph the materials in place in such a manner to provide information on provenience. The artifacts and other archaeological materials will then be re-deposited at their original location.

The archaeological monitor and/or Tribal representative will document their observations on a daily basis, including field notes and photographs that record the location, character of the sampling or other ground-disturbing activity, any archaeological discoveries made, and any decisions made within the provisions of this plan by the archaeological monitor and Tribal representative in response to any archaeological discoveries. A standardized archaeological monitoring form may be substituted for the field notes referenced above.

All archaeological monitors and Tribal representatives will be required to have read the applicable health and safety plan and to have complete understanding of the archaeological monitoring provisions of this plan. The archaeological monitors will also be required to meet requirements for personal protective equipment. In addition, all on-site personnel are subject to the directions of the task field supervisor at all times.

4.2.1.2 Discoveries–Archaeological Monitors Present

At the discretion of the archaeological monitor or Tribal representative, ground-disturbing sampling or associated activity may be slowed or halted at any time that a suspected archaeological object or archaeological resource is encountered. The objective of this slowing or halting of ground-disturbing cleanup activity is to allow the archaeologist to confirm and/or make a preliminary assessment of the discovery. At the discretion of the archaeological monitor or Tribal representative, a specific sample may be relocated from the location of the discovery but at the sampling location. Such relocation will be coordinated with the on-site sampling manager or supervisor.

At the request of the archaeological monitor or Tribal representative, the sampling personnel will either

- Assist in securing access to the location of the discovery and take appropriate measures to protect the location of the discovery from rain, stormwater, and other possible disturbances, or
- Assist in moving the artifacts to a protected and secure area of the site away from the immediate sampling area. Removal of artifacts from the discovery location will be undertaken only if leaving the artifacts in place would jeopardize their integrity due to erosion or collection by unauthorized individuals.

The archaeological monitor, Tribal representative, or a member of the TAI Technical Team will remain on-site to ensure the security of the find until more extensive efforts can be made to secure the site from further disturbance or a more extensive evaluation and documentation of the discovery can be made.

Notification of any archaeological discoveries must be provided to EPA for further coordination with consulting parties within 24 hours of the discovery. EPA contact information is provided in Attachment F2. All telephone notification of discoveries must be promptly followed by notification in writing (via email or conventional mail).

4.2.1.3 Discovery of Human Remains

Native peoples in the UCR Study Area consider the graves of their ancestors to be important in both their cultural identity and in defining their relationship with the land. These graves are therefore considered sacred and should be left undisturbed. Should inadvertent disturbance occur, the remains and associated materials ("funerary objects") must be treated with respect and honor. All appropriate federal, tribal, and state laws, regulations, and procedures regarding burials should be rigorously enforced. In the event that likely or confirmed human remains are encountered, all further sampling or other ground-disturbing activity will cease immediately.

Upon such discovery, the Sampling Team will notify EPA for further coordination with consulting parties (consisting minimally of the CCT, STI, and the DAHP. The Sampling Team will assist the archaeological monitor and Tribal representative in securing the location of the discovery.

If no archaeological monitor or Tribal representative is present, the TAI Technical Team will secure the location of the discovery in such a manner that both maintains the physical integrity of the remains and any associated objects and precludes further disturbance, or a member of the TAI Technical Team will remain on-site until an archaeologist or Tribal representatives can arrive to assess the find.

Other conditions for responses to discoveries of archaeological materials may be defined in the permit(s) issued for the sampling program. Responses to any discoveries of burials must comply with provisions of NAGPRA and its implementing regulations (in addition to those referenced above), as well as the existing protocols of the CCT, and STI (these protocols are provided in Attachment F2).

4.2.2 Curation

Artifacts and other cultural materials that may be recovered during the sampling program (with the exception of human remains and associated items subject to NAGPRA) will be curated at a facility that meets the standards of 36 CFR 79. The appropriate Tribe will designate the curation facility for cultural materials recovered from tribal lands.

4.2.3 Reporting

Within 150 days of completion of each sampling activity that is covered under this plan, a professional archaeologist will prepare a confidential written report and presents the results of the archaeological monitoring and responses to any discoveries of archaeological resources or burials. The report will include: (1) copies of field notes, descriptions and maps of all locations at which sampling-related archaeological monitoring was conducted; (2) descriptions of any discoveries made during such monitoring and the outcome of the discoveries (including the rationale for the decisions for the disposition of any finds); (3) descriptions and maps of all non-monitored locations at which inadvertent discoveries were made and the outcome of those discoveries; and (4) recommendations for any changes in the monitoring protocol or

coordination plan that may be appropriate to address results of the monitoring or how well existing coordination procedures worked.

The draft report will be provided to EPA for review and dissemination to the consulting parties for review and comment.

4.3 Confidentiality

The Sampling Team shall make its best efforts, in accordance with state and federal law, to ensure that its employees and contractors keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential. Pertinent TAI employees and contractors will be required to read and sign a confidentiality statement that specifies procedures to be followed in response to media and public contacts regarding archaeological and other cultural resources. To the extent permitted by law, prior to any release of information, EPA, TAI, and the other consulting parties shall concur on the amount of information, if any, to be released to the public, any third party, and the media and the procedures for such a release.

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GLOSSARY OF TERMS

Burial—A burial is defined in NAGPRA as "[a]ny natural or prepared physical location, whether originally below, on, or above the surface of the earth, into which as part of the death rite or ceremony of a culture, individual human remains are deposited."

Curation—Long-term storage and preservation of archaeological collections. Archaeological collections from federal lands must be curated at facilities that meet the standards of 36 CFR 79.

Ethnohistoric—Information on Native peoples gathered from historical accounts.

Historic, historic-period, historical—The NHPA uses the term “historic” to refer to properties that are listed or have been determined eligible for listing on the National Register of Historic Places. To avoid confusion with this definition of “historic,” “historic-period” or “historical” are used to reference resources, places, events, and people associated with the period since the appearance of Euroamericans and the beginning of written accounts (ca. 1780–1810 in the Pacific Northwest).

Protohistoric—The period of time transitional from prehistory to history. In the Pacific Northwest, the protohistoric can be generally defined as from the late 1600s until late 1700s.

ATTACHMENT E2: U.S. EPA CONTACT INFORMATION

Monica Tonel is the primary contact for the EPA. Ms. Tonel's phone number is (206) 553-0323 (office) and email is Tonel.Monica@epa.gov. Ms. Tonel will have a cell phone number that will be provided to the Sampling Team(s), Tribes, and state, prior to field sampling activities commencing.

If Ms. Tonel cannot be reached, then Laura Buelow is the alternate EPA contact at (509) 376-5466 (office) or (509) 420-0435 (cell) and at Buelow.Laura@epa.gov.

In the event that either Ms. Tonel or Ms. Buelow cannot be contacted, then Matt Wilkening will be contacted at (208) 378-5760 (office) and at Wilkening.Matt@epa.gov.

ATTACHMENT E3: PROTOCOLS FOR INADVERTENT DISCOVERIES

Lake Roosevelt Protocols for Native American Graves Protection and Repatriation Act (NAGPRA) Inadvertent Discoveries or Intentional Excavations: Confederated Tribes of the Colville Reservation

This protocol is intended to cover NAGPRA items exposed by inadvertent discoveries or intentional excavations within EPA Sample Units. The term "NAGPRA items" in this document refers to human NAGPRA items, associated funerary objects, and objects of cultural patrimony as they are defined in 25 USC 3001. This document does not address inadvertent discoveries on lands within reservation boundaries or trust land outside of the reservation boundaries of the CCT. Funding of actions is not covered under this protocol.

1. If NAGPRA items that are potentially human are encountered, any activity in the vicinity of the discovery shall cease and all reasonable efforts shall be made to protect the NAGPRA items and all appropriate effort shall be made to determine if the NAGPRA items are human. The activity shall resume only when clearance to proceed is received by the CCT THPO and WA state DAHP.
2. If the NAGPRA items are determined to be human, the burial or location shall not be disturbed in any way. Any discovered human NAGPRA items and associated artifacts will be treated in a respectful manner.
3. In cases where a potential crime scene exists, *personnel except those necessary to protect the location will leave the immediate vicinity in order to prevent unintentional destruction of crime scene information*. The Stevens County Sheriff's Office will be immediately notified.
4. The Colville THPO and the archaeologists working for the Colville Tribes (numbers listed below) will also be contacted immediately after law enforcement. The CCT staff will also be in contact with DAHP's State Physical Anthropologist. Live phone contact is required; backup staff are identified if the primary contacts are unavailable. Phone contact will be followed up by written confirmation, email is acceptable. Email should not include detailed (site specific information) for security reasons.
5. A professional archaeologist will assist law enforcement in determining if the NAGPRA items are archaeological in origin. If the crime scene is ARPA-related (i.e., there is evidence for intentional disturbance or looting of archaeological materials), an archaeologist shall assist law enforcement as needed in the collection of archeological data to support the ARPA case.
6. Guy Moura, CCT THPO and Program Manager of the CCT History/Archaeology Program is the primary contact for the CCT. Mr. Moura's phone number at the Program is (509) 634-2695 and email is guy.moura@colvilletribes.com. After hours, Mr. Moura can be contacted at (509) 631-1705 (cell). If Mr. Moura cannot be reached, then Jon Meyer, Tribal Archaeologist is the alternate contact at (509) 634-2691 (office) or (509) 631-2130 (cell) and atjon.meyer@colvilletribes.com. In the event that neither Mr. Moura or Mr. Meyer cannot be contacted, then Eric Oosahwee-Voss, CCT Archaeologist will be contacted at (509) 634-2690 (office) or (509) 631-1173 (cell) and at eric.oosahwee-voss@colvilletribes.com. Mr. Meyer or Mr. Oosahwee-Voss shall participate in the NAGPRA consultation process on Mr. Moura's behalf until his return. Jackie Cook, Repatriation Specialist will also participate in the NAGPRA consultation process. Ms. Cook's contact information is (509) 634-2635 (office) or (509) 631-1176 (cell) and

jackie.cook@colvilletribes.com.The CCT shall maintain a presence at the location of the discovery as needed until all contacts have been made and appropriate treatment of the NAGPRA items has been conducted.

7. As soon as the NAGPRA items have been determined to be human, then all effort shall be made in the field to determine whether human NAGPRA items are Native American. If yes, skip Steps 8 and 9 below and proceed to Step 10.
8. If the NAGPRA items are determined not to be Native American, then WA state laws apply and shall be followed (Title 68, Chapter 68.50 RCW HUMAN NAGPRA ITEMS).
9. If the NAGPRA items' affiliation cannot be determined in the field, further nondestructive analysis of human NAGPRA items and/or associated cultural materials may be required. The CCT and DAHP shall coordinate regarding the types of non-destructive analysis to be conducted.
10. Provenience information will be collected as specified by the written plan of action.
11. Recording of provenience may include any or all of the following: documenting the location of the burial or scattered NAGPRA items and general site conditions on a site form or on an addendum to an existing form; describing the surface visible NAGPRA items to the degree that can be accomplished without causing additional disturbance to the grave; documenting the location of the burial on a USGS 7.5' topographic sheet and with a GPS unit.
12. If it is possible to rebury or cap the NAGPRA items in place, then that decision shall be documented in the written plan of action (see below).
13. If NAGPRA items must be excavated or removed, procedures will be specified by the written plan of action. If NAGPRA items are to be excavated or removed by personnel other than those employed by the CCT or DAHP, an ARPA permit will be required from the NPS.
14. Excavation or removal procedures may include any or all of the following: NAGPRA items will be removed using standard professional archaeological practices in a culturally sensitive manner at the direction of a CCT History/Archaeology Department representative. Such practices may include collection of horizontal provenience data referenced to a site datum point; if excavation is required, vertical provenience data shall be tracked through the use of controlled 10-cm levels within a standard grid unit, screening of all excavated fill through 1/8-inch screen mesh, and photographic and to-scale plan map documentation of excavated features. All recovered items shall be listed in the field during collection to minimize handling after recovery.
15. Inadvertent discoveries that result from activities requiring easements or other non-ARPA permits (such as access, construction, etc.) shall be dealt with by the permitting agencies. This protocol document will be included with documents issued to permittees.
16. The written plans of action for individual discoveries will detail exact procedures for further implementation of NAGPRA. A sample written plan of action is attached.

Template NAGPRA Plan of Action for Lake Roosevelt

This plan of action shall comply with the requirements of the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.), its implementing regulations (43 CFR Part 10) and the Archaeological Resources Protection Act (ARPA) (16 USC 470 et seq.) with its implementing regulations (43 CFR Part 7).

1. The kinds of objects to be considered as cultural items as defined in Section 10.2 (b):
   - ✓ Human remains
   - ✓ Associated funerary objects
   - ✓ Unassociated funerary objects
   - ✓ Objects of cultural patrimony
   - ✓ Sacred objects

   These objects are cultural objects as defined under NAGPRA 43 CFR Part 10.2 (d).
2. The specific information used to determine custody pursuant to Section 10.6:
   - ✓ Traditional association (this is where Tribe's area of interest is cited with reference to Lake Roosevelt)
   - ✓ Cultural affiliation
   - ✓ Evidence: geographical, archaeological, linguistic, folklore, oral tradition, historical
3. The planned treatment, care, and handling of human remains and other objects as defined in NAGPRA
4. The planned archaeological recording of the human remains and other objects as defined in NAGPRA
5. The kinds of analysis planned for each kind of object
6. Any steps to be followed to contact Indian Tribe officials at the time of intentional excavation or inadvertent discovery of specific human remains and other objects as defined in NAGPRA
7. The kind of traditional treatment, if any, to be afforded the human remains and other objects as defined in NAGPRA by members of the Indian Tribe
8. The nature of reports to be prepared
9. The planned disposition of human remains, and other objects as defined in NAGPRA.

ATTACHMENT F: LABORATORY ANALYTICAL METHODS

SUBSAMPLING AND COMPOSITING OF SAMPLES

ALS-KELSO

SOP ID: GEN-SUBS	Rev. Number: 5	Effective Date: 06/30/2013

Approved By: _____ Date: 6/13/13
Department Supervisor - Harvey Jacky

Approved By: _____ Date: 6/13/13
QA Manager - Suzanne LeMay

Approved By: _____ Date: 6/13/13
Laboratory Director - Jeff Grindstaff

Issue Date: _____	Doc Control ID#: _____	Issued To: _____

Standard Operating Procedure

for

SUBSAMPLING AND COMPOSITING OF SAMPLES

1. SCOPE AND APPLICATION

1.1. This standard operating procedure describes procedures for obtaining subsamples used for laboratory analysis. The procedure also describes general practices for making composite samples from multiple individual samples. Procedures are given for aqueous, soil, sediment, vegetation and miscellaneous matrices. The SOP does not apply to tissue samples. Procedures for tissue samples are described in the GEN-TISP and MET-TDIG SOPs.

1.2. The SOP describes routine, or default, procedures for samples that do not require VOC analyses. Handling of VOC samples is described in SOP VOC-5035. Program or project-specific requirements may differ from those described in the SOP. Samples analyzed by EPA CLP procedures are specifically excluded from this procedure, and will be handled according to the applicable SOW.

1.3. Multi-increment samples require special handling and subsampling procedures. In addition to routine procedures, this SOP also includes instructions for handling and sampling from multi-increment samples submitted to the laboratory.

1.4. This procedure does not apply to situations where the entire sample (container) is used for the analysis.

2. METHOD SUMMARY

2.1. Obtaining a representative analytical subsample from the field sample submitted is essential to providing meaningful data. The subsample must be taken to most closely reflect the predominant composition of the sample. For aqueous and liquid samples, this is usually accomplished by shaking or inverting the sample. For soil, sediment, powders, and other solids the procedures are more involved. Procedures for subsampling are based on the information given in the references listed.

2.2. Some projects may employ multi-increment (MI) sampling in the field. The primary objective of MI sampling is to control the certain statistical errors associated with discrete sampling. Some studies have shown that MI sampling, using 30+ sample increments within a decision unit (a defined field sampling area) may provide a more representative view of contaminant concentrations than traditional discrete sampling approaches. References listed provide additional background on MI sampling. When this approach is taken it is important that laboratory procedures are consistent with field procedures when taking samples.

2.3. Unique sample matrices such as vegetation, wood and wood chips, mechanical parts and filters, etc. pose additional challenges to obtaining representative samples. For these samples the laboratory staff should consult with the Project Manager to determine the subsampling strategy. These special situations will be handled on a case-by-case basis. Service requests should list any specific sample preparation required.

3. DEFINITIONS

3.1. Sample – A portion of material taken from a larger quantity for the purpose of estimating properties or composition of the larger quantity (ASTM).

3.2. Subsample – A portion of a sample taken for the purpose of estimating properties or composition of the whole sample (ASTM).

3.3. Composite sample – A mixture of multiple samples or subsamples produced to result in one sample representative of multiple field samples.

3.4. Representative subsample – A subsample collected in such a manner that it reflects one or more characteristics of interest (a defined by the project objectives) of the laboratory sample from which it was collected (ASTM).

3.5. Multilayered sample – A sample consisting of two or more clearly differentiated components (ASTM).

3.6. Multi-increment (MI) sample – A field sample consisting of multiple bulk containers from one decision unit (defined in a MI sampling plan) submitted to the lab for subsampling into a representative sample for analysis.

4. INTERFERENCES

4.1. When obtaining subsamples it is important to minimize any chances for sample contamination or cross-contamination between samples. Work should be performed in an organized and neat manner. Spilling of samples (from overfilled containers, etc) should be minimized and spills cleaned up. Equipment and laboratory tools used with samples should be cleaned between samples to prevent cross-contamination.

4.2. Analysis-specific interferences are described in the applicable analytical SOP.

5. SAFETY

5.1. All appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personal protective equipment, such as, safety glasses, lab coat and the correct gloves.

5.2. Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

6. SAMPLE COLLECTION, CONTAINERS, PRESERVATION AND STORAGE

6.1. Refer to the analytical SOP for sample collection preservation and storage of samples. Subsamples and composite samples held for later analysis should be preserved and stored in the same manner as specified for field samples.

6.2. Projects for MI samples may include additional instructions not found in the analytical SOP. The analyst should consult with the Project Chemist, or refer to the Project Chemist's instructions, prior to working with these samples.

7. APPARATUS AND EQUIPMENT

7.1. Laboratory balance capable of weighing the desired sample mass. There are various makes and models of balances available for use, with each department having balances appropriate for its use. For weighing solids and non-aqueous liquids (wastes), use a top-loader balance. Ensure that the mass (sample + container) to be placed on the pan is within the calibration-verified range of the balance.

7.2. Wiley laboratory mill, Model 4. Operate the Wiley mill following the manufacturer's recommendations.

7.3. Sieve shakers.

7.4. Shatter box.

7.5. Mechanical mixer and/or shaker.

7.6. Stainless steel or Glass mixing bowl.

7.7. Metal or disposable spoons and spatulas.

7.8. Aluminum foil.

7.9. Weighing boats, plastic or aluminum

7.10. Clean sample containers and lids (various sizes) as specified in the applicable test SOP.

7.11. Common laboratory glassware/apparatus (beakers, flasks, pipets, syringes, etc.).

7.12. Multi-Increment Samples

7.12.1. Flat spatula

7.12.2. Flat stainless steel masons trowel

7.12.3. Volatile sample containers.

7.12.3.1. 250-500 milliliter (ml) narrow mouth, amber bottles (recommended)

7.12.3.2. 4-8 ounce (oz) amber jars with Teflon lined septum lids

7.12.4. Large stainless steel spoon or scoop

7.12.5. Large clean containers (a large stainless steel or glass bowl, Ziploc bags, or 5-gallon bucket)

7.12.6. #10 (2mm) sieve

7.12.7. Stainless steel cookie sheet or other tray

8. REAGENTS

8.1. Dichloromethane, acetone, and acetonitrile may be used during the noted procedures for cleaning and decontamination of equipment.

9. RESPONSIBILITIES

9.1. It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

10. PREVENTIVE MAINTENANCE

10.1. No preventive maintenance is required other than normal glassware and apparatus cleaning.

11. PROCEDURE

11.1. Aqueous samples – Subsampling

11.1.1. Examine the sample. Thoroughly mix all samples by vigorous shaking. Immediately open the container and obtain the subsample. Additional filtering of the subsample may be required by the analytical SOP.

11.1.2. If the sample is multi-layered (a water layer with a sand/sediment layer that cannot be mixed or non-aqueous liquid layer) the Project Chemist should be consulted on how to proceed with the sample. Additional analyses or sample preparations may be necessary depending on the client's data needs. Document the condition of the sample and decision made on subsampling.

11.2. Aqueous samples – Compositing

11.2.1. The customer may require compositing based on flow rates to create a flow proportional composite. The compositing instructions are included with the Form V. Equal volume compositing is assumed if there are no specific instructions provided for compositing ratios.

11.2.2. Setup the necessary glassware and/or sample container receiving the composite sample. Ensure that proper measuring glassware is used, typically a graduated

cylinder or volumetric flask for larger volumes and pipet or syringe for smaller volumes.

11.2.3. Working quickly, mix the individual samples (as described above), open the container(s) and obtain the composite aliquot. Add each aliquot to the composite container and cap between samples.

11.2.4. Once all composite aliquots are obtained, cap and mix the composite sample. Label the container appropriately. Complete all documentation necessary to describe the compositing procedure, including samples used, aliquot taken, etc.

11.3. General considerations – Non-liquid samples

11.3.1. The analyst must first understand what the sample matrix of interest is. The project information should be consulted. If the sample appears to be homogeneous (other than extraneous materials described below) particle size reduction is not necessary. Particle size reduction should is performed only when required by the project QAPP, project specifications, or client request. If particle size reduction is required, use the appropriate apparatus (Wiley mill, shatter box, etc.) to perform crushing, grinding, milling, or sieving, and document. Refer to ASTM D6323 for guidelines on performing particle size reduction.

11.3.2. Once the matrix of interest is known, examine the sample for presence of extraneous material. The default procedure is to remove these items, or not include in the representative subsample. However, the presence of these materials should be documented in lab records and the Project Manager should be consulted prior to subsampling. Some examples are given below.

11.3.2.1. Soil, solid, and sediment samples may include such material as larger rocks, sticks, leaves, pieces of metal, man-made materials, etc.
11.3.2.2. Wood or bark samples may include chunks of soil, mud, rocks, etc.
11.3.2.3. Vegetation samples may include chunks of soil, mud, rocks, sticks (not of the sample type, etc.).
11.3.2.4. Sediment samples may include rocks, twigs, vegetation, organisms, etc.
11.3.2.5. Sediment/marine projects, organisms are typically analyzed under separate sampling and analysis plans.
11.3.2.6. Mechanical parts, filters, etc., may include chunks of soil, mud, rocks, sticks, etc.

11.3.3. Examine soil samples to determine if the sample contains significant amounts of water. If the amount of water is greater than approximately 30%, treat the sample as a sediment sample.

11.3.4. Samples which are especially heterogeneous, as well as various special matrices, may require additional preparation. These will be handled on a case-by-case basis after consultation with the appropriate supervisors and Project Manager. Unique matrices for TCLP and other leaching procedures should be handled according to the applicable SOP or reference method.

11.4. Soil/solid Samples – Subsampling

11.4.1. Samples in jars

11.4.1.1. Using a spatula or other utensil made of an inert material, thoroughly mix and homogenize the sample, making sure to loosen sample from the sides of the container, and continue mixing the entire contents, breaking up soil clumps, etc., until there is no visible segregation of the sample by layer, grain size, color, etc. The sample should appear uniform in color and texture.

11.4.1.2. Once mixed, remove the desired mass of sample for the analysis and document accordingly. Recap the jar and return to storage.

11.4.2. Samples in sleeves (core samples) and large bulk containers.

11.4.2.1. Samples in sleeves are emptied into a metal or glass homogenizing container and thoroughly stirred using a spatula or other utensil. When homogenized the appropriate sample portions are placed in jars. Perform additional drying and grinding only when specified for the project. Client specifications for drying and grinding will be communicated by the Project Chemist.

11.4.2.2. When working with sleeves and resulting homogenized samples/subsamples, always double-check the sample ID on the sleeve against the sample numbers on the samples.

11.5. Soil/solid samples – Compositing

11.5.1. Thoroughly mix each individual sample as described in 11.4 above.

11.5.2. Combine equal masses from each of the individual samples into a clean stainless steel mixing bowl. The amount used will depend upon the number of analyses to be performed on the composite and/or the amount available. The analyst preparing the composite will document the mass of each individual sample used for the composite, the date and time of compositing, and any other pertinent observations.

11.5.3. The sample is thoroughly homogenized using a spatula or other utensil and returned to clean glass jars. The sample container is labeled as a composite and with the sample identification, dated, and initialed.

11.5.4. The composite sample and remaining individual samples are returned to storage.

11.6. Sediment Samples – Subsampling

11.6.1. Standard procedure calls for mixing overlying water into the sample. EPA SW-846 methods for organic extractions specify to decant and discard overlying water. However, the Puget Sound Protocols and others have options for decanting and discarding this water, decanting and performing a separate water analysis, or mixing the water into the sample. The analyst should confirm which option is to be used on the sample. For projects not within the scope of the Puget Sound Protocols or similar project plans, the overlying water should be decanted and

discarded for organics analysis. For metals and inorganics, mix the overlying water into the sample.

11.6.1.1. **Note:** If water is decanted and discarded and percent solids is to be applied or determined, a separate solids determination must be made on the decanted sample.

11.6.2. Thoroughly mix and homogenize the sample, making sure to mix the entire contents of the jar. Additional steps may be needed to homogenize the sample (break up soil clumps, etc.). The sample should be mixed so there is a uniform color and texture. See section 11.4.1.1.

11.6.2.1. **Note:** Sediment samples may contain considerable amounts of organics matter. Ensure that samples and thoroughly mixed. Document the presence of substantial organic matter, shells, etc.

11.6.3. Once mixed, remove the desired mass of sample for the analysis and document accordingly. Recap the jar and return to storage.

11.6.4. The subsample is transferred to an appropriate, labeled container. The sample container is stored in the appropriate refrigerator in sample receiving and any empty sleeve can be stored at room temperature.

11.7. Sediment Samples – Compositing

11.7.1. Thoroughly mix each individual sample as described in 11.6 above.

11.7.2. Combine equal masses from each of the individual samples into a clean stainless steel mixing bowl. The amount used will depend upon the number of analyses to be performed on the composite and/or the amount available. The analyst preparing the composite will document the mass of each individual sample used for the composite, the date and time of compositing, and any other pertinent observations.

Note: Equal masses are used unless otherwise instructed. It may be required to use the entire jar or other measure.

11.7.3. The sample is thoroughly homogenized using a spatula or other utensil and returned to clean glass jars. The sample container is labeled as a composite and with the sample identification, dated, and initialed.

11.7.4. The composite sample and remaining individual samples are returned to storage.

11.7.5. Samples should be received prepared from the field as sample increments. Although unlikely, in cases where proper preparation of increments from *large bulk samples* does not occur in the field, the following steps will be taken.

11.7.5.1. When obtaining sample increments from a large bulk container (bucket, large jar, large bag, etc.) be sure to sample from the center and remove the soil 1-2 inches deep. Using the large spoon or scoop, collect the sample increment according to the work plan. Scoop approximately 30-60 grams into a large, clean container and move on to the next sample increment

location. Be cautious of oversize material, which means more mass may need to be taken from each increment to end with the 30-50 g sub-sample after sieving (a 5 kg field sample may not be uncommon). Increments can be sieved directly into the bucket, or they can be bagged and sieved later.

11.8. Incremental sampling can be accomplished in the laboratory set up to conduct sub-sampling according to the following procedure.

11.9. Basic Procedure for Incremental Sampling Methodology (ISM)

11.9.1. After the 30-50 sample increments have been field collected into a container. (a 5 kg field sample may not be uncommon) air dry the entire sample (all received containers) in aluminum pans rinsed 3 times with DCM (dichloromethane/methylene chloride). Note, if Aluminum is a target analyte of interest then substitute the aluminum pans for glass or stainless steel. Air drying may take 2-4 days with occasional stirring.

11.9.2. The sample is considered air dried when the dried sample weight loss is less than 1 percent in a 4 hour period of air drying. However, due to high variability of laboratory samples, sample dryness should be confirmed by a senior analyst or supervisor prior to going further with the procedure.

11.9.3. Rinse all utensils and equipment with DCM three times prior to use (stainless steel tray, mortar & pestle, 2mm sieve & catch pan, trowel, ISM spatula).

11.9.4. Lightly grind the air dried sample with a mortar & pestle in order to break up dirt and clay chunks (do not size reduce rocks or vegetation) and pass sample through a 2mm sieve.

11.9.5. Weigh the remaining +2mm fraction in an appropriate sized jar and record the weight on the ISM bench sheet. Describe the +2mm fraction on the bench sheet (size of rocks, type of any vegetation, etc).

11.9.6. Weigh and record the weight of the -2mm fraction.

11.9.7. Mix the sample, dump on a DCM-rinsed stainless steel pan, and spread the sample out with a trowel, forming a rectangle no more than 1cm deep.

11.9.8. Divide the sample into a minimum of 30 equal sections (30 to 50 sections is recommended) using the trowel blade.

11.9.8.1. Collect an equal (approximate) amount of sample from each of the sections (based on the chart below) and place into an appropriate sized labeled jar (4oz for organics, 2oz for metals & TS). Scrape the modified flat spatula along the bottom of the tray and pull straight up to make sure all depths and particle sizes are represented in the collection area. Record the exact final weight of sample for each test on the ISM bench sheet and on the jar. Metals tests should be weighed on an analytical balance. All larger amounts can be done on a 2-place balance. The subsampling process must be repeated for each separate analysis to be performed on the sample. The subsampling process must be performed for each individual

QC sample as well. The entire aliquot in the jar will be analyzed (TOC is the exception).

11.9.8.2. If sample volume is sufficient, it is recommended to repeat the process into a second jar to obtain a second backup sample in the event that re-analysis is required.

11.10. Recommended Aliquot Size and QC Requirements:

Test	Air Dried Aliquot	Approximate Amount per Increment	QC Requirement
8151	40.00 g	1.33 g	MS/DMS per 20
8270	30.00 g	1.33 g	MS/DMS per 20
8270 LL	20.00g	0.67 g	MS/DMS per 20
PCB-LL	30.00 g	1.00 g	MS/DMS per 20
PEST-LL	30.00 g	1.00 g	MS/DMS per 20
PCB	15.00 g	0.50 g	MS/DMS per 20
PEST	15.00 g	0.50 g	MS/DMS per 20
PAH	10.00 g	0.50 g	MS/DMS per 20
PAH ULL	20.00g	0.67 g	MS/DMS per 20
8290/Dioxin	15.00 g	0.50 g	MS/DMS per 20
TOC	15.00 g	0.50 g	None
Total Solids	15.00 g	0.50 g	DUP per 10
200 Total Metals	1.0000 g	0.0333 g	DUP/MS per 10
6000 Total Metals	1.0000 g	0.0333 g	DUP/MS per 20
Hg	0.5000 g	0.0167 g	DUP/MS per 20

11.11. Alaska Methods AK102 and AK103 call for the extraction of from 10-30 g of sample material (soil). For MI purposes, the minimum required amount of material per analysis is 30 g.

11.12. Place the remaining -2mm sample into jars labeled as "-2mm archive." If there are multiple jars, label them as "1 of 3", "2 of 3", etc. Give all jars to SMO for barcode labeling. Usually, the -2mm archive and test archive (back-up samples) jars are placed in a freezer, while the +2mm archive and test jars (with QC) are placed on the room temperature shelves.

12. Laboratory Analysis

12.1. The laboratory must analyze the entire contents of the prepared (or submitted) jar. The results may be less defensible if only a subsample or fraction of the jar contents is analyzed.

13. Procedure for ISM following State of Hawaii DOH Protocol

13.1. Samples requesting the Hawaii DOH procedure require wet and/or dry sieving depending on the test/analytes being aliquoted. Refer to a copy of the Hawaii DOH procedure and/or the Project Manager for details before beginning.

13.1.1. Subsample bulk MI samples to be tested for SVOCs, including TPH-D, some PAHs, and Mercury, unstable pesticides, should be subsampled without drying or sieving in order to minimize chemical loss or alteration and meet holding times for analysis.

13.1.1.1. If both SVOC and non-volatile PAHs are targeted contaminants of interest then include testing for both in laboratory subsamples collected from the multi-Increment sample prior to drying and sieving

13.1.1.2. Refer to Table 2a. of Technical Guidance Manual Notes: Decision Unit and Multi-Increment Sample Investigations , March 2011, State of Hawaii, Department of Health, Reference document number 2011-143-RB. See PMs for a copy of this document.

13.2. For wet ISM aliquots, organic tests (SVG/SVM) require a larger aliquot size to accommodate for the extra water content. In most cases, low-level organic tests will require a 40g wet aliquot (max weight capacity for most tests) and normal level tests will require a 20g wet aliquot (double the target dry weight).

13.3. Use a separate sample from the wet material and test for soil moisture in order to convert analytical results to dry-weight basis.

13.4. Not all samples from Hawaii require the State of Hawaii DOH procedure. See service request and/or verify with the Project Manager.

14. Procedure for ISM on 8330B Explosives

14.1. Samples from Ammunition Depots and anywhere except Firing Ranges (not DOD):

14.1.1. Follow the basic ISM procedure, except all utensils/pans need rinsed 3 times with Acetonitrile (instead of DCM). Collect a 10.00g aliquot and place in a 4oz amber jar (explosives are sunlight sensitive).

14.2. Samples from Firing Ranges:

14.2.1. Grinding: For firing ranges, the entire -2mm portion collected from the sieving procedure must be ground to a powder in the shatter box.

14.3. 8330B DOD samples:

14.3.1. Grinding: For DOD work, the entire -2mm portion collected from the sieving procedure must be ground to a powder in the shatter box prior to proceeding. Note: high-speed milling, such as in the shatter box, can elevate sample temperature due to friction. The thermal stability of the target analytes should be considered when performing this grinding procedure. Method 8330 B specifies a

2-minute (or longer) cool down period between five 60-second grinding intervals to maintain acceptable temperatures and minimize loss of volatile energetic contaminants.

14.3.2. SRM: A SRM (supplied by the Organic LC instrument lab) must be taken through the grinding and ISM procedure (already dry so doesn't need to be air dried or sieved). Shatter box 50g to 100g of the well-mixed SRM, and then make a 10g aliquot after grinding. Place the aliquot in 4oz amber jar. Archive the remaining SRM in an amber jar.

14.3.3. Grinding Blank: Matrix sand blanks (use baked sand) must be ground in the shatter box between each sample and aliquoted following the ISM procedure. The blanks can be ground in equal portions and then recombined at the end to make one sample requiring one ISM aliquot procedure. (Example: To ISM a 200g portion for use in making the final 10g aliquot, divide 200g by the number of samples needing shatter box and grind that amount of matrix sand between each sample. Recombine all ground matrix sand at the end and ISM one 10g aliquot from the 200g of ground matrix sand.) Archive the remaining matrix sand in an amber jar.

15. Analyte-Specific Considerations

15.1. Metals:

15.1.1. It has been proven that grinding can greatly improve the reproducibility for metals analyses. However, erosion of the metals surfaces used in grinding may contribute to a high bias in the samples. It is recommended that the tungsten carbide grinding mill is used when grinding soils in the shatter box thereby limiting the amount of potential bias in the prepared samples.

15.1.2. When grinding soil samples that may potentially contain ores of malleable metals (e.g lead, Copper, tin) be aware that the malleable particles may tend to smear during grinding, and may be lost from the samples to equipment surfaces. This anomaly may bias sample results low, decontamination of equipment surfaces may be difficult and could result in high bias in subsequent samples from carry over.

15.1.3. Reproducibility for Lead analyses in unground, incrementally sampled (IS) samples from small arms firing ranges may have an unacceptable large variability. The large variability for Lead may be due to single particles of Lead between one and two millimeters in diameter being present in only some of the replicate splits. If the end data is to assess risk of accidental ingestion of Lead, precision for the concentration of lead contained in larger particles may be of less interest then the Lead contained in the finer, less than 0.25 mm, fraction. Using a finer mesh sieve (0.25 mm rather than 2 mm) may improve precision and reproducibility. However, sieving unground samples through sieves finer than two millimeters is not appropriate if analyzing for high explosives or propellants. Typical mass sizes for energetic analytes are in particles sizes greater than 0.59 millimeters.

15.1.4. MI samples collected for Arsenic analyses that contain greater than 20 mg/K total Arsenic should be tested for bioaccessible Arsenic. This should be discussed with the project manager. If deemed appropriate, the entire <2mm fraction of the respective samples should be sieved to a ≤0.25 mm, representatively sub-sampled

and analyzed for bioaccessible Arsenic using SBRC methodology, 1-2 grams are required.

15.2. Polycyclic Aromatic Hydrocarbons (PAHs)

15.2.1. Currently there is little information in published procedures specific to the laboratory processing of IS samples for PAHs. Laboratory processing of samples per EPA Method 8330 B as described in Section 14.1 is recommended.

15.3. Perchlorate

15.3.1. Currently there is little information in published procedures specific to the laboratory processing of IS samples for Perchlorate. Laboratory processing of samples per EPA Method 8330 B as described in Section 14.1 is recommended. A 10 gram aliquot is required for all propellants and explosives. It is recommended that a 10 gram IS sample should be extracted with 100mL s of DI water for Perchlorate analysis by EPA Method 314.

15.4. Vegetation samples

15.4.1. Since vegetation samples often are not amenable to standard mixing and homogenization techniques, or specific sections of the vegetation are targeted, these are handled on a case-by-case basis with instructions from the Project Chemist. The Project Chemist should obtain sample-specific instructions from the client. The Project Chemist will then communicate the specification to the lab personnel using the ALS Form V document for the project. If the client makes reference to specific procedures, methods, or technical references, the Project Chemist will make the document(s) available to the laboratory personnel.

15.5. Paperboard samples

15.5.1. In general, prepare paperboard samples as described below. Project-specific instructions may replace these.

15.5.2. Look at SR, determine the jars you will need:

15.5.2.1.

Metals = 8 oz jar.
Voa = 8 oz jar.
Dioxins = 8 oz jar.
SVG = 32 oz jar.
SVM = 32 oz jar.
PHC (8315) = 8 oz jar.
Gen Chem (not Biology) = 8 oz jar.

15.5.3. Make sample labels according to test and put on appropriate jar.

15.5.4. If FDA Ext is on the Service Request for PHC you will need a 16 oz jar per sample. Do Not Composite into one sample. Each sample is a separate sample.

15.5.5. Prepare the FDA Ext first.

15.5.5.1. Cut the sheet of paper into one 10" x 10" square.
15.5.5.2. Cut the 10" x 10" into strips at the cut lines 7 ½, 5 and 2 ½.
15.5.5.3. Cut the strips at the cut lines 7 ½, 5 and 2 ½. This will make 16 2" squares.
15.5.5.4. Put each sample into its own jar and label accordingly. i.e. (1,2 3, etc.) PHC will composite in the lab.

15.5.6. Put one sheet of paper into shredder, run the shredder back and forth to get the entire sample out. Use tongs to remove any remaining sample in bottom of shredder (make sure to turn off before you do this)

15.5.7. Shred equal amounts of each sample (1 or more sheets) to create the composite sample. Homogenize sample thoroughly and aliquot into each jar needed for analysis. Put sample storage on lid of jar.

15.5.8. Dioxins get sent out to Houston. Label lid "Out".

15.5.9. Take all composites to Sample Storage for ALS labeling and shelving.

15.5.10. Update Composites as being done….Open Starlims, double click on Ad Hoc by Test (Under Results entry), highlight samples composited and click the Update to Done button at the top of page. Do not add jars when asked. Just click the X on the right hand corner.

16. QA/QC REQUIREMENTS

16.1. Ongoing QC Samples required for each sample batch (20 or fewer samples) are described in the SOP for Sample Batches and in the determinative SOPs.

17. DATA REDUCTION AND REPORTING

17.1. All compositing and subsampling data must be recorded into the bench records by the analyst. In addition to sample volumes and masses, sample identifications, etc., this should include descriptions of unique samples or sample components.

17.2. It is the supervisor's responsibility to ensure that analytical data is reviewed and to ensure that all quality control requirements have been met.

18. TRAINING

18.1. Refer to the determinative SOPs and the SOP for Documentation of Training for standard procedures.

19. REFERENCES

19.1. *Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples*, U.S. Environmental Protection Agency, EPA/600/R-03/027, November 2003

19.2. *Standard Guide for Laboratory Subsampling of Media Related to Waste Management Activities*, ASTM D 6323, Annual Book of ASTM Standards, 1999.

19.3. Test Methods for Evaluating Solid Waste, EPA SW-846, Final Update III, December 1996.

19.4. *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, January, 1996.

19.5. Draft Guidance on Multi-Increment Soil Sampling State of Alaska, Department of Environmental Conservation, March 2007.

19.6. Technical Guidance manual; Hawai'i Department of Health, Office of Hazard Evaluation and Emergency response, 2009.

19.7. Standard operating Procedure, In Vitro Method for Determination of Lead and Arsenic Bioavailability; Solubility/Bioavailability Research Consortium, Document 8601-102.011-0601-1099-RN01.

19.8. Figure 1: Multi Incremental Sampling Worksheet

20. CHANGES SINCE THE LAST REVISION

20.1. Sec. 11.11: Added 8270 LL and SIM PAH LL. Also corrected akiquot mass for 8270 and PAH.
20.2. Sec. 15.2.1: Added section reference for 8330B processing.
20.3. Sec. 15.3: Added section reference for 8330B processing.

Figure 1 – Multi Incremental Sampling Worksheet

Service Request #: K120
Analysis: Multi Incremental Sampling (MIS/ISM)

Sample Number	+2mm Fraction Air Dried Weight (g)	Comments, Description of +2mm Fraction	-2mm Fraction Air Dried Weight (g)	-2mm Fraction Multi Incremental Sample Aliquots									
				Test	Sample Wt. (g)	Test	Sample Wt. (g)	Test	Sample Wt. (g)	Test	Sample Wt. (g)	Test	Sample Wt. (g)

Comments:

Balance ID: K-BALANCE-

Prepared By:	Date:
Reviewed By:	Date:

METALS DIGESTION METHOD 3050B

MET-3050B

ALS-KELSO

SOP ID: MET-3020a Rev. Number: 13 Effective Date: 12/1/2012

Approved By: _____ Date: 11/28/12
Department Supervisor - Jeff Coronado

Approved By: _____ Date: 11/28/12
QA Manager - Suzanne LeMay

Approved By: _____ Date: 11/29/12
Laboratory Director - Jeff Grindstaff

Issue Date: _____ Doc Control ID#: _____ Issued To: _____

METALS DIGESTION
SOP: MET-3050B
Revision 13
Effective Date: 12/1/12

Procedure Change Form

SOP Section Number	Date Procedure Change Implemented	Description of Procedure Change	Supervisor Approval and Notification of Other Analysts
11.5	04/08/14	Add "Note 2": All Wisconsin samples must digest for 2 hours after generation of brown fumes has ceased.	J.C.
11.7	04/08/14	Add Note: All Wisconsin samples must digest for 2 hours after the final peroxide addition.	J.C.

Standard Operating Procedure

For

METALS DIGESTION – 3050B

1. SCOPE AND APPLICATION

1.1. This procedure uses techniques described in method 3050B for acid digestion of sediments, sludges, and soil samples designated for "Total Metals" analysis. One technique is designed for the preparation of samples for analysis by flame AA (Methods 7420-Pb, 7742-Se, and 7062-As) or ICP-OES (methods 6010 and 200.7). Another technique is given for the preparation of samples for analysis by GFAA (see SOP MET-GFAA for methods) or ICP-MS (methods 6020 and 200.8). This procedure is not a *total digestion* technique, but extracts "environmentally available" elements from the sample of interest.

2. METHOD SUMMARY

2.1. One-gram equivalent dry weight sediment, sludge, or soil samples are digested with repeated additions of nitric acid (HNO_3) and hydrogen peroxide (H_2O_2). For GFAA and ICP-MS analysis the resultant digestate is reduced in volume while heating and then diluted to a final volume of 100 mL. For ICP-OES and flame AA analysis, hydrochloric acid (HCl) is added to the initial digestate and the sample is refluxed prior to dilution to a final volume of 100 mL.

3. DEFINITIONS

3.1. **Batch** - A batch of samples is a group of environmental samples that are prepared and/or analyzed together as a unit with the same process and personnel using the same lot(s) of reagents. It is the basic unit for analytical quality control.

3.2. **Preparation Batch** - A preparation batch is composed of one to twenty field samples, all of the same matrix, and with a maximum time between the start of processing of the first and last samples in the batch to be 24 hours.

3.3. **Sample**

3.3.1. Field Sample - An environmental sample collected and delivered to the laboratory for analysis; a.k.a., client's sample.

3.3.2. Laboratory Sample - A representative portion, aliquot, or subsample of a field sample upon which laboratory analyses are made and results generated.

3.4. **Quality System Matrix** - The *matrix* of an environmental sample is distinguished by its physical and/or chemical state and by the program for which the results are intended. The following sections describe the matrix distinctions. These matrices shall be used for purpose of batch and quality control requirements.

3.4.1. Solids - Any solid sample such as soil, sediment, sludge, and other materials with >15% settleable solids.

3.5. **Laboratory Control Sample (LCS)** - A laboratory blank that has been fortified with target analyte and used to determine that the analysis is in control.

3.6. **Matrix Spike (MS)** - In the matrix spike analysis, predetermined quantities of target analytes are added to a sample matrix prior to sample preparation and analysis. The percent recovery is calculated. The MS is used to evaluate the effects of the sample matrix on the method used for the analysis. The concentration of the spike should be at three to five times the sample result or at levels specified by a project analysis plan.

3.7. **Duplicate Sample (DUP)** - A laboratory duplicate. The duplicate sample is a separate field sample aliquot that is processed in an identical manner as the sample proper. The relative percent difference between the samples is calculated and used to assess analytical precision.

3.8. **Method Blank (MB)** - The method blank is an artificial sample composed of analyte-free water or solid matrix and is designed to monitor the introduction of artifacts into the analytical process. The method blank is carried through the entire analytical procedure.

4. INTERFERENCES

Refer to the determinative method for a discussion of interferences.

5. SAFETY

5.1. All appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personnel protective equipment, such as, safety glasses, lab coat and the correct gloves.

5.2. Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

5.3. Hydrochloric and/or Nitric Acid are used in this method. These acids are extremely corrosive and care must be taken while handling them. A face shield must be used while pouring concentrated acids. And safety glasses should be worn while working with the solutions. Lab coat and gloves should always be worn while working with these solutions.

6. SAMPLE COLLECTION, PRESERVATION AND STORAGE

6.1. Samples may be collected in plastic or glass jars. Non-aqueous samples are refrigerated at 4 ± 2°C from receipt until analysis.

6.2. The recommended holding time is 6 months from the day of sampling.

7. APPARATUS AND EQUIPMENT

7.1. 125 mL plastic cup beaker cup, calibrated at 50mL and 100mL

7.2. Borosilicate watch glasses

7.3. Block Digester, calibrated to maintain 95°C ± 2°C

7.4. Hot Plates: "Thermolyne Cimerac 3", calibrated to maintain 95°C ± 2°C

7.5. Laboratory balance, top-loader capable of reading 0.01g

7.6. Evergreen disposable tubes 50 ml: an Accuracy and Precision verification check must be made with each new vendor lot prior to use. Refer to the SOP for *Checking Volumetric Labware ADM-VOLWARE*, for further detailed instructions. Performance data must meet the accuracy and precision requirements specified in Table 1 (*ADM-VOLWARE*) for non volumetric Labware used for measuring initial and/or final digestate volumes.

7.7. USS # 10 sieve.

8. STANDARDS AND REAGENTS

8.1. Reagent grade chemicals shall be used in all tests. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lowering the accuracy of the determination. The preparation for all laboratory prepared reagents and solutions must be documented in a laboratory logbook. Refer to the SOP *Reagent/Standards Login and Tracking (ADM-RTL)* for the complete procedure and documentation requirements.

8.2. Reagent water: ASTM Type I water (resistivity ≥18 MΩ-cm, conductivity ≤0.056 uS/cm).

8.3. Concentrated Nitric Acid: J.T. Baker "Instra-analyzed", Trace Metals Grade

8.4. Concentrated Hydrochloric Acid: EMD GR ACS

8.5. Hydrogen Peroxide (30%): EMD GR ACS

8.6. Standards

8.6.1. Stock standards may be purchased from a number of vendors. All reference standards ,where possible must be traceable to SI units or NIST certified reference materials. The vendor assigned expiration date is used.

8.6.2. Metals spiking solutions: Five spiking solutions are needed to prepare the matrix spike sample; SS1, SS2, SS3, SS4, and SS5.

8.6.3. Follow the formulations laid out on the "Metals Spike Form" (see Attachments for example). These solutions are prepared in acid rinsed Class A volumetric flasks using purchased custom mixed standards or 1000 ppm single analyte standards. Aliquots are made using acid rinsed Class A volumetric pipettes of the appropriate size.

8.6.4. SS1 (Al, Ag, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Sb, V, and Zn): Fill a 1000 mL volumetric flask approximately half full with reagent water, add 50 mL of nitric acid and mix. Next add 100 mL of the custom mixed standard (CAS-CAL-14) purchased from "Inorganic Ventures". In addition add 50 mL of 1000 ppm Antimony(use the Antimony standard that does not contain HCL.) Dilute to volume with reagent water, mix thoroughly and transfer to a 1000 mL Teflon bottle for storage. The solution

expiration date is determined by the earliest expiration date of any single component in the solution.

8.6.5. SS2 (GFAA As, Cd, Cu, Pb, Se, Tl): Fill a 500 mL volumetric flask approximately half full with reagent water, add 25 mL of nitric acid and mix. Next add 2.0 mL each of 1000 ppm Arsenic, Cadmium, Copper, Lead, Selenium, and Thallium. Dilute to volume with reagent water, mix thoroughly and transfer to a 500 mL Teflon bottle for storage. The solution expiration date is determined by the earliest expiration date of any single component in the solution.

8.6.6. SS3 (As, Se, and Tl): Fill a 500 mL volumetric flask approximately half full with reagent water, add 25 mL of nitric acid and mix. Next add 50 mL each of 1000 ppm Arsenic, Selenium, and Thallium. Dilute to volume with reagent water, mix thoroughly and transfer to a 500 mL Teflon bottle for storage. The solution expiration date is determined by the earliest expiration date of any single component in the solution.

8.6.7. SS4 (B, Mo): Fill a 500 mL volumetric flask approximately half full with reagent water, add 25 mL of nitric acid and mix. Next add 50 mL each of 1000 ppm Boron and Molybdenum. Dilute to volume with reagent water, mix thoroughly and transfer to a 500 mL Teflon bottle for storage. The solution's expiration date is determined by the earliest expiration date of any single component in the solution.

8.6.8. SS5 (K,Na,Mg,Ca): Fill a 200 mL volumetric flask approximately half full with reagent water add 10.0 mL of nitric acid and mix. Next add 20 mL each of 10,000 ppm Potassium, Sodium, Magnesium and Calcium. Dilute to volume with reagent water, mix thoroughly and transfer to a 250 mL Teflon bottle for storage. The solution's expiration date is determined by the earliest expiration date of any single component in the solution.

8.7. Metals reference material (ERA Priority PollutnT/CLP Inorganic Soil) for use as the laboratory control sample. The expiration date is assigned by the manufacturer.

8.8. Teflon beads, Teflon boiling chips, or other suitable blank material.

9. PREVENTIVE MAINTENANCE

9.1. All maintenance activities are recorded in a maintenance logbook. Pertinent information must be in the logbook. Maintenance entries should include date, symptom of problem, corrective actions, and description of maintenance, date, and name. The log should contain a reference to return to analytical control.

9.2. Maintenance for this procedure is generally limited to glassware cleaning, pipet monitoring, and hot plate calibration. Procedures for glassware washing are described in the SOP for Metals Laboratory Glassware Cleaning (MET-GC). Procedures for pipet monitoring are given in the SOP for Checking Volumetric Labware, (ADM-VOLWARE).

9.3. Each hotplate or block digester is uniquely identified and the temperature is verified with each batch of samples. To perform the verification, a certified thermometer is placed in a container half filled with mineral oil, which is then placed in the center of the hotplate or block digester. The thermometer does not touch the bottom of the container. The temperature is turned to the 95°C setting and the mineral oil is allowed to come to

temperature. The analyst will verify that the hotplate gives a temperature of 95°C ± 2°C. If not, the thermostat is adjusted until the thermometer reads and maintains 95°C ± 2°C. The thermostat is then marked to clearly indicate the correct setting to be used during sample digestion (when using Hot Plates.). Each hot Block has an assigned calibrated thermometer. The Temperature and the correction factor of the assigned thermometer is recorded on the digestion bench sheet.

10. RESPONSIBILITIES

10.1. It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

10.2. It is the responsibility of the department supervisor/manager to document analyst training.

11. PROCEDURE

11.1. Record all digestion and sample information on the applicable benchsheet.

11.2. Mix the sample thoroughly to achieve homogeneity. Sieve if necessary using a USS #10 sieve.

11.3. It can be difficult to obtain a representative sample with wet or damp materials. As per Method 3050B, wet samples may be dried, crushed, and ground to reduce subsample variability, however, drying is not recommended since drying may affect the extraction of the analytes of interest in the sample.

11.4. Weigh approximately 1g of sample into a 125ml plastic beaker cup and record the weight to the nearest 0.01g. For sludge's and sediments that have high moisture content, use more sample. A plastic 10.0 mL disposable pipette is used to measure 10.0 mL of sample. The volume and weight of the pipetted sample is recorded. In cases where the sludge is very thick a 10.0 mL graduated cylinder may be used. The objective is to use about 1g of dry weight sample. For analysis of Lead by Flame AA, use about 2.5g of dry wt. sample and change the final dilution volume to 50ml. This will achieve a lower detection limit needed for most projects. At this point add the appropriate spiking solutions directly onto the designated spike sample prior to addition of reagents.

11.5. Add 5ml reagent water and 5ml concentrated HNO_3. Place in a hot block, cover and reflux (without boiling) at 95ºC for 10 to 15 minutes. Allow the sample to cool. Add 5ml of concentrated HNO_3, cover and reflux for 30 minutes. If brown fumes are generated, indicating oxidation of the sample by HNO_3, repeat the addition of 5ml of HNO_3 and reflux over and over until no brown fumes are given off. Reduce the digestate volume to approximately 5 mL without boiling or digest for two hours maintaining a covering of solution over the bottom of the beaker at all times. If this occurs discard the digestate and begin with a new sample aliquot.

Note: The 95°C hot block temperature must be monitored and documented on a per-batch basis. The actual measured temperature, thermometer correction factor, and corrected temperature must all be recorded.

11.6. Cool the sample and add 3 mL of 30% H_2O_2. Cover and heat to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessive effervescence. Heat in the hot block until effervescence subsides. Remove from hot block and cool the beaker.

11.7. Continue to add 30% H_2O_2 in 3ml aliquots with warming until the effervescence is minimal, or until the general sample appearance is unchanged. Do not add more than 10ml of 30% H_2O_2. When the peroxide additions are complete cover the sample with a watch glass and continue heating the acid-peroxide digestate until the volume has been reduced to approximately 5 mL or heat at 95°± 5°C without boiling for 2 hours. Do not let the samples go to dryness, by ensuring the solution covers the bottom of the vessel at all times.

If the sample is being prepared for analysis by ICP-OES or Flame AA, add 10 mL of concentrated HCl. If the sample is being prepared for ICP-MS or GFAA analysis no HCl is added. Dilute the sample to 100 mL with reagent water: ASTM Type I water (resistivity ≥18 M□-cm, conductivity ≤0.056 uS/cm) in a 125 mL plastic beaker cup.

Note: For method 7062 and 7742 samples, the 3050B soil digestion is modified as follows: After the final peroxide addition (i.e. before the final reduction stage) add 5.0mL of concentrated hydrochloric acid and reduce the digestate volume to less than 5.0mL, but not to dryness. After cooling, dilute the digestate to 100mL with reagent water.

11.8. Cover and reflux the Flame AA and ICP samples for 15 minutes at 95°C. After cooling, the samples may be diluted to 100ml for ICP analysis, or 50ml for Flame AA analysis.

11.9. Particulates in the digestates that may clog the nebulizer are allowed to settle overnight, or the digestates may be centrifuged.

11.10. To improve the solubility for Antimony, Barium, Lead and Silver, the following modification of the digestion procedure may be used as directed by the client or project chemist.

11.10.1. Weigh (to the nearest 0.01g) 1.00 g of sample into a 125ml plastic cup. For sludge's and sediments that have high moisture content, use more sample. The objective is to use about 1g of dry weight sample.

11.10.2. Add 2.5mL HNO_3 and 10mL HCl and cover with a watch glass. Reflux for 15 minutes.

11.10.3. Filter the digestate through Whatman No. 41or equivalent filter paper and collect in a 100mL volumetric flask. Wash the filter paper, while still in the funnel, with no more than 5mL of hot (95°) HCl, and then with 20mL of hot (95°) reagent water. Collect washing in the same volumetric flask.

11.10.4. Remove the filter and residue from the funnel, and place them back in the beaker. Add 5mL HCl, cover and heat at 95° ± 5° until the filter paper dissolves. Remove from the heat and wash the cover and sides with reagent water.

11.10.5. Filter the residue and collect the filtrate in the same 100mL flask. Allow to cool, then dilute to volume.

11.10.6. If precipitation occurs in the flask upon cooling, do not dilute to volume. Instead, add up to 10mL of HCl to dissolve the precipitate. After precipitate is dissolved, dilute to volume with water.

12. QA/QC REQUIREMENTS

12.1. Initial Precision and Recovery Validation

12.1.1. The accuracy and precision of the procedure must be validated before analyses of samples begin, or whenever significant changes to the procedures have been made. To do this, four blank matrix samples are spiked with the LCS spike solution, then prepared and analyzed.

12.2. Monitor Hot Blocks and Hotplates on a per batch basis. Report all deficiencies to the Lab Manager. Corrective action must be taken.

12.3. Digest one laboratory control sample with each batch. Weigh 1.00 g of the current lot of Environmental Resource Associates PriorityPollutnT/CLP Inorganic Soil prepared reference material into a 150 mL beaker and digest as per the procedure.

12.4. Digest one preparation blank (method blank) per digestion batch, or per 20 samples whichever is more frequent. For the method blank, use Teflon beads, Teflon boiling chips, or other suitable solid blank material and follow the digestion procedures.

12.5. Digest one duplicate and one spiked sample with each sample matrix. Prepare one duplicate and spike sample per each digestion batch, or per twenty samples whichever is more frequent. At times, specific samples will be assigned as duplicates of spikes depending on client requirements.

12.6. Soil spikes for ICP are prepared by adding 2.0 mL of SS1, and 1.0 mL of SS3, SS4 and SS5 directly to the sample aliquot, prior to the addition of any water or acid. Fill out a spiking data sheet and keep it with the digestion data sheets.

For ICP and ICP-MS digestions 1.0 mL of SS1 and 0.50 mL of SS3 and SS4 are added to the sample aliquot designated as the matrix spike sample. The matrix spike sample is then digested as per the procedure.
For GFAA digestions 2.0 mL of SS2 is added to the sample aliquot designated as the matrix spike sample. The matrix spike sample is then digested as per the procedure.

13. REPORTING

13.1. Digestion data sheets including weights and volumes used and reagents/acids are completed and a prep run number or batch lot number is assigned and attached to the data sheet. The lot numbers for the reagents used are added to the digestion data sheet (see Attachments).

13.2. Spiking sheets are included (See Attachments).

14. CORRECTIVE ACTION

14.1. Refer to the SOP for *Corrective Action* for procedures for corrective action. Personnel at all levels and positions in the laboratory are to be alert to identifying problems and nonconformities when errors, deficiencies, or out-of-control situations are detected.

14.2. Handling out-of-control or unacceptable data

14.2.1. On-the-spot corrective actions that are routinely made by analysts and result in acceptable analyses should be documented as normal operating procedures, and no specific documentation need be made other than notations in laboratory maintenance logbooks, runlogs, for example.

14.2.2. Documentation of a nonconformity must be done using a Nonconformity and Corrective Action Report (NCAR) when: a) corrective action is not taken or not possible b) corrective action fails to correct an out-of-control problem on a laboratory QC or calibration analysis c) reanalysis corrects the nonconformity but is not a procedurally compliant analysis.

15. METHOD PERFORMANCE

Available method performance data is given in the reference method. In addition, this procedure was validated through single laboratory studies of accuracy and precision as in the determinative procedure. The method detection limit(s) and method reporting limit(s) are established for the determinative procedure.

16. POLLUTION PREVENTION

It is the laboratory's practice to minimize the amount of solvents, acids and reagent used to perform this method wherever feasible. Standards are prepared in volumes consistent with methodology and only the amount needed for routine laboratory use is kept on site. The threat to the environment from solvent and reagents used in this method can be minimized when recycled or disposed of properly.

17. WASTE MANAGEMENT

17.1. The laboratory will comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the ALS EH&S Manual.

17.2. This method uses acid. Waste acid is hazardous to the sewer system and to the environment. All acid waste must be neutralized to a pH of 2.5-12 prior to disposal down the drain. The neutralization step is considered hazardous waste treatment and must be documented on the treatment by generator record. See the ALS EH&S Manual for details.

18. TRAINING

18.1. Training outline

18.1.1. Review literature (see references section). Read and understand the SOP. Also review the applicable MSDS for all reagents and standards used. Following these reviews, observe the procedure as performed by an experienced analyst at least three times.

18.1.2. The next training step is to assist in the procedure under the guidance of an experienced analyst. During this period, the analyst is expected to transition from a role of assisting, to performing the procedure with minimal oversight from an experienced analyst.

18.1.3. Perform initial precision and recovery (IPR) study as described above for water samples. Summaries of the IPR are reviewed and signed by the supervisor. Copies may be forwarded to the employee's training file. For applicable tests, IPR studies should be performed in order to be equivalent to NELAC's Initial Demonstration of Capability.

18.2. Training is documented following the *SOP ADM-TRAIN*.

NOTE: When the analyst training is documented by the supervisor on internal training documentation forms, the supervisor is acknowledging that the analyst has read and understands this SOP and that adequate training has been given to the analyst to competently perform the analysis independently.

19. METHOD MODIFICATIONS

19.1. The method uses 2 mL of water and 3 mL of H_2O_2 in step 11.6. The lab does not add the 2 mL of water. 3.0 mL aliquots of 30% H_2O_2 in lieu of 1.0 mL aliquots are added subsequently.

20. REFERENCES

20.1. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. EPA SW-846, 3rd Edition, Final Update III, Method 3050B, December 1996.

20.2. Table A - METALS SPIKING SOLUTIONS CONCENTRATIONS FORM

21. CHANGES SINCE THE LAST REVISION

21.1. Reformatted to ALS style.
21.2. Sec. 11.5: Changed wording to reflect hotplate temperature monitoring per batch

Table A

METALS SPIKING SOLUTIONS CONCENTRATIONS FORM

Solution Name	Element	mLs of 1000ppm Solution	Final Volume	Solution Conc. mg/L	Concentration in the digest mg/L
SS1	HNO3	50.0	1000ml	-	
	Al	100*	1000ml	200	2
	Ag	100*	1000ml	5	0.05
	Ba	100*	1000ml	200	2
	Be	100*	1000ml	5	0.05
	Cd	100*	1000ml	5	0.05
	Co	100*	1000ml	50	0.5
	Cr	100*	1000ml	20	0.2
	Cu	100*	1000ml	25	0.25
	Fe	100*	1000ml	100	1
	Pb	100*	1000ml	50	0.5
	Mn	100*	1000ml	50	0.5
	Ni	100*	1000ml	50	0.5
	Sb	50	1000ml	50	0.5
	V	100*	1000ml	50	0.5
	Zn	100*	1000ml	50	0.5
SS2	HNO3	25.0	500ml	-	
GFAA SPIKE	As	2.0	500ml	4	0.04
	Cd	2.0	500ml	4	0.04
	Pb	2.0	500ml	4	0.04
	Se	2.0	500ml	4	0.04
	Tl	2.0	500ml	4	0.04
	Cu	2.0	500ml	4	0.04
SS3	HNO3	25.0	500ml	-	
	As	50.0	500ml	100	1
	Se	50.0	500ml	100	1
	Tl	50.0	500ml	100	1
SS4	HNO3	25	500ml	-	
	B	50	500ml	100	1
	Mo	50	500ml	100	1

* Denotes volume of mixed stock standard.
** Denotes 10,000 ppm individual stock standards.

DETERMIMATION OF METALS AND TRACE ELEMENTS BY INDUCTIVELY COUOPLED PLASMA-MASS SPECTROMETRY (ICP-MS)

MET-6020

ALS-KELSO

SOP ID:	MET-6020	Rev. Number:	15	Effective Date:	07/31/2013

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Issue Date:	_____	Doc Control ID#:	_____	Issued To:	_____

Standard Operating Procedure

For

DETERMIMATION OF METALS AND TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA-MASS SPECTROMETRY (ICP-MS) METHOD 6020

1. SCOPE AND APPLICATION

1.1 This procedure is used to determine the concentrations of certain elements in water, soil, tissues, aqueous and non-aqueous wastes, and sediment samples using EPA Method 6020 or 6020A. Table 1 indicates analytes that are typically determined by this procedure and lists the standard Method Reporting Limits (MRLs) for each analyte in water and soil. Equivalent nomenclature for MRL includes Estimated Quantitation Limit (EQL) and Practical Quantitation Limit (PQL). Therefore, MRL=EQL=PQL. Project-specific MRLs may apply, and if lower than standard MRLs, it is demonstrated through method detection limit determinations and analysis of MRL standards that the MRL is achievable. Method Detection Limits (MDLs) that have been achieved are listed in Table 1. These may change as new studies are performed.

1.2 The complexity of the technique generally requires outside study of appropriate literature as well as specialized training by a qualified spectroscopist. The scope of this document does not allow for the in-depth descriptions of the relevant spectroscopic principles required for gaining a complete level of competence in this scientific discipline.

2 SUMMARY OF METHOD

2.1 Prior to analysis, samples must be digested using appropriate sample preparation methods. The digestate is analyzed for the elements of interest using ICP-mass spectrometry (ICP-MS).

2.2 Methods 6020 and 6020A describe the multi-elemental determination of analytes by ICP-MS. The method measures ions produced by a radio-frequency inductively coupled plasma. Analyte species originating in a liquid are nebulized and the resulting aerosol transported by argon gas into the plasma torch. The ions produced are entrained in the plasma gas and introduced, by means of an interface, into a mass spectrometer. The ions produced in the plasma are sorted according to their mass-to-charge ratios and quantified with a channel electron multiplier. Interferences must be assessed and valid corrections applied or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents, and constituents of the sample matrix.

3 DEFINITIONS

3.1 **Batch** – A batch of samples is a group of environmental samples that are prepared and/or analyzed together as a unit with the same process and personnel using the same lot(s) of reagents. It is the basic unit for analytical quality control.

3.1.1 Preparation Batch – A preparation batch is composed of one to twenty field samples, all of the same matrix, and with a maximum time between the start of processing of the first and last samples in the batch to be 24 hours.

3.2 Analysis Batch – Samples are analyzed in a set referred to as an analysis sequence. The sequence begins with instrument calibration (initial or continuing verification) followed by sample extracts interspersed with calibration standards (CCBs, CCVs, etc.) The sequence ends when the set of samples has been analyzed or when qualitative and/or quantitative QC criteria indicate an out-of-control situation.

3.3 **Sample**

3.3.1 Field Sample – An environmental sample collected and delivered to the laboratory for analysis; a.k.a., client's sample.

3.3.2 Laboratory Sample – A representative portion, aliquot, or subsample of a field sample upon which laboratory analyses are made and results generated.

3.4 **Quality System Matrix** – The *matrix* of an environmental sample is distinguished by its physical and/or chemical state and by the program for which the results are intended. The following sections describe the matrix distinctions. These matrices shall be used for purpose of batch and quality control requirements.

3.4.1 Aqueous – Any groundwater sample, surface water sample, effluent sample, and TCLP or other extract. Specifically excluded are samples of the drinking water matrix and the saline/estuarine water matrix.

3.4.2 Drinking water – Any aqueous sample that has been designated a potable or potential potable water source.

3.4.3 Saline/Estuarine water – Any aqueous sample from an ocean or estuary or other salt-water source.

3.4.4 Nonaqueous Liquid – Any organic liquid with <15% settleable solids.

3.4.5 Animal tissue – Any tissue sample of an animal, invertebrate, marine organism, or other origin; such as fish tissue/organs, shellfish, worms, or animal material.

3.4.6 Solids – Any solid sample such as soil, sediment, sludge, and other materials with >15% settleable solids.

3.4.7 Chemical waste – Any sample of a product or by-product of an industrial process that results in a matrix not described in one of the matrices in Sections 3.4.1 through 3.4.6. These can be such matrices as non-aqueous liquids, solvents, oil, etc.

3.4.8 Miscellaneous matrices – Samples of any composition not listed in 3.4.1 – 3.4.7. These can be such matrices as plant material, paper/paperboard, wood, auto fluff, mechanical parts, filters, wipes, etc. Such samples shall be batched/grouped according to their specific matrix.

3.5 Matrix Spike/Duplicate Matrix Spike (MS/DMS) Analysis – In the matrix spike analysis, predetermined quantities of target analytes are added to a sample matrix prior to sample preparation and analysis. The purpose of the matrix spike is to evaluate the effects of the sample matrix on the method used for the analysis. Duplicate samples are spiked, and analyzed as a MS/DMS pair. Percent recoveries are calculated for each of the analytes detected. The relative percent difference (RPD) between the duplicate spikes (or samples) is calculated and used to assess analytical precision. The concentration of the spike should be at the mid point of the calibration range or at levels specified by a project analysis plan.

3.6 Laboratory Duplicates (DUP) – Duplicates are additional replicates of samples that are subjected to the same preparation and analytical scheme as the original sample. The relative percent difference (RPD) between the sample and its duplicate is calculated and used to assess analytical precision.

3.7 Surrogate – Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction and chromatography, but which are not normally found in environmental samples. The purpose of the surrogates is to evaluate the preparation and analysis of samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to extraction and analysis. Percent recoveries are calculated for each surrogate.

3.8 Method Blank (MB) – The method blank is an artificial sample composed of analyte-free water or solid matrix and is designed to monitor the introduction of artifacts into the analytical process. The method blank is carried through the entire analytical procedure.

3.9 Laboratory Control Samples (LCS) – The LCS is an aliquot of analyte free water or analyte free solid to which known amounts target analytes are added. The LCS is prepared and analyzed in exactly the same manner as the samples. The percent recovery is compared to established limits and assists in determining whether the batch is in control.

3.10 Independent Verification Standard (ICV) – A pre-mixed, purchased, second-source standard analyzed after the calibration curve. This is used to verify the validity of the initial calibration standards

3.11 Continuing Calibration Verification Standard (CCV) – A mid-level standard analyzed at specified intervals. Used to verify that the initial calibration curve is still valid for quantitative purposes.

3.12 Duplicates and Duplicate Matrix Spikes are additional replicates of samples that are subjected to the same preparation and analytical scheme as the original sample. Depending on the method of analysis, either a duplicate analysis (and/or a matrix spiked sample) or a matrix spiked sample and duplicate matrix spiked sample (MS/DMS) are analyzed.

3.13 Standard Reference Material (SRM) – A material with specific certification criteria and is issued with a certificate or certificate of analysis that reports the results of its characterizations and provides information regarding the appropriate use(s) of the material.

An SRM is prepared and used for three main purposes: (1) to help develop accurate methods of analysis; (2) to calibrate measurement systems used to facilitate exchange of goods, institute quality control, determine performance characteristics, or measure a property at the state-of-the-art limit; and (3) to ensure the long-term adequacy and integrity of measurement quality assurance programs.

4 INTERFERENCES

4.1 Isobaric elemental interferences in ICP-MS are caused by isotopes of different elements forming atomic ions with the same nominal mass-to-charge ratio (m/z). A data system must be used to correct for these interferences. This involves determining the signal for another isotope of the interfering element and subtracting the appropriate signal from the analyte isotope signal. Attention should be given to circumstances where very high ion currents at adjacent masses may contribute to ion signals at the mass of interest. Matrices exhibiting a significant problem of this type may require resolution improvement, matrix separation, or analysis using another isoptope.

4.2 Isobaric molecular and doubly-charged ion interferences in ICP-MS are caused by ions consisting of more than one atom or charge, respectively. Most isobaric interferences that could affect ICP-MS determinations have been identified in the literature. Refer to Method 6020/A for further discussion.

5 SAFETY

5.1 All appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personnel protective equipment, such as, safety glasses, lab coat and the correct gloves.

5.2 Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

5.3 Hydrochloric and/or Nitric Acid are used in this method. These acids are extremely corrosive and care must be taken while handling them. A face shield should be used while pouring acids. And safety glasses should be worn while working with the solutions. Lab coat and gloves should always be worn while working with these solutions.

5.4 High Voltage – The RF generator supplies up to 2000 watts to maintain an ICP. The power is transferred through the load coil located in the torch box. Contact with the load coil while generator is in operation will likely result in death. When performing maintenance on the RF generator, appropriate grounding of all HV capacitors must be performed as per manufacturer.

5.5 UV Light – The plasma is an intense source of UV emission, and must not be viewed with the naked eye. Protective lenses are in place on the instrument. Glasses with special protective lenses are available when direct viewing of the plasma is necessary.

6 SAMPLE COLLECTION, CONTAINERS, PRESERVATION, AND STORAGE

6.1 Aqueous samples are typically collected in plastic containers. Aqueous samples are preserved with nitric acid (pH<2), then refrigerated at 4 ± 2°C from receipt until digestion.

Soil or solid samples may be collected in plastic or glass jars. Non-aqueous samples are refrigerated at 4 ± 2°C from receipt until digestion.

6.2 Samples are prepared via procedures in SOPs MET-DIG, MET-3020A, or MET-3050 depending on matrix and project specifications.

6.3 Digestates are stored in the appropriate volumetric containers. Following analysis, digestates are stored until all results have been reviewed. Digestates are neutralized prior to disposal through the sewer system, 2 weeks after data is reviewed.

7 APPARATUS & EQUIPMENT

7.1 Instruments: Thermo Elemental ExCell (K-ICP-MS-02) Serial # EX191, Thermo Elemental X-Series (K-ICP-MS-03) Serial # X0193, and NexION 300D (K-ICP-MS-04).

7.2 Thermo Meinhard type (Part # 1201318)

7.3 Thermo Impact Bead Quartz Spray Chamber (Part # 3600170)

7.4 Thermo X7 Nickel Sample Cone (1.0 mm orifice) (Part # 3004661), or Xi sample cone (part # 3600812)

7.5 Thermo X7 Nickel Skimmer Cone (0.75 mm orifice) (Part # 3200860) or Xi skimmer cone(part # 3600811)

8 STANDARDS, REAGENTS, AND CONSUMABLE MATERIALS

8.1 All standards are prepared from NIST traceable standards. The expiration dates are assigned according to the EPA method and the vendor's assigned expiration dates. For example, working ICS solutions are prepared weekly in accordance with Method 6020, Section 5.6.1.

8.1.1 1000 ppm Single Element Stock Standard Solutions: Each stock standard is store at room temperature on shelves located in room 113 of the metals lab. The manufacturer, lot number, and expiration date of each stock standard is recorded in a bound logbook also located in room 113. Additionally each stock standard is given a unique, identifying name.

8.1.2 Intermediate Standard Solutions: Intermediate mixed stock solutions are made from the individual stock standards described above. The individual component of each mixed solution is recorded in a bound logbook located in the ICP-MS laboratory and mixed solution is given a unique, identifying name. The expiration date for the intermediate standard is the earlier of any one of its stock components.

8.1.3 Calibration Standards: Calibration standards are made fresh daily from the intermediate standard solutions. Each individual intermediate standard used in the calibration standard is recorded in a bound logbook located in the ICP-MS laboratory, and the calibration standard solution is given a unique, identifying name. The calibration standards unique name is used on the raw data to link the data to the subsequent prepared standards and ultimately the original purchased stock standard.

8.2 Standards Preparation

8.2.1 Expiration of all standard solutions defaults to the earliest expiration date of an individual component unless otherwise specified.

8.2.2 Calibration Standards

The calibration standard is prepared from two intermediate stock solutions. These solutions are prepared in acid rinsed 1000 mL Class A volumetric flasks following the formulations laid out on the attached example standard sheet (see Attachments). The working calibration standard is made daily by aliquoting 2.5 mL of each of the intermediate solutions in to a 100 mL Class A volumetric flask and diluting to volume with 1% HNO3. This standard is also used as the Continuing Calibration Verification (CCV).

8.2.3 Initial Calibration Verification (ICV)

8.2.3.1 The ICV intermediate stock solution is prepared in an acid rinsed 100 mL Class A volumetric flask. The solution is prepared by adding 2.0 mL of Inorganic Ventures QCP-CICV-1, 1.0 mL each of QCP-CICV-2 and QCP-CICV-3, 0.5 mL of 1000 ppm Molybdenum stock solution, 0.5 mL of 1000 ppm Uranium stock solution, and 0.5mL of 1000ppm B, Bi, Sr, Ti solution and diluting to volume with 1% HNO3.

8.2.3.2 The working ICV solution is prepared by aliquoting 0.5 mL of the mixed ICV intermediate solution into an acid rinsed 100 mL Class A volumetric flask and diluting to volume with 1% HNO3.

NOTE: The ICV solution is not at the midpoint of the linear range which may be as high as 1000 µg/L for some elements. The ICV solution used is a premixed standard purchased from Inorganic Ventures and contains the elements of interest between 2.5 and 100 µg/L. This solution provides calibration confirmation at more representative levels, given that most ICP-MS analyses are quantifying analytes in the low-ppb to sub-ppb range.

8.2.4 Interference Check Solutions (ICSA and ICSAB)

8.2.4.1 The ICSA is prepared in an acid rinsed 50 mL Class B volumetric flask by aliquoting 1.0 mL of Elements ICSAm (CS-CAK02) solution and diluting to volume with 1% HNO3.

8.2.4.2 The ICSAB is prepared in an acid rinsed 50 mL Class B volumetric flask by aliquoting 1.0 mL of Elements ICSAm (CS-CAK02), 0.125 mL of Inorganic Ventures 6020ICS-9B, and 0.250 mL of 10 ppm Molybdenum solutions and diluting to volume with 1% HNO3.

8.2.5 Post-digestion spikes are performed by adding appropriate amounts of the calibration intermediate solutions to aliquots of the sample digestate. The volumes of each standard used vary based on the native concentrations found in the field samples. Refer to the post-digestion spike in Section 12 for details.

8.2.6 Refer to the appropriate digestion SOP for details of LCSW and matrix spike solution composition and preparation.

8.2.7 Tuning / Mass Calibration Solution

8.2.7.1 A 1ppm intermediate solution containing Be, Bi, Ce, Co, In, Li, Pb, Mg, and U is prepared by adding 1.0 mL of each from 1000 ppm stock standards to an acid rinsed 1000 mL volumetric flask and diluting to volume with 1% nitric acid. The expiration date for the intermediate solution is the earliest of any one of its stock components.

8.2.7.2 The working solution is prepared in three ways:

- For the ExCell (K-ICP-MS-02) a 1.0 ppb tune/mass calibration solution is prepared by adding 1.0 mL of intermediate solution to an acid rinsed 1000 mL volumetric flask and diluting to volume with 1% nitric acid.
- For the X-Series (K-ICP-MS-03) instrument a 5.0 ppb tune/mass calibration solution is prepared by adding 5.0 mL of intermediate solution to an acid rinsed 1000 mL volumetric flask and diluting to volume with 1% nitric acid.
- For the NexION (K-ICP-MS-04) instrument a 2.0 ppb tune/mass calibration solution is prepared by adding 2.0 mL of intermediate solution to an acid rinsed 1000 mL volumetric flask and diluting to volume with 1% nitric acid.
- The expiration date for this solution is taken from the intermediate stock above.

8.3 Internal Standards Stock Solution – Prepare a 10 µg/mL solution containing ^{71}Ga, ^{115}In, ^{6}Li, ^{175}Lu, ^{103}Rh ^{45}Sc, and ^{89}Y by adding 10.0 mL of each 1000 ppm single element stock solution to a acid rinsed 1000 mL volumetric flask and diluting to volume with 1% nitric. Use this solution for addition to blanks, calibration standards and samples at a ration of 0.5 mL of internal standard to 100 mL of solution, or dilute by an appropriate amount using 1% (v/v) nitric acid, if the internal standards are being added by peristaltic pump.

8.4 Additional Reagents

8.4.1 Reagent water, ASTM Type II

8.4.2 "OmniTrace Ultra" Concentrated Nitric Acid (EM Science # NX0408-2)

8.4.3 Argon (Airgas Industrial Grade – 99.999% pure, bulk delivered)

9 PREVENTIVE MAINTENANCE

9.1 All maintenance is documented in the instrument logbook. ALS/Kelso maintains a service contract with the instrument manufacturer that allows for an unlimited number of service calls and full reimbursement of all parts and labor.

9.2 Most routine maintenance and troubleshooting is performed by ALS staff. Preventive maintenance activities listed below should be performed when needed as determined by instrument performance (i.e. stability, sensitivity, etc.) or by visual inspection. Other

maintenance or repairs may, or may not require factory service, depending on the nature of the task.

- cone removal and cleaning
- removal and cleaning of ICP glassware and fittings
- checking and cleaning RF contact strips
- checking air filters and cleaning if necessary
- checking the oil mist filters and cleaning if necessary
- checking the rotary pump oil and adding or changing if necessary
- removal and cleaning of extraction lens
- removal and cleaning of ion lens stack
- replace the electron multiplier as necessary

10 RESPONSIBILITIES

10.1 It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

10.2 It is the responsibility of the department supervisor/manager to document analyst training. Documenting method proficiency, as described in the SOP for Documentation of Training, is also the responsibility of the department supervisor/manager.

11 PROCEDURE

11.1 Refer to method 6020 (or 6020A) and the instrument manuals for detailed instruction on implementation of the following daily procedures preceding an analytical run.

11.2 After the instrument has been placed in the "Operate" mode, begin completing the daily instrument log (see Attachments). Refer to the instrument manuals for the optimum settings for each instrument.

11.3 The following parameters are monitored to assure awareness of changes in the instrumentation that serve as signals that optimum performance is not being achieved, or as indicators of the physical condition of certain consumable components (i.e. EMT and cones).

11.3.1 Multiplier Voltages

11.3.2 Gas Flows - Coolant Ar

11.3.3 The nebulizer and auxiliary flows are adjusted later as part of the optimizing procedure.

11.4 Optimization

11.4.1 Gas Flows

11.4.1.1Allow a period of not less than 30 minutes for the instrument to warm up.

11.4.1.2 Aspirate a mixed tune solution into the plasma and monitor the instrument output signal of In at mass 115 on the ratemeter. Adjust the nebulizer and auxiliary flows to obtain maximum signal. Adjust the tension screw on the peristaltic pump to obtain minimum noise in the analytical signal. Record flow rates and note any large variances.

Note: Significant differences in flow rates will be observed for different torches and cones.

11.4.2 Tuning

11.4.2.1 Ion Lens Setting - While monitoring the output signal of a mixed tune solution at mass 115 on the ratemeter, adjust the ion lenses to obtain maximum sensitivity. Refer to the instrument manual for details on performing the adjustments.

11.4.2.2 Mass Calibration - Aspirate the tune / mass calibration solution described in section 8.2.7.2 and perform the mass calibration using the instrument's Mass Calibration program. (Refer to the instrument manual for details pertaining to the mass calibration procedure.) The acceptance criteria for the mass calibration is <0.1 amu from the true value. If the mass calibration fails criteria re-tune the instrument and perform the mass calibration procedure again.

11.4.2.3 Resolution Check - Using the spectra created during the mass calibration procedure; perform the resolution check to assure the resolution is less than 0.9 AMU at 10% peak height. If the resolution does not pass criteria adjust the instrument's resolution settings, run a new scan of the mass calibration solution and recheck.

11.4.2.4 Stability Check - Using the tune / mass calibration solution, perform a short-term stability check as per EPA Method 6020 or 6020A. The relative standard deviations of five scans for each element in the tune solution must be < 5%. If the test does not pass criteria determine the cause (i.e. dirty cones, improper tune, etc.) correct the problem and re-run the test.

11.5 Analytical Run

11.5.1 Calibrate the instrument using a calibration blank (Standard 0), composed of reagent water and 1% nitric acid, and the working calibration standard (8.2.2). The masses typically monitored and those used for quantification are listed in Table 1. These masses are set as defaults in the instrument's analytical procedures. To begin select the correct method. Nebulize Standard 0 (Blank) into the plasma. Allow 1-2 minutes for system to equilibrate prior to establishing baseline. Follow directions on computer screen to perform standardization. Nebulize the working calibration standard into the plasma. The operator must sign and date the first page of standardization.

11.5.2 After the first CCB and before the ICS standards a CRA (MRL / LLICV / LLCCV) standard is analyzed. Method 6020 requires the detection to be > the MDL but < 2x

the MRL. For 6020A, the criteria are 70-130% recovery. For DoD projects, the CRA criteria are 80-120%.

Note: For 6020A the LLCCV must also be analyzed at the end on the analytical run sequence.

11.5.3 Perform the analysis in the order listed below. A daily run log of all samples analyzed is maintained.

Initial Calibration Verification (ICV)
Continuing Calibration Verification (CCV)
Initial Calibration Blank (ICB)
Continuing Calibration Blank (CCB)
CRA (MRL / LLICV / LLCCV)
ICSA
ICSAB
Analyze 10 Samples
CCV
CCB
Analyze 10 Samples
CCV
CCB
Repeat sequence as required to complete analytical run, analyzing CCVs/CCBs every 10 analyses and at the end of the run.

12 QA/QC REQUIREMENTS

12.1 Initial Precision and Recovery Validation

The accuracy and precision of the procedure must be validated before analysis of samples begins, or whenever significant changes to the procedures have been made. To do this, four LCS aliquots are prepared and analyzed. The average percent recovery of for each analyte must be 85-115% (for water, and within the LCS limits for soils) and the RSD <20%.

12.2 Method Detection Limits

12.2.1 A method detection limit (MDL) study must be undertaken before analysis of samples can begin. To establish detection limits that are precise and accurate, the analyst must perform the following procedure. Spike a minimum of seven blank matrices at a level near or below the MRL. Follow the procedures starting in Section 11 to analyze the samples. Refer to CE-QA011, *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantification* details of performing the MDL study.

12.2.2 Calculate the average concentration found (x) and the standard deviation of the concentrations for each analyte. Calculate the MDL for each analyte using the correct T value for the number of replicates. MDL's must be verified annually or whenever there is a significant change in the background or instrument response.

12.3 For method 6020A, an LLQC sample (a CRA that is carried through the digestion) must be analyzed to verify accuracy at the MRL. The recovery must be 70-130%.

12.4 Instrument Detection Limits (IDLs) and linear ranges studies are performed quarterly. These will be calculated and made available to the ICP-MS operator. Linear range studies determine the Linear Dynamic Range (LDR) of the each instrument by analysis of a high concentration standard with results with ± 10% of the expected value. For non-DoD projects samples may be quantified between the MRL and 90% of the LDR without flagging. The Linear Calibration Range (LCR) is established by the highest calibration standard.

- **Note:** IDLs must be < LOD for DOD projects. DoD project samples with concentrations above the calibration standard must be diluted to bring results within the quantitation range. The LOQ and cal standard establish the quantitation range. The lab may report a sample result above quantitation range if the lab runs and passes a CCV that is > sample result.

12.5 The Initial Calibration Verification (ICV) standard is analyzed immediately after calibration. The results of the ICV must agree within ±10% of the expected value. If the control limits are exceeded, the problem will be identified and the instrument recalibrated.

12.6 A Continuing Calibration Verification (CCV) and Continuing Calibration Blank (CCB) are analyzed after calibration then every 10 samples thereafter with a final CCV/CCB closing the final samples of the analytical run.

12.6.1 The results of the CCV must agree within ±10% of the expected value.

12.6.2 The CCB measured values must be less than the MRL / LOQ for each element for standard applications. Other project-specific criteria may apply (for DoD QSM projects CCB can have no analytes > the LOD).

12.6.3 If the control limits are exceeded, the problem will be identified and corrective action taken. The instrument recalibrated. The previous 10 samples must be reanalyzed.

12.7 The ICSA and ICSAB solutions are analyzed after calibration and before any field samples. The solutions are then reanalyzed every 12 hours. Results of the ICSA are used by the analyst to identify the impact of potential interferences on the quality of the data. Based on these results appropriate action should be taken when interferences are suspected in an field sample including, but not limited to, selecting and alternative isotope for quantification, manual correction of the data, elevating the MRL, selection of an alternative method (e.g. optical ICP, GFAA) or flagging the result as estimated when no other action is possible. Results for the spiked analytes in the ICSAB solution must agree with ± 20% of the expected value.

INTERFERENCE CHECK SAMPLE COMPONENTS AND CONCENTRATIONS

	Solution A Concentrations (mg/L)	**Solution B** Concentrations (mg/L)
Al	20.0	20.0
Ca	60.0	60.0

Fe	50.0	50.0
Mg	20.0	20.0
Na	50.0	50.0
P	20.0	20.0
K	20.0	20.0
S	20.0	20.0
C	40.0	40.0
Cl	424	424
Mo	0.05	0.05
Ti	0.40	0.40
As	0.0	0.025
Cd	0.0	0.025
Cr	0.0	0.050
Co	0.0	0.050
Cu	0.0	0.050
Mn	0.0	0.050
Ni	0.0	0.050
Se	0.0	0.025
Ag	0.0	0.0125
V	0.0	0.050
Zn	0.0	0.025

NOTE: The concentration of interfering elements in the ICSA and ICSAB solutions are spiked at levels 5 times lower than recommended in Table 1 of Method 6020A. Running the full strength solutions as described in 6020A introduces too much material approximately 0.35 % dissolved solids into the ICP-MS system when trying to conduct low level analysis. Since the ICP-MS instrumentation is able to handle a maximum of 0.2% solids, the 6020A ICSA solution is higher in interfering components than any sample that would run through the instrument. However, the ICS solutions will be analyzed at levels that will provide approximately 0.1% dissolved solids.

12.8 Internal standards are used to correct for physical interferences. Masses used as internal standards include; ^{71}Ga, ^{115}In, ^{6}Li, ^{175}Lu, ^{103}Rh ^{45}Sc, and ^{89}Y. These internal standards are used in combination to cover the appropriate mass ranges. Internal standard correction is applied to the analytical isotopes via interpolation of the responses from nearest internal standard isotopes (Thermo instruments) or direct correlation of analyte to IS (NexION). This function is performed in real-time by the instruments operating system. Internal standards must be run within 50 AMU of the masses that are analyzed. Internal standard recoveries must fall between 30% and 125% when running method 6020, or 70% to 125% when running method 6020A Revision 1. If not, then the sample must be reanalyzed after a fivefold or greater dilution has been performed.

12.9 A method blank is digested and analyzed with every batch of 20 (or fewer) samples to demonstrate that there are no method interferences. If the method blank shows any hits above the MRL for standard applications, or >½ the MRL for DoD projects or > 1/10 the sample result, corrective action must be taken. The MB can only be rerun once. Corrective action includes recalculation, reanalysis, system cleaning, or re-extraction and reanalysis.

12.10 Laboratory Control Samples are analyzed at a frequency of 5% or one per batch, whichever is greater. See the Attachments for a listing of control limits. For method 6020A, the LCS recovery limits are 80-120%. If statistical in-house limits are used, they must fall within the 80-120% range. Project, QAPP, or client-specific control limits may supersede the limits listed, but laboratory limits should be consistent with specified limits in order to establish that the specified limits can be achieved. If the control limits are exceeded, the associated batch of samples will be re-digested and reanalyzed.

12.11 A digested duplicate and matrix spike are analyzed at a frequency of 5% or one per batch, whichever is greater. The matrix spike recovery and relative percent difference will be calculated while analysis is in progress. See the Attachments for a listing of control limits. Project, QAPP, or client-specific control limits may supersede the limits listed. If the control limits are exceeded, the samples will be re-digested and reanalyzed, unless matrix interference or sample non-homogeneity is established as cause. In these instances, the data and the report will be flagged accordingly.

12.12 A Matrix Spike sample is digested one per batch, or per 20 samples (i.e. 5%). Default spike concentrations are listed in the sample digestion SOPs. Spike concentrations may be adjusted to meet project requirements. The matrix spike recovery will be calculated while the job is in progress. Where specified by project requirements, a matrix spike duplicate may be required. Matrix spike recovery criteria are derived from lab data and are listed in Table 2. For method 6020A, the recovery limits are 75-125%. If statistical in-house limits are used, they must fall within the 75-125% range. In some cases, project-specific QC limits may be required. Unless specified otherwise, for DoD QSM projects the project LCS criteria will be used for evaluation of matrix spikes. If an analyte recovery is outside acceptance limits proceed with the additional quality control tests described in sections 12.13 and 12.14. Based on results of these tests, the physical nature of the sample (e.g. homogeneity), and any specific project requirements, a determination can then be made as to appropriate corrective action (e.g. re-digestion, reporting with a qualifier, alternative methodologies, etc.). If the analyte concentration is >4x the spike level the spike control limit is no longer applicable and no action is required. For specifics on the preparation and composition of matrix spike solutions refer to the appropriate digestion SOP.

Note: For DOD projects a MS/MSD is required with every extraction batch. The %RSD should be < 20%.

12.13 Post Digestion Spike Test: When analysis is conducted via 6020 a post digestion spike must be performed for each matrix and each batch of sample. The prepared sample or its dilution is spiked for each element of interest at a concentration sufficiently high to be observed. Typically 20 µL of 10,000 ppb intermediate stock is added to a 10 mL aliquot of sample. If analyte concentrations are elevated in the sample, spiking at a higher concentration may be required. The post spike should be recovered to within 75-125% of the known value or within the laboratory derived acceptance criteria. When analysis is conducted via 6020A, the post digestion spike test is performed whenever matrix spike or replicate criteria are exceeded. An analyte spike is added to a portion of a prepared sample, or its dilution, and should be recovered to within 80% to 120% of the known value. If this spike fails, then the dilution test (Sec. 12.14) should be run on this sample. If both the matrix spike and the post digestion spike fail, then matrix effects are confirmed.

12.14 Dilution Test: When analysis is conducted via 6020, a serial dilution test must be performed for each matrix and each batch of sample. For sample concentrations that are sufficiently

high (minimally, a factor of greater than 100 times the MDL), the analysis of a fivefold (1+4) dilution must agree within ± 10% of the original determination. When analysis is conducted via 6020A, the dilution test is performed whenever matrix spike or replicate criteria and post digestion spike criteria are exceeded. If the dilution test fails then a chemical or physical effect should be suspected. Corrective action can include additional dilution of the sample, the use of alternate methodologies, etc. or the data can be flagged and reported. The exact course of action will be dependent on the nature of the samples and project requirements and should be discussed with the project manager.

12.15 Instrument blanks should be evaluated for potential carryover and rinse times need to bring the analyte signal to within the CCB criteria discussed above in section 12.6.2. Results from instrument blanks run after standards or control samples should be used to establish levels at which carryover in samples may occur. Samples exhibiting similar effects of carryover should be reanalyzed.

12.16 Refer to the Quality Control section of EPA Methods 6020 and 6020A for additional information describing required QA/QC. Note that the nomenclature of certain QC samples in the method differs from that of the CLP SOW, but the function of those samples is equivalent in both cases.

13 DATA REDUCTION, REPORTING, AND REVIEW

13.1 Calculations

Calculate sample results using the data system printouts and digestion information. the digestion and dilution information is entered into the data system. The data system then uses the calculations below to generate a sample result.

Aqueous samples are reported in µg/L:

$$\mu g / L\ (Sample) = C^{*} \text{ x Digestion Dilution Factor x Post Digestion Dilution Factor}$$

C*= Concentration of analyte as measured at the instrument in ug/L (in digestate).

Solid samples are reported in mg/Kg:

$$mg/Kg\ (Sample) = C^{*} \text{ x Post Digestion Dilution Factor } x \frac{Digestion\ Vol.(ml)}{Sample\ wt.(g)} x \frac{1mg}{1000ug} x \frac{1L}{1000ml} x \frac{1000g}{1Kg}$$

C*= Concentration of analyte as measured at the instrument in ug/L (in digestate).

NOTE: If results are to be reported on a dry weight basis, determine the dry weight of a separate aliquot of the sample, using the SOP for Total Solids.

13.2 Common isobaric interferences are corrected using equations equivalent to those listed in EPA Methods 6020, 6020A, and 200.8. Monitoring of multiple isotopes for a single element provides a mechanism for identifying isobaric interferences. Refer to the Interferences section of EPA methods for additional descriptions of possible interferences and the mechanisms required for adequately compensating for their effects.

13.3 Data Review and Reporting

13.3.1 The ICP-MS operator reviews the MS data and signs and dates the Data Review Form. A qualified senior staff spectroscopist performs a secondary review of the data and the Data Review Form is signed and dated. The data is then delivered to the report generation area where it is filed in the service request file. Once all of the data for the service request is complete, a CAR is generated.

13.3.2 The data is saved on the local hard drive and is also copied to the appropriate directory on the network. The data directories are located at r:\icp\wip\data. The data is kept on the local directory for 1 month. The network files are periodically backed up on disc or network tape.

13.3.3 For "non-production" work (such as method development or research/development studies) the analyses are performed under the direction of a senior spectroscopist. All associated data is scrutinized by the senior spectroscopist. Original raw data and associated records are archived in the analytical project file.

13.3.4 The final review and approval of all data is performed by qualified spectroscopists.

14 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

14.1 Refer to the SOP for *Non Conformance and Corrective Action (CE-QA008)* for procedures for corrective action. Personnel at all levels and positions in the laboratory are to be alert to identifying problems and nonconformities when errors, deficiencies, or out-of-control situations are detected.

14.2 Handling out-of-control or unacceptable data

14.2.1 On-the-spot corrective actions that are routinely made by analysts and result in acceptable analyses should be documented as normal operating procedures, and no specific documentation need be made other than notations in laboratory maintenance logbooks, runlogs, for example.

14.2.2 Some examples when documentation of a nonconformity is required using a Nonconformity and Corrective Action Report (NCAR):

- Quality control results outside acceptance limits for accuracy and precision
- Method blanks or continuing calibration blanks (CCBs) with target analytes above acceptable levels
- Sample holding time missed due to laboratory error or operations
- Deviations from SOPs or project requirements
- Laboratory analysis errors impacting sample or QC results
- Miscellaneous laboratory errors (spilled sample, incorrect spiking, etc)
- Sample preservation or handling discrepancies due to laboratory or operations error

15 METHOD PERFORMANCE

15.1 This method was validated through single laboratory studies of accuracy and precision. Refer to the reference method for additional available method performance data.

The method detection limit (MDL), limit of detection (LOD) and limit of quantitation (LOQ) are established using procedures described in CE-QA011, *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantification.* Method Reporting Limits are established for this method based on MDL studies and as specified in the ALS, Kelso Quality Assurance Manual.

16 TRAINING

16.1 A minimum of two senior level spectroscopists are to be maintained on staff at all times. Senior spectroscopists are defined as individuals with a minimum of ten years combined education and experience in, or related to atomic spectroscopy. Of those ten years, a minimum of two years of ICP-MS experience is required.

16.2 All technical staff is encouraged to attend one technical seminar per year. In addition to the technical seminars, senior spectroscopists are required to complete a one week training session offered by the instrument manufacturer.

16.3 Training outline

16.3.1 Review literature (see references section). Read and understand the SOP. Also review the applicable MSDS for all reagents and standards used. Following these reviews, observe the procedure as performed by an experienced analyst at least three times.

16.3.2 The next training step is to assist in the procedure under the guidance of an experienced analyst. During this period, the analyst is expected to transition from a role of assisting, to performing the procedure with minimal oversight from an experienced analyst.

16.3.3 Perform initial precision and recovery (IPR) study as described above for water samples. Summaries of the IPR are reviewed and signed by the supervisor. Copies may be forwarded to the employee's training file. For applicable tests, IPR studies should be performed in order to be equivalent to NELAC's Initial Demonstration of Capability.

16.4 Training and proficiency is documented in accordance with the SOP ADM-TRANDOC.

17 POLLUTION PREVENTION AND WASTE MANAGEMENT

17.1 It is the laboratory's practice to minimize the amount of solvents, acids, and reagents used to perform this method wherever feasibly possible. Standards are prepared in volumes consistent with methodology and only the amount needed for routine laboratory use is kept on site. The threat to the environment from solvents and/or reagents used in this method can be minimized when recycled or disposed of properly.

17.2 The laboratory will comply with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the ALS Environmental Health and Safety Manual.

18 METHOD MODIFICATIONS

18.1 There are no known modifications in this laboratory standard operating procedure from the reference method.

19 CHANGES SINCE THE LAST REVISION

19.1 Reformatted to ALS branding.
19.2 Replaced "CAS" references with "ALS".
19.3 Updated SOP references.
19.4 Sec. 1.1: Removed reference to annual studies, replaced with "new".
19.5 Sec. 7.1: Added NexION 300D.
19.6 Sec 8.2.7.1: Removed Ba and Tl from the intermediate solution; added Ce.
19.7 Sec 8.2.7.2: Added NexION working solution prep.
19.8 Sec. 8.3.2.1: Revised ICV int. stock sol. prep instructions.
19.9 Sec. 8.2.7.1/2: Updated solution prep instructions.
19.10 Sec. 12.8: Added description of NexION IS correction.
19.11 Sec. 18: New.

20 REFERENCES

20.1 USEPA, Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Update III Method 6020, Revision 0, September 1994.

20.2 USEPA, Test Methods for Evaluating Solid Waste, SW-846, Update IV, Method 6020A, Revision 1, February 2007.

20.3 VG and Thermo Elemental Instrument Manuals

TABLE 1
Method Reporting Limits and Method Detection Limits – Water Matrix

	Water (ug/L)			Water (ug/L)			Seawater (ug/L)		
	CLP Digestion			3020 Digestion			Reductive Precipitation		
Analyte	MRL (DoD)	**MRL**	**MDL**	MRL (DoD)	**MRL**	**MDL**	MRL (DoD)	**MRL**	**MDL**
Aluminum	2	**2**	**0.3**	2.4	**2**	**0.8**	–	**–**	**–**
Antimony	0.09	**0.05**	**0.03**	0.09	**0.05**	**0.03**	–	**–**	**–**
Arsenic	0.5	**0.5**	**0.08**	0.5	**0.5**	**0.07**	0.5	**0.5**	**0.02**
Barium	0.06	**0.05**	**0.02**	0.12	**0.05**	**0.04**			
Beryllium	0.02	**0.02**	**0.008**	0.02	**0.02**	**0.006**	0.02	**0.02**	**0.0007**
Bismuth	0.1	**0.1**	**0.02**	–	**–**	**–**	–	**–**	**–**
Boron	0.9	**0.5**	**0.3**	–	**–**	**–**	–	**–**	**–**
Cadmium	0.02	**0.02**	**0.008**	0.06	**0.02**	**0.02**	0.02	**0.02**	**0.006**
Chromium	0.2	**0.2**	**0.07**	0.2	**0.2**	**0.05**	0.2	**0.2**	**0.03**
Cobalt	0.02	**0.02**	**0.005**	0.02	**0.02**	**0.005**	0.02	**0.02**	**0.001**
Copper	0.1	**0.1**	**0.02**	0.21	**0.1**	**0.07**	0.1	**0.1**	**0.03**
Lead	0.03	**0.02**	**0.009**	0.06	**0.05**	**0.02**	0.02	**0.02**	**0.003**
Manganese	0.06	**0.05**	**0.02**	0.05	**0.05**	**0.01**	–	**–**	**–**
Molybdenum	0.09	**0.05**	**0.03**	0.09	**0.05**	**0.03**	–	**–**	**–**
Nickel	0.2	**0.2**	**0.07**	0.2	**0.2**	**0.05**	0.2	**0.2**	**0.03**
Selenium	1.2	**1**	**0.4**	1	**1**	**0.2**	–	**–**	**–**
Silver	0.03	**0.02**	**0.009**	0.03	**0.02**	**0.009**	0.02	**0.02**	**0.004**
Thallium	0.02	**0.02**	**0.003**	0.02	**0.02**	**0.004**	0.02	**0.02**	**0.0009**
Tin	0.1	**0.1**	**0.04**	–	**–**	**–**	–	**–**	**–**
Uranium	0.02	**0.02**	**0.005**	0.02	**0.02**	**0.004**	–	**–**	**–**
Vanadium	0.2	**0.2**	**0.08**	0.2	**0.2**	**0.05**	–	**–**	**–**
Zinc	0.5	**0.5**	**0.1**	0.6	**0.5**	**0.2**	0.5	**0.5**	**0.04**

TABLE 1 (continued)
Method Reporting Limits and Method Detection Limits – Solid Matrix

	Soil/Sediment (mg/kg)			Tissue (mg/kg, dry basis)		
	3050 Digestion			PSEP		
Analyte	MRL (DoD)	**MRL**	**MDL**	MRL (DoD)	**MRL**	**MDL**
Aluminum	2	**2**	**0.5**	2	**2**	**0.4**
Antimony	0.09	**0.05**	**0.03**	0.06	**0.05**	**0.02**
Arsenic	0.5	**0.5**	**0.1**	0.5	**0.5**	**0.05**
Barium	0.09	**0.05**	**0.03**	0.15	**0.05**	**0.05**
Beryllium	0.06	**0.02**	**0.02**	0.02	**0.02**	**0.005**
Bismuth	0.1	**0.1**	**0.02**	–	–	–
Cadmium	0.02	**0.02**	**0.008**	0.03	**0.02**	**0.01**
Chromium	0.2	**0.2**	**0.04**	–	–	–
Cobalt	0.02	**0.02**	**0.003**	0.02	**0.02**	**0.006**
Copper	0.3	**0.1**	**0.1**	0.1	**0.1**	**0.03**
Lead	0.06	**0.05**	**0.02**	0.02	**0.02**	**0.006**
Manganese	0.12	**0.05**	**0.04**	0.06	**0.05**	**0.02**
Molybdenum	0.15	**0.05**	**0.05**	0.06	**0.05**	**0.02**
Nickel	0.2	**0.2**	**0.05**	0.2	**0.2**	**0.03**
Selenium	2	**1**	**0.4**	–	–	–
Silver	0.06	**0.02**	**0.02**	0.02	**0.02**	**0.006**
Thallium	0.02	**0.02**	**0.003**	0.02	**0.02**	**0.005**
Tin	0.2	**0.1**	**0.06**	–	–	–
Uranium	0.02	**0.02**	**0.004**	0.02	**0.02**	**0.007**
Vanadium	0.2	**0.2**	**0.04**	0.2	**0.2**	**0.04**
Zinc	0.6	**0.5**	**0.2**	1.2	**0.5**	**0.4**

ATTACHMENTS

List of Target Element Masses

Example Standard Sheet

QC Acceptance Criteria

Analyte	ISOTOPES ANALYZED	ISOTOPE REPORTED
Aluminum	27	27
Antimony	121,123	123
Arsenic	75	75
Barium	135,137,138	137
Beryllium	9	9
Cadmium	111,112,114	111
Chromium	52,53	52
Cobalt	59	59
Copper	63,65	65
Lead	206,207,208	208
Manganese	55	55
Molybdenum	95,97,98	98
Nickel	60,61,62	60
Selenium	77,78,82	82
Silver	107,109	107
Thallium	203,205	205
Uranium	238	238
Vanadium	51	51
Zinc	66,67,68	66

SOLUTION: ICP-MS, 200.8 INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml		CONCENTRATION (µg/L)
	HNO3			50.0 ml.		5%
	Al			1.0 ml.		1000
	Sb			1.0 ml.		1000
	As			1.0 ml.		1000
	Ba			1.0 ml.		1000
	Be			1.0 ml.		1000
	Cd			1.0 ml.		1000
	Cr			1.0 ml.		1000
	Co			1.0 ml.		1000
	Cu			1.0 ml.		1000
	Pb			1.0 ml.		1000
	Mn			1.0 ml.		1000
	Mo			1.0 ml.		1000
	Ni			1.0 ml.		1000
	Se			1.0 ml.		1000
	Tl			1.0 ml.		1000
	V			1.0 ml.		1000
	U			1.0 ml.		1000
	Zn			1.0 ml.		1000

SOLUTION: ICP-MS, 200.8 SILVER INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml	CHECK OFF	CONCENTRATION (µg/L)
	HNO3			50.0		5%
	Ag			1.0		1000

SOLUTION: ICP-MS 25ppb Calibration Standard and CCV
MATRIX: 1% HNO3
VOLUME: 100 ml.

SOURCE	ALIQUOT PER 100 ml.		CONCENTRATION (µg/L)
HNO3 (Ultrex)	1.0		1%
INTERMEDIATE STOCK	2.5		25.0
SILVER INTERMEDIATE STOCK	2.5		25.0

SOLUTION: ICP-MS, 200.8 INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml		CONCENTRATION (µg/L)
	HNO3			50.0 ml.		5%
	Al			1.0 ml.		1000
	Sb			1.0 ml.		1000
	As			1.0 ml.		1000
	Ba			1.0 ml.		1000
	Be			1.0 ml.		1000
	Cd			1.0 ml.		1000
	Cr			1.0 ml.		1000
	Co			1.0 ml.		1000
	Cu			1.0 ml.		1000
	Pb			1.0 ml.		1000
	Mn			1.0 ml.		1000
	Mo			1.0 ml.		1000
	Ni			1.0 ml.		1000
	Se			1.0 ml.		1000
	Tl			1.0 ml.		1000
	V			1.0 ml.		1000
	U			1.0 ml.		1000
	Zn			1.0 ml.		1000

SOLUTION: ICP-MS, 200.8 SILVER INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml	CHECK OFF	CONCENTRATION (µg/L)
	HNO3			50.0		5%
	Ag			1.0		1000

SOLUTION: ICP-MS 25ppb Calibration Standard and CCV
MATRIX: 1% HNO3
VOLUME: 100 ml.

SOURCE	ALIQUOT PER 100 ml.		CONCENTRATION (µg/L)
HNO3 (Ultrex)	1.0		1%
INTERMEDIATE STOCK	2.5		25.0
SILVER INTERMEDIATE STOCK	2.5		25.0

SOLUTION: ICP-MS, 200.8 INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml		CONCENTRATION (µg/L)
	HNO3			50.0 ml.		5%
	Al			1.0 ml.		1000
	Sb			1.0 ml.		1000
	As			1.0 ml.		1000
	Ba			1.0 ml.		1000
	Be			1.0 ml.		1000
	Cd			1.0 ml.		1000
	Cr			1.0 ml.		1000
	Co			1.0 ml.		1000
	Cu			1.0 ml.		1000
	Pb			1.0 ml.		1000
	Mn			1.0 ml.		1000
	Mo			1.0 ml.		1000
	Ni			1.0 ml.		1000
	Se			1.0 ml.		1000
	Tl			1.0 ml.		1000
	V			1.0 ml.		1000
	U			1.0 ml.		1000
	Zn			1.0 ml.		1000

SOLUTION: ICP-MS, 200.8 SILVER INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml	CHECK OFF	CONCENTRATION (µg/L)
	HNO3			50.0		5%
	Ag			1.0		1000

SOLUTION: ICP-MS 25ppb Calibration Standard and CCV
MATRIX: 1% HNO3
VOLUME: 100 ml.

SOURCE	ALIQUOT PER 100 ml.		CONCENTRATION (µg/L)
HNO3 (Ultrex)	1.0		1%
INTERMEDIATE STOCK	2.5		25.0
SILVER INTERMEDIATE STOCK	2.5		25.0

SOLUTION: ICP-MS, 200.8 INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml		CONCENTRATION (µg/L)
	HNO3			50.0 ml.		5%
	Al			1.0 ml.		1000
	Sb			1.0 ml.		1000
	As			1.0 ml.		1000
	Ba			1.0 ml.		1000
	Be			1.0 ml.		1000
	Cd			1.0 ml.		1000
	Cr			1.0 ml.		1000
	Co			1.0 ml.		1000
	Cu			1.0 ml.		1000
	Pb			1.0 ml.		1000
	Mn			1.0 ml.		1000
	Mo			1.0 ml.		1000
	Ni			1.0 ml.		1000
	Se			1.0 ml.		1000
	Tl			1.0 ml.		1000
	V			1.0 ml.		1000
	U			1.0 ml.		1000
	Zn			1.0 ml.		1000

SOLUTION: ICP-MS, 200.8 SILVER INTERMEDIATE STOCK
MATRIX: 5% HNO3
VOLUME: 1000 ml.

	ELEMENT			ALIQUOT OF 1000 ppm Std./1000ml	CHECK OFF	CONCENTRATION (µg/L)
	HNO3			50.0		5%
	Ag			1.0		1000

SOLUTION: ICP-MS 25ppb Calibration Standard and CCV
MATRIX: 1% HNO3
VOLUME: 100 ml.

SOURCE	ALIQUOT PER 100 ml.		CONCENTRATION (µg/L)
HNO3 (Ultrex)	1.0		1%
INTERMEDIATE STOCK	2.5		25.0
SILVER INTERMEDIATE STOCK	2.5		25.0

METALS ANALYSES						
Method	Prep Method	Matrix	Analyte	LCS Accuracy (% Rec.)	Matrix Spike (% Rec.)	Precision (RPD)
6020	3050B	Soil	Aluminum	41-158	75-125*	20
6020	3050B	Soil	Antimony	50-150	10-103	20
6020	3050B	Soil	Arsenic	78-122	57-133	20
6020	3050B	Soil	Barium	81-119	54-173	20
6020	3050B	Soil	Beryllium	83-117	64-133	20
6020	3050B	Soil	Boron	67-133	75-125*	20
6020	3050B	Soil	Cadmium	81-119	68-137	20
6020	3050B	Soil	Chromium	80-119	34-175	20
6020	3050B	Soil	Cobalt	82-118	74-118	20
6020	3050B	Soil	Copper	83-116	22-181	20
6020	3050B	Soil	Lead	79-121	27-178	20
6020	3050B	Soil	Manganese	81-119	75-125*	20
6020	3050B	Soil	Molybdenum	75-125	53-143	20
6020	3050B	Soil	Nickel	81-118	59-132	20
6020	3050B	Soil	Selenium	80-120	65-125	20
6020	3050B	Soil	Silver	66-134	62-131	20
6020	3050B	Soil	Thallium	79-120	70-128	20
6020	3050B	Soil	Uranium	80-120*	75-125*	20
6020	3050B	Soil	Vanadium	79-121	59-142	20
6020	3050B	Soil	Zinc	73-121	37-162	20
6020	CLP/3020A	Water	Aluminum	85-120	56-143	20
6020	CLP/3020A	Water	Antimony	91-112	66-133	20
6020	CLP/3020A	Water	Arsenic	89-112	72-129	20
6020	CLP/3020A	Water	Barium	92-111	86-117	20
6020	CLP/3020A	Water	Beryllium	81-122	73-125	20
6020	CLP/3020A	Water	Cadmium	92-111	87-113	20
6020	CLP/3020A	Water	Chromium	88-113	60-136	20
6020	CLP/3020A	Water	Cobalt	87-114	84-115	20
6020	CLP/3020A	Water	Copper	89-113	62-130	20
6020	CLP/3020A	Water	Lead	90-112	76-117	20
6020	CLP/3020A	Water	Manganese	89-115	25-180	20
6020	CLP/3020A	Water	Molybdenum	66-135	67-138	20
6020	CLP/3020A	Water	Nickel	89-113	78-117	20
6020	CLP/3020A	Water	Selenium	87-115	47-150	20
6020	CLP/3020A	Water	Silver	64-134	55-136	20
6020	CLP/3020A	Water	Thallium	78-123	75-121	20
6020	CLP/3020A	Water	Vanadium	87-113	82-119	20
6020	CLP/3020A	Water	Zinc	86-119	65-126	20

BIOACCESSIBILITY OF METALS IN SOIL AND SOLID WASTE

MET-BIOACC

ALS-KELSO

SOP ID:	MET-BIOACC	Rev. Number:	1	Effective Date:	07/31/2013

Approved By: _____ Date: 7/16/13
Department Supervisor - Jeff Coronado

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Issue Date:	_____	Doc Control ID#:	_____	Issued To:	_____

Standard Operating Procedure

for

BIOACCESSIBILITY OF METALS IN SOIL AND SOLID WASTE

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the procedure used to determine a bioaccessibility value for Arsenic and/or Lead for soils and solid waste. This procedure describes the extraction procedure and calculations. The determinative analytical procedures are described in detail in separate SOPs.

1. METHOD SUMMARY

A soil or solid waste sample is dried and sieved to achieve a homogeneous sample. An aliquot of this homogenized sample is extracted at constant temperature for one hour then filtered to produce a final "in-vitro" aqueous extract. This extract is then analyzed for Arsenic and/or Lead by various instrumental techniques depending on target method reporting limit (MRL) and detection limit requirements. The result of the in-vitro analysis are used in conjunction with separate total metals results to calculate a bioaccessibility value.

2. DEFINITIONS

2.1. **Duplicate Sample** (DUP) – A laboratory duplicate. The duplicate sample is a separate field sample aliquot that is processed in an identical manner as the sample proper. The relative percent difference between the samples is calculated and used to assess analytical precision.

2.2. **Laboratory Control Sample** – An analyte-free matrix to which a known quantity of analytes are added. The LCS is subjected to the same processing as field samples and is carried through the entire analytical process. The percent recovery of the analyte in the LCS is used to assess analysis performance in terms of accuracy.

2.3. **Method Blank** – The method blank is a blank matrix designed to monitor introduction of artifacts into the process. The method blank is carried through the entire analytical procedure.

2.4. **Post-Extraction Matrix Spike** – A known amount of Arsenic and/or Lead added to an aliquot of final extract to demonstrate the analytical method is free from interference in the extraction matrix.

2.5. **Reagent Blank** – Extraction solution analyzed once per batch.

3. INTERFERENCES

3.1. When obtaining subsamples it is important to minimize any chances for sample contamination or cross-contamination between samples. Work should be performed in

an organized and neat manner. Equipment and laboratory tools used with samples should be cleaned between samples to prevent cross-contamination.

3.2. Analysis-specific interferences are described in the applicable analytical SOP.

4. SAFETY

4.1. All appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personnel protective equipment, such as, safety glasses, lab coat and the correct gloves.

4.2. Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental Health and Safety Manual and the appropriate MSDS prior to beginning this method.

4.3. Hydrochloric is used in this method. This acid is extremely corrosive and care must be taken while handling them. A face shield should be used while pouring acids and safety glasses should be worn while working with the solutions. Lab coat and gloves should always be worn while working with these solutions.

5. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

5.1. ALS laboratory staff does not collect samples. Samples are collected by field sampling staff of ALS customers using their sampling plans and procedures.

5.2. Samples may be collected in plastic or glass jars, typically 2 ounce (although larger jars may be used). Samples are refrigerated at 4 ± 2°C from receipt until analysis. Samples should be analyzed within 6 months of sampling.

6. APPARATUS AND EQUIPMENT

6.1. Aluminum drying pans

6.2. Laboratory drying oven

6.3. 60 mL Syringe – Luer-Lok (VWR # BD309653 or equivalent)

6.4. Syringe Filters – Millipore Millex-HV Hydrophilic PVDF 0.45 µm (VWR # SLHV025NK or equivalent)

6.5. pH Meter – Orion model 230A or equivalent

6.6. pH Probe – Thermo Combination pH Probe (part # 9256BN)

6.7. Modified Toxicity Characteristic Leaching Procedure (TCLP) extractor – TCLP extraction unit with tumbler assembly enclosed by oven capable of maintaining 37°C. Modified TCLP extractor located in room 108.

6.8. Water bath, capable of maintaining 37 ± 2°C

6.9. HDPE bottles, 125 mL

6.10. Evergreen disposable tubes, 50 mL. Check tubes for accuracy on a per batch basis by filling a tube to the 50 mL mark and measuring the water's mass. The measured mass must be accurate to ±3%; if not, obtain a new lot of tubes and retest. Pipettors: All-plastic pneumatic fixed-volume and variable pipettors in the range of 20 uL to 1.0 mL.

6.11. Top-loader laboratory balance capable of weighing to the nearest 0.01 g

7. STANDARDS, REAGENTS AND CONSUMABLE MATERIALS

7.1. Document all reagent and acid preparation information in a logbook, including acids and acid mixtures. Label all reagents and acids/mixtures with appropriate identification,, tracking , and expiration date information.

7.2. Reagent water: ASTM Type II deionized (DI) water

7.3. Hydrochloric Acid (12N) – EMD ACS Grade (HX0603-75)

7.4. 2.0 pH Buffer – VWR BDH5010-500mL

7.5. 4.0 pH Buffer – VWR BDH0198-2.0L

7.6. Glycine (Crystalline Granules) – J.T. Baker, Pharmaceutical Grade (0581-01)

7.7. Extraction Solution – To 1.9 L of reagent water add 60.06 g of Glycine. Place the mixture in a water bath at 37°C at allow to come to equilibrium. Standardize the pH meter using 2.0 and 4.0 pH standards which have also been brought to 37°C in the water bath. Add hydrochloric acid until the extraction solution reaches a pH of 1.50 ± 0.05. Bring the solution to a final volume of 2.0 L with reagent water.

7.8. QC Spiking solutions – Since the determinative methodology may vary, refer to the applicable determinative SOP for preparation of spiking solutions.

8. PREVENTIVE MAINTENANCE

Maintenance for this procedure is generally limited to glassware cleaning, pipet monitoring, and tumbler monitoring. Procedures for glassware washing are described in the SOP for Metals Laboratory Glassware Cleaning (MET-GC).

9. RESPONSIBILITIES

9.1. It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

9.2. It is the responsibility of the department supervisor/manager to document analyst training and method proficiency.

10. PROCEDURE

10.1. Sample Preparation

10.1.1. Record all sample preparation and sample information on the applicable bench sheet. This includes acid mixture tracking documentation.

10.1.2. Using a spatula or other utensil, thoroughly mix and homogenize the sample, making sure to mix the entire contents of the jar. Additional steps may be needed to homogenize the sample (break up soil clumps, etc.). The sample should be mixed so there is a uniform color and texture. Since the entire jar is used, do not remove any extraneous material (this will be removed by sieving).

10.1.3. Transfer the entire mixed contents of the sample jar to an aluminum drying pan. Dry the sample in a drying oven at a temperature <40°C. The dried sample is then sieved to <250 µm. All subsequent analysis are performed on the <250 µm fraction.

10.1.4. The <250 µm sample is mixed thoroughly and placed in an appropriate sized glass jar. Subsamples are taken from this homogenized sample with a spatula or other utensil for analysis.

10.2. Leaching Procedure

10.2.1. Pre-heat the modified TCLP extractor to 37 ± 2 °C.

10.2.2. Weigh 1.00 ± 0.05 g of sample and quantitatively transfer to a 125 mL HPDE bottle. Next add 100 ± 0.5 mL of extraction solution (pre-heated to 37°C) to the bottle. Hand-tighten the cap, shake and invert to ensure there is no leakage and that no sample remains caked on the bottom of the bottle.

10.2.3. Open the door allowing access to the extractor oven then quickly place the bottles (field samples and all associated QC samples) on the tumbler and reseal the oven. Allow the temperature to return to equilibrium in the oven (usually 2 to 3 minutes) and begin the extraction.

10.2.4. Rotate the tumbler end over end at 30 ± 2 rpm for 1 hour. Record the start time of the rotation.

10.2.5. When the extraction is complete remove the bottles and arrange them on a bench top. Transfer 25-30 mL of extract to a 60 mL syringe and filter through a 0.45 µm disk filter. Capture the filtrate in 50 mL polypropylene centrifuge tubes and cap tightly. Store the filtered extracts in a refrigerator at 4 ± 2°C until they are analyzed.

10.2.6. The time each sample is filtered, and the extraction stopped, must be recorded. The elapsed time of the extraction cannot exceed 1 hour and 30 minutes. Any samples with extraction times greater than this must be re-extracted.

10.2.7. Measure the pH of the sample remaining in the extraction bottle. Standardize the pH meter using 2.0 and 4.0 pH standards which have also been brought to 37°C in the water bath. Rinse and blot electrode, then immerse into the sample. Press pH and record the pH when stabilized. Remove the electrode from samples after each measurement and rinse 3 times with D.I. water.

10.2.8. If the pH is not within ± 0.5 pH units of the starting pH then the extract must be discarded and reanalyzed using the procedure below.

10.2.8.1. Scenario 1: If the pH has dropped by more than 0.5 pH units repeat the test exactly as before. If the pH has dropped by more that 0.5 pH units again, record the pH and proceed with the analysis of the extract.

10.2.8.2. Scenario 2: If the pH has risen more than 0.5 pH units the extraction is repeated, however the extractor is stopped at 5, 10, 15, and 30 minutes and the pH adjusted down to 1.5 with dropwise additions of HCl. The pH is also adjusted upon final removal from the extractor (i.e. at 60 minutes). Note: Samples with rising pH cannot be extracted concurrently with sample being extracted with the standard procedure.

Note: All pH measurements indicated above are made by first calibrating the pH meter using 2.0 and 4.0 pH standards that have be equilibrated to 37°C in a water bath. The pH probe is acid then DI rinsed prior to making measurements is extracts and is subsequently acid then DI rinsed between samples to prevent any cross contamination.

10.3. Analysis

10.3.1. Extracts are analyzed for Arsenic and/or Lead by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES), Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS), or Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) following SW-846 methodologies. Details of the instrumental analysis are described in SOPs for the specific analytical procedure and are outside the scope of this document.

11. QA/QC REQUIREMENTS

11.1. Initial Precision and Recovery Validation

The accuracy and precision of the procedure must be validated before analysis of samples begins. To do this, four LCS aliquots are prepared and analyzed. The average percent recovery of for each analyte must be 85-115% and the RSD <20%.

11.2. Method Detection Limits

11.2.1. A method detection limit (MDL) study must be undertaken before analysis of samples can begin. To establish detection limits that are precise and accurate, the analyst must perform the following procedure. Spike a minimum of seven blank matrices at a level near or below the instrument limit of quantitation. Follow the procedures starting in Section 11 to analyze the samples. Refer to

CE-QA011, *Determination of Method Detection Limits and Limits of Detection* for details of performing the MDL study.

11.2.2. Calculate the average concentration found (x) and the standard deviation of the concentrations for each analyte. Calculate the MDL for each analyte using the correct T value for the number of replicates. MDL's must be performed annually.

11.3. General ongoing QC Samples required for each sample batch (20 or fewer samples) are described in the ALS-Kelso Quality Assurance Manual and in the SOP for Sample Batches. QC samples for the in vitro extraction must include the following:

11.3.1. Reagent Blank - Extraction solution analyzed once per batch. Ideally no target analytes should be detected in the reagent blank, but any detections must be <½ the MRL.

11.3.2. A method blank (bottle blank) is analyzed once per batch. A 100 mL aliquot of extraction solution is carried through the entire extraction procedure. The concentration found in the method blank must be less than the MRL for non-DoD projects and < ½ the MRL for DoD projects.

11.3.3. A Laboratory Control Sample (LCS) is analyzed once per batch using an aliquot of the extraction solution spiked at 1.0 mg/L for Arsenic and/or 10 mg/L for Lead using traceable 1000 mg/L stock solutions. Recovery for the LCS must fall between 85-115%.

11.3.4. A duplicate sample is performed at a frequency of 1 for every 10 samples. The duplicate analysis is evaluated against a control limit of ± 20% RPD.

11.3.5. A post-extraction matrix spike is analyzed once per batch. A known amount of Arsenic and/or Lead added to an aliquot of final extract to demonstrate the analytical method is free from interference in the extraction matrix. The spike concentration should be 1-5 times the native level found in the extract. The post-extraction matrix spike analysis is evaluated against a control limit of 75-125% recovery.

12. DATA REDUCTION, REVIEW, AND REPORTING

12.1. It is the analyst's responsibility to review analytical data to ensure that all quality control requirements have been met for each analytical run. Results for QC analyses are calculated and recorded as specified in section 12.

12.2. Calculations

12.2.1. Total Arsenic and/or Lead must also be determined for each sample subjected to this procedure. An additional aliquot of the homogenized <250 µm sample is digested via EPA method 3050B and analyzed by ICP, ICP-MS, or GFAA. Again, the details of the instrumental analysis are described in SOPs for the specific analytical procedure.

12.2.2. The bioaccessibility of Arsenic or Lead is calculated as follows:

$$Bioaccessibility\ value = \frac{(Concentration\ in\ in-vitro\ extract, mg/L)\ (0.1L)}{(Concentration\ in\ solid\ sample, mg/Kg)(0.001Kg)} \times 100$$

12.3. The data packet for the sequence is submitted for review by supervisor or designee. The results are transferred to the appropriate report form located in the ALS network directory R:\ICP\WIP. Once the results are transferred, the report is reviewed.

12.4. Refer to the *SOP for Laboratory Data Review Process* for general instructions for data review.

13. METHOD PERFORMANCE

13.1. This method will be validated through single laboratory studies of accuracy and precision.

13.2. The method detection limit (MDL) is established for the determinative methods using the procedure described in CE-QA011, *Determination of Method Detection Limits and Limits of Detection*.

14. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

14.1. Refer to the SOP for *Non Conformance and Corrective Action (CE-QA008)* for procedures for corrective action. Personnel at all levels and positions in the laboratory are to be alert to identifying problems and nonconformities when errors, deficiencies, or out-of-control situations are detected.

14.2. Handling out-of-control or unacceptable data

14.2.1. On-the-spot corrective actions that are routinely made by analysts and result in acceptable analyses should be documented as normal operating procedures, and no specific documentation need be made other than notations in laboratory maintenance logbooks, runlogs, for example.

14.2.2. Some examples when documentation of a nonconformity is required using a Nonconformity and Corrective Action Report (NCAR):

- Quality control results outside acceptance limits for accuracy and precision
- Method blanks or continuing calibration blanks (CCBs) with target analytes above acceptable levels
- Sample holding time missed due to laboratory error or operations
- Deviations from SOPs or project requirements
- Laboratory analysis errors impacting sample or QC results
- Miscellaneous laboratory errors (spilled sample, incorrect spiking, etc)
- Sample preservation or handling discrepancies due to laboratory or operations error

15. POLLUTION PREVENTION AND WASTE MANAGEMENT

15.1. It is the laboratory's practice to minimize the amount of solvents, acids, and reagents used to perform this method wherever feasibly possible. Standards are prepared in volumes consistent with methodology and only the amount needed for routine laboratory use is kept on site. The threat to the environment from solvents and/or reagents used in this method can be minimized when recycled or disposed of properly.

15.2. The laboratory will comply with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the ALS Environmental Health and Safety Manual.

15.3. This method uses acid. Waste acid is hazardous to the sewer system and to the environment. All acid waste must be neutralized to a pH of 2.5-12 prior to disposal down the drain. The neutralization step is considered hazardous waste treatment and must be documented on the treatment by generator record. See the ALS EH&S Manual for details.

16. TRAINING

16.1. Refer to ADM-TRAIN, *ALS-Kelso Training Procedure* for standard procedures.

16.2. Training outline

16.2.1. Review literature (see references section). Read and understand the SOP. Also review the applicable MSDS for all reagents and standards used. Following these reviews, observe the procedure as performed by an experienced analyst at least three times.

16.2.2. The next training step is to assist in the procedure under the guidance of an experienced analyst. During this period, the analyst is expected to transition from a role of assisting, to performing the procedure with minimal oversight from an experienced analyst.

16.2.3. Perform initial precision and recovery (IPR) study by performing 4 replicate LCS analyses. Summaries of the IPR are reviewed and signed by the supervisor and forwarded to the employee's training file.

16.3. Training is documented following ADM-TRAIN, *ALS-Kelso Training Procedure*.

NOTE: When the analyst training is documented by the supervisor on internal training documentation forms, the supervisor is acknowledging that the analyst has read and understands this SOP and that adequate training has been given to the analyst to competently perform the analysis independently.

17. METHOD MODIFICATIONS

17.1. This section is not applicable because this procedure is a laboratory developed method.

18. REFERENCES

18.1. *In Vitro Method for Determination of Lead Bioaccessibility,* Solubility/Bioavailability Research Consortium Standard Operating Procedure, Revision 8.

19. CHANGES SINCE THE LAST REVISION

19.1. Reformatted SOP to ALS branding.
19.2. Replaced "CAS" references with "ALS".
19.3. Updated SOP references.
19.4. Sec. 17: New section.
19.5. Sec. 19: New section.
19.6. Added benchsheet as an attachment.

ATTACHMENT A
In Vitro Extraction Benchsheet
(1 page)

In Vitro Extraction

Sample ID	Sample Preparation		Extraction								Filtration	
	Weight (g)	Volume (mL)	Start Time	End Time	Elapsed Time (min)	Starting pH	Ending pH	ΔpH	Starting Temp. (°C)	Ending Temp. (°C)	Time	Time Elapsed from Extraction (min)
Acceptance Range	0.95-1.05	95.5-100.5	---	---	55-65	---	---	max = 0.5	35-39	35-39		max = 90

SRM = NIST 2711, Montana Soil Spike Solution = _____

Analyst:_____ Date:_____

Reviewer:_____ Date:_____

In Vitro Extraction

Sample ID	Sample Preparation		Extraction								Filtration	
	Weight (g)	Volume (mL)	Start Time	End Time	Elapsed Time (min)	Starting pH	Ending pH	ΔpH	Starting Temp. (°C)	Ending Temp. (°C)	Time	Time Elapsed from Extraction (min)
Acceptance Range	0.95-1.05	95.5-100.5	---	---	55-65	---	---	max = 0.5	35-39	35-39		max = 90

SRM = NIST 2711, Montana Soil Spike Solution = _____

Analyst:_____ Date:_____

Reviewer:_____ Date:_____

ALS Standard Operating Procedure

DOCUMENT TITLE:	METALS LABORATORY GLASSWARE CLEANING
REFERENCED METHOD:	N/A
SOP ID:	MET-GC
REVISION NUMBER:	5
EFFECTIVE DATE:	08/15/2014

METALS LABORATORY GLASSWARE CLEANING

ALS-KELSO

SOP ID:	MET-GC	Rev. Number:	5	Effective Date:	08/15/2014

Approved By: _____ Date: 8/8/14
Department Manager/Technical Director – Jeff Coronado

Approved By: _____ Date: 8-8-14
QA Manager – Lee Wolf

Approved By: _____ Date: 8/8/14
Laboratory Director – Jeff Grindstaff

Issue Date: _____ Doc Control ID#: _____ Issued To: _____

ANNUAL REVIEW

SIGNATURES BELOW INDICATE NO PROCEDURAL CHANGES HAVE BEEN MADE TO THE SOP SINCE THE APPROVAL DATE ABOVE. THIS SOP IS VALID FOR TWELVE ADDITIONAL MONTHS FROM DATE OF THE LAST SIGNATURE UNLESS INACTIVATED OR REPLACED BY SUBSEQUENT REVISIONS.

Signature	Title	Date
Signature	Title	Date
Signature	Title	Date
Signature	Title	Date

TABLE OF CONTENTS

METALS LABORATORY GLASSWARE CLEANING

1. SCOPE AND APPLICATION

1.1. This method describes the necessary steps to be taken to obtain target analyte-free labware. Sample digestion/preparation must be performed in meticulously clean labware to aide in the control and elimination of potential metal contaminants.

1.2. This procedure can also be applied to decontamination of field equipment. Refer to Appendix A.

2. METHOD SUMMARY

2.1. Glassware used in metals analysis is washed with soap and water, rinsed with hot water and further rinsed with deionized (DI) water. This step is followed by soaking the glassware in an 8 % Nitric Acid bath for a minimum of two hours and a final rinse with DI water.

3. DEFINITIONS

3.1. Not applicable

4. INTERFERENCES

4.1. Some soaps and detergents could contain target metals analytes. For this reason, the labels should be checked for ingredients that may contain target analytes.

4.2. Acids may contain trace amounts of target analytes. It is important to verify that each lot is free of such target analytes.

5. SAFETY

5.1. Appropriate safety precautions for handling solvents, reagents and samples must be taken when performing this procedure. This includes the use of personnel protective equipment, such as, safety glasses, lab coat and the correct gloves.

5.2. Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

5.3. Hydrochloric and/or Nitric Acid are used in this procedure. These acids are extremely corrosive and care must be taken while handling them. A face shield should be used while pouring acids. And safety glasses should be worn while working with the solutions. Lab coat and gloves should always be worn while working with these solutions.

6. SAMPLE COLLECTION, CONTAINERS, PRESERVATION AND STORAGE

6.1. Not applicable

7. STANDARDS, REAGENTS, AND CONSUMABLE MATERIALS

7.1. Soap – Citranox , Prepare a 2% solution of Citranox in DI WATER

7.2. Hot tap water and DI water for rinsing.

7.3. Nitric Acid – General Grade – 8-10% solution for glassware soaking

7.4. Hydrochloric Acid

7.5. Acetone - low grade for drying and initial solvent rinse.

8. APPARATUS AND EQUIPMENT

8.1. Sink with hot tap water and DI water plumbed.

8.2. Protective equipment – Fume hood, gloves, lab coat, apron, and eyewear suitable for acid and solvent usage.

8.3. Plastic tubs and sponges – for collecting glassware soaking and cleaning

8.4. Nitric Acid bath for soaking glassware.

8.5. Solvent waste can and storage containers.

9. PREVENTIVE MAINTENANCE

9.1. Laboratory water systems are maintained so as to produce the acceptable water for glassware washing and other related cleaning. Water and specifications are described in the FAC-WATER SOP.

10. RESPONSIBILITIES

10.1. It is the responsibility of the analyst to perform this function according to this SOP. It is the responsibility of the department supervisor/manager to ensure that the procedure is being implemented correctly.

10.2. It is the responsibility of the department supervisor/manager to document analyst training as described in ADM-TRAIN, *ALS-Kelso Training Procedure*.

11. PROCEDURE

11.1. Laboratory Glassware

11.1.1. Vigorously wash glassware using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the glassware.

11.1.2. Rinse with hot tap water followed by DI water

11.1.3. Soak in dilute nitric acid (8%) for at least two hours.

11.1.4. Remove glassware from nitric acid bath and thoroughly rinse with DI water. Using your gloved hand by rubbing the surface of the glassware, while rinsing with DI water will help remove the acid from the inside and outside surfaces of the glassware.

11.1.5. Perform a final rinse using DI water without rubbing the gloved hand over the glassware.

11.1.6. After the final DI rinse, immediately place glassware face down on a tray holding several layers of paper toweling.

11.2. Graduated Cylinders

11.2.1. Vigorously wash glassware using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the glassware.

11.2.2. Rinse with hot tap water.

11.2.2.1. Use as much water pressure as possible.

11.2.2.2. Fill at least four times

11.2.3. Rinse with D.I. water.

11.3. TCLP/SPLP Extraction Bottles – Metals and Organics

11.3.1. Metals TCLP bottles – wide mouth plastic

11.3.1.1. Vigorously wash glassware using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the bottle.

11.3.1.2. Rinse with hot tap water.

11.3.1.3. Use as much water pressure as possible.

11.3.1.4. Fill at least four times

11.3.1.5. Rinse with 25% HCL

11.3.1.6. Rinse with DI Water

11.3.2. Organics TCLP Bottles – narrow mouth/Teflon

11.3.2.1. Vigorously wash glassware using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the bottle.

11.3.2.2. Rinse with hot tap water.

11.3.2.3. Use as much water pressure as possible.

11.3.2.4. Fill at least four times

11.3.2.5. Rinse with D.I. water.

11.3.2.6. In a fume hood, rinse with Acetone to remove any organic residue. The Acetone should drain into a waste beaker. The waste beaker should be emptied into an appropriate waste container labeled as "Acetone Waste" and stored for proper disposal by the solvent disposal team.

11.4. Closed Vessel Oil Digestion Bombs

11.4.1. Rinse each tissue bomb with acetone, discarding the waste from each vessel into a designated acetone waste container.

11.4.2. Vigorously wash glassware using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the digestion bomb.

11.4.3. Rinse with hot tap water.

11.4.4. Use as much water pressure as possible.

11.4.5. Fill at least four times

11.4.6. Add 3.0 mL of general grade nitric acid to each digestion bomb. Tighten cap with the bomb wrench and heat in an oven for 30 minutes. Remove from oven after 30 minutes and tighten the caps of the bomb. Put the digestion bomb back into the oven and continue to heat for at least 2 hours.

11.4.7. Remove the bombs from the oven, cool to room temperature and rinse with DI water a minimum of 6 times.

11.4.8. After the final DI rinse, immediately place Teflon bombs face down on a tray holding several layers of paper toweling.

11.5. Tissue Digestion Bombs

11.5.1. Vigorously wash Teflon bombs using the Citranox detergent solution which has been added to hot water. Use a sponge to remove any materials that adhere to the sides of the digestion bomb.

11.5.2. Rinse with hot tap water.

11.5.2.1. Use as much water pressure as possible.

11.5.2.2. Fill at least four times

11.5.3. Add 3.0 mL of general grade nitric acid to each tissue digestion bomb. Tighten cap with the bomb wrench and heat in an oven for two hours.

11.5.4. Remove the bombs from the oven, cool to room temperature and rinse with DI water at least 6 times.

11.5.5. After the final DI rinse, immediately place Teflon bombs face down on a tray holding several layers of paper toweling.

11.6. Decontamination of field equipment - refer to Appendix A.

12. QA/QC REQUIREMENTS

12.1. Not applicable – see determinative methods.

13. DATA REDUCTION, REVIEW, AND REPORTING

13.1. Not applicable

14. CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

14.1. Refer to the SOP for *Nonconformity and Corrective Action* (CE-QA008) for procedures for corrective action. Personnel at all levels and positions in the laboratory are to be alert to identifying problems and nonconformities when errors, deficiencies, or out-of-control situations are detected.

14.2. Handling out-of-control or unacceptable data

14.2.1. On-the-spot corrective actions that are routinely made by analysts and result in acceptable analyses should be documented as normal operating procedures, and no specific documentation need be made other than notations in laboratory maintenance logbooks, runlogs, for example.

14.2.2. Some examples when documentation of a nonconformity is required using a Nonconformity and Corrective Action Report (NCAR):

- Quality control results outside acceptance limits for accuracy and precision
- Method blanks or continuing calibration blanks (CCBs) with target analytes above acceptable levels
- Sample holding time missed due to laboratory error or operations
- Deviations from SOPs or project requirements
- Laboratory analysis errors impacting sample or QC results
- Miscellaneous laboratory errors (spilled sample, incorrect spiking, etc.)
- Sample preservation or handling discrepancies due to laboratory or operations error.

15. METHOD PERFORMANCE

15.1. Not applicable

16. POLLUTION PREVENTION AND WASTE MANAGEMENT

16.1. It is the laboratory's practice to minimize the amount of solvents, acids, and reagents used to perform this method wherever feasibly possible. Standards are prepared in volumes consistent with methodology and only the amount needed for routine laboratory use is kept on site. The threat to the environment from solvents and/or reagents used in this method can be minimized when recycled or disposed of properly.

16.2. The laboratory will comply with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the ALS Environmental Health and Safety Manual.

16.3. This method uses non-halogenated solvents and any waste generated from this solvent must be placed in the collection cans in the lab. The solvent will then be added to the hazardous waste storage area and disposed of in accordance with Federal and State regulations.

16.4. This method uses acid. Waste acid is hazardous to the sewer system and to the environment. All acid waste must be neutralized to a pH of 2.5-12 prior to disposal down the drain. The neutralization step is considered hazardous waste treatment and must be documented on the treatment by generator record. See the ALS EH&S Manual for details.

17. TRAINING

17.1. Refer to ADM-TRAIN, ALS-Kelso Training Procedure for standard procedures.

17.2. Training is documented following ADM-TRAIN, ALS-Kelso Training Procedure.

NOTE: When the analyst training is documented by the supervisor on internal training documentation forms, the supervisor is acknowledging that the analyst has read and understands this SOP and that adequate training has been given to the analyst to competently perform the analysis independently.

18. METHOD MODIFICATIONS

18.1. Not applicable.

19. REFERENCES

19.1. Not applicable.

20. CHANGES SINCE THE LAST REVISION

20.1. Updated to current ALS format.
20.2. Minor formatting and text corrections.
20.3. Section 1.2 – added.
20.4. Section 9 – added.
20.5. Section 10.2 – added.
20.6. Section 11.6 – added.
20.7. Section 14 – Standard SOP language added.
20.8. Section 16 – prior pollution prevention and waste management sections combined and added standard language for 16.3 and 16.4.
20.9. Section 17 – revised.
20.10. Appendix A – new.

APPENDIX A
Decontamination of Field Equipment

Decontamination Supplies and Reagents

1. Tubing as specified by client/project.
2. Plastic buckets as specified by client/project.
3. ASTM Type 1 deionized (DI) water.
4. Hydrochloric Acid (BDH, ACS grade), diluted with Type 1 water to 25%.
5. Ceramic knife.
6. 12"x12" Lint free clean room wipes (Amplitude Helix, item # 89030-184).
7. Plastic Zip Lock bags (13"x15 5/8" and 22"x 22").
8. Field Equipment Decontamination (FED) logbook (current version 14-MET-FED-01).

Tubing Preparation for Clean Sampling

The following cleaning procedures are all carried out in the ALS/Kelso Class 1000 clean room (Rm. 314) fitted with Class 100 laminar flow fume hoods.

Bulk tubing is either supplied by the client or purchased by ALS as per the client's specifications.

Procedure:

1. Bulk tubing is measured and cut to the specified length with a ceramic knife. This procedure being conducted on an available clean room counter.
2. 250 mL of 25% HCl is added to one end of the tubing and gravity fed through the length tubing. Acid exiting the opposite end of the tubing is captured in an appropriate waste container for later neutralization and disposal.
3. (Note: If an entire roll of tubing is being cleaned without cutting to lengths 2 L of 25% HCl is passed through the tubing using a peristaltic pump.)
4. Following the acid rinse the same end of tubing is connected to a DI faucet. The tubing is then rinsed with a minimum of 3 L of DI water.
5. After as much water as possible is allowed to gravity drain from the rinsed tubing the discharge end of the tube is connected to vacuum using the 2 L trap assembly. Vacuum is then applied to remove as much residual water from the tubing as possible.

6. The ends of the tubing are next sealed with DI rinsed aluminum foil and Teflon tape. The exterior of the tubing is wiped down with lint free wipes, coiled, then double bagged in appropriate size zip lock bags.

7. The bagged tubing is then labeled with a lot number obtained from the FED logbook.

Bucket Decontamination

Procedure:

1. Rinse interior and exterior of bucket and lid vigorously with tap water using as much pressure as possible.

2. Rinse interior and exterior of bucket and lid with 25% HCl.

3. Rinse interior and exterior of bucket and lid with vigorously with DI water using as much pressure as possible.

Quality Control

1. Equipment (i.e. tubing, buckets, etc.) of the same type, prepared on the same day, using the same reagents is given a unique lot number. The unique lot number is assigned using the FED logbook name and page number (e.g. page eight of the current log book generates a lot number of (13-METFED-01). Only information for one lot is recorded per page in the logbook.

2. In the FED logbook, record the type of equipment, and for tubing the lengths prepared. Also include lot number or unique CAS identification number (i.e. from the Reagent Logbook) for the acid used.

3. Tubing Blank: Using one section of cleaned tubing from each lot, fill a 1 L polymer metals sample container with DI water and preserve with nitric acid (if 1631 Hg is required transfer 150 mL of this aliquot to a fluoropolymer container prior to preservation).

4. Bucket Blanks: Fill one bucket with DI water. Fill a 1 L polymer metals sample container from this bucket and preserve with nitric acid. If needed, also fill a 500 mL fluoropolymer container and preserve with HCl.

5. Analyze the DI sample for the list of metals specified by the project plan by the appropriate analytical procedure (typically ICP/MS and/or P&T/CVAFS). Where project specifications are not available, analyze a comprehensive list of metals utilizing the most sensitive methodology for each. If contamination is detected, identify the source of the contamination, re-clean the associated tubing, and recheck as described above. This must be repeated until satisfactory results are achieved. Once satisfactory results are produced, an analytical report summarizing the results is generated. The tubing in then ready for shipment to the client.

DETERMINATION OF METALS AND TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

MET-ICP

ALS-KELSO

SOP ID:	MET-ICP	Rev. Number:	24	Effective Date:	12/1/2012

Approved By: _____ Date: 11/26/12
Department Manager – Jeff Coronado

Approved By: _____ Date: 11/26/12
QA Manager – Suzanne LeMay

Approved By: _____ Date: 11/27/12
Laboratory Director – Jeff Grindstaff

Issue Date:	_____	Doc Control ID#:	_____	Issued To:	_____

Standard Operating Procedure

For

DETERMINATION OF METALS AND TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

1. SCOPE AND APPLICATION

1.1 This procedure describes the steps taken for the analysis of soil, sludge surface water and drinking water digestates using EPA methods 6010C, 200.7, and CLP ILM04.0 for a variety of elements. The digested samples and QC standards are all diluted in a similar acid matrix. A procedure is also given for calculation of hardness by Standard Methods 2340B.

1.2 The Method Reporting Limits (MRLs) for common elements are listed in Table 1. Equivalent nomenclature for MRL includes Estimated Quantitation Limit (EQL). Therefore, MRL=EQL. The reported MRL may be adjusted if required for specific project requirements; however, the capability of achieving other reported MRLs must be demonstrated. The Method Detection Limits (MDLs) that have been achieved are listed in Table 1. The MDL and MRL may change as annual studies are performed.

1.3 In cases where there is a project-specific quality assurance plan (QAPP), the project manager identifies and communicates the QAPP-specific requirements to the laboratory. In general, project specific QAPPs supersede method specified requirements. An example of this are projects falling under DoD ELAP or project which require older versions of EPA methods (i.e. 6010B). QC requirements defined in the SOP *Department of Defense Projects – Laboratory Practices and Project Management (ADM-DOD)* may supersede the requirements defined in this SOP.

2 METHOD SUMMARY

2.1 A representative aliquot of sample is prepared as described in the applicable digestion SOP. The digestate is analyzed for the elements of interest using ICP spectrometry. The instrument measures characteristic emission spectra by optical spectrometry. The intensity of emission lines are monitored.

2.2 Final results are calculated using the digestion information and the results from the ICP analysis. Data is reported using standard ALS procedures and formats, or following project specific reporting specifications.

2.3 Deviations from the reference method(s): This SOP contains no deviations from the reference methods.

3 DEFINITIONS

3.1 **Analysis Sequence** - Samples are analyzed in a set referred to as an analysis sequence. The sequence begins with instrument calibration followed by sample digestates interspersed with calibration standards.

3.2 **Independent Calibration Verification** (ICV) - ICV solutions are made from stock solutions different from the stock used to prepare calibration standards and are used to verify the validity of the standardization.

3.3 **Laboratory Control Sample** (LCS): A laboratory blank that has been fortified with target analyte and used to determine that the analysis is in control. For solids, a reference material may be used unless prohibited by project protocols.

3.4 **Matrix Spike** (MS) - In the matrix spike analysis, predetermined quantities of standard solutions of certain analytes are added to a sample matrix prior to sample digestion and analysis. The purpose of the matrix spike is to evaluate the effects of the sample matrix on the methods used for the analyses. Percent recoveries are calculated for each of the analytes detected.

3.5 **Matrix Spike Duplicate** (MSD) - In the matrix spike duplicate analysis, predetermined quantities of standard solutions of certain analytes are added to a sample matrix prior to sample digestion and analysis. The purpose of the matrix spike duplicate is to evaluate the effects of the sample matrix on the methods used for the analyses. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the matrix spikes is calculated and used to assess analytical precision.

3.6 **Duplicate Sample** (DUP) - A laboratory duplicate is a separate field sample aliquot that is processed in an identical manner as the sample proper. The relative percent difference between the samples is calculated and used to assess analytical precision.

3.7 **Method Blank** - The method blank is an artificial sample designed to monitor introduction of artifacts into the process. The method blank is carried through the entire analytical procedure.

3.8 **Continuing Calibration Verification Standard (CCV)** - A standard analyzed at specified intervals and used to verify the ongoing validity of the instrument calibration.

3.9 **Instrument Blank (CCB)** - The instrument blank (also called continuing calibration blank) is a volume of blank reagent of composition identical to the digestates. The purpose of the CCB is to determine the levels of contamination associated with the instrumental analysis.

3.10 **Laboratory fortified Blank (LFB)**- A laboratory blank that has been fortified with target analyte at the method reporting limit and used to determine if the laboratory can detect contaminants at the method reporting limit.

4 INTERFERENCES

4.1 Interferences from contaminated reagents must be eliminated. The purity of acids must be established by the laboratory as being high enough to eliminate the introduction of contamination above the MRL (or above ½ the RL for DoD work).

4.2 Background emission and stray light can be compensated by background correction.

4.3 Spectral overlaps resulting in interelement contributions can be corrected for by using interelement correction factors. Interelement correction factors are established for each instrument and are maintained by the analyst at the workstation.

5 SAFETY

5.1 Chemicals, reagents and standards must be handled as described in the ALS safety policies, approved methods and in MSDSs where available. Refer to the ALS Environmental, Health and Safety Manual and the appropriate MSDS prior to beginning this method.

5.2 Hydrochloric, Nitric and Hydrofluoric Acids are used in this method. These acids are extremely corrosive and care must be taken while handling them. A face shield should be used while pouring acids. Safety glasses, lab coat and gloves should be worn while working with the solutions. A face shield is required when working with Hydrofluoric Acids.

5.3 High Voltage - The power unit supplies high voltage to the RF generator which is used to form the plasma. The unit should never be opened. Exposure to high voltage can cause injury or death.

5.4 UV Light -The plasma when lit is a very intense light, and must not be viewed with the naked eye. Protective lenses are in place on the instrument. Glasses with special protective lenses are available.

6 SAMPLE COLLECTION, CONTAINERS, PRESERVATION, AND STORAGE

6.1 Samples are prepared using methods 3005A, 3010A, 3050, or CLPILM04.0 (ALS SOPs MET-3005A, MET-3010A, MET-3050, and MET-DIG). Samples are received in the ICP lab as completed digestates. Samples are stored in 50 mL plastic centrifuge tubes, 100 mL digestion vessels or in 100 mL volumetric flasks.

6.2 Water samples analyzed by EPA method 200.7 are preserved after arrival at the laboratory. These samples are held for a minimum of 24 hours and the pH verified to be <2 prior to digestion.

6.3 Soil samples are diluted prior to instrumental analysis by a factor of 2. This allows the method to meet the required 1 g of sample to 200 mL dilution during digestion.

6.4 Following analysis, digestates are stored until two weeks after all results have been reviewed and then brought to 3< pH<10 and disposed of through the sewer system.

7 APPARATUS & EQUIPMENT

7.1 Inductively Coupled Plasma Atomic Emission Spectrometer

7.1.1 Thermo Scientific ICAP 6500 (AES-03).
7.1.2 Thermo Scientific ICAP 6500 (AES-04).

7.2 Concentric nebulizers.

7.3 Microflow nebulizer for ICAP 6500.

7.4 Torches and injector tips for each ICP.

7.5 Cyclonic spray chambers for each instrument.

7.6 Water coolers for each ICP.

7.7 Argon Humidifiers for the ICAP 6500.

7.8 ESI SC4 DX Autosampler with Fast System for ICAP 6500.

7.9 Peristaltic Pumps for each Spectrometer.

7.10 RF Generators for each ICP (internal on the ICAP 6500).

8 STANDARDS, REAGENTS, & CONSUMABLE MATERIALS

8.1 Standards Preparation

8.1.1 Stock standard solutions may be purchased from a number of vendors. All reference standards, where possible, must be traceable to SI units or NIST certified reference materials. The preparation for all laboratory prepared reagents and solutions must be documented in a laboratory logbook. Refer to the SOP *Reagent/Standards Login and Tracking (ADM-RTL)* for the complete procedure and documentation requirements. Manufacturer's expiration dates are used to determine the viability of standards.

8.1.2 Calibration Standards

Calibration standards are prepared from commercially purchased single element 1000 ppm or 10,000 ppm stock standards as well as pre-mixed multi element stock standards. All standards are aliquoted using Class A volumetric pipettes, or calibrated fixed and adjustable volume autopipettors. All dilutions are made in Class A volumetric glassware.

The standard mixes for each ICP system vary based on the requirements of each instrument. The composition of the ICAP 6500 standards are outlined in Table 2.

8.1.3 Continuing Calibration Verification (CCV) Standards

CCV standards are analyzed at the midpoint of the calibration. These standards are produced by making a two-fold dilution of each calibration standard. The CCV standards are then run in sequence during the analytical run.

8.1.4 Initial Calibration Verification (ICV) Standards

The ICV working standards are produced by direct dilution of three certified mixed stock solutions (QCP-CICV1, QCP-CICV2, and QCP-CICV3) purchased from Inorganic Ventures or another qualified vendor and various single element stock solutions from sources different than the calibration standards. The composition of these standards is outlined in Table 3.

8.1.5 Interference Check Solutions (ICSA & ICSAB)

The ICSA and ICSAB working standards are produced by direct dilution of certified mixed stock solutions (CLPP-ICS-A and CLPP-ICS-B or equivalent.) Antimony is also added to the ICSAB solution from a 1000 ppm single element stock standard. The composition of these standards is outlined in Table 4.

8.1.6 CRI/Low Level Calibration Verification

The CRI, Low Level Initial Calibration Verification (LLICV), and Low Level Continuing Calibration Verification (LLCCV) are produced by diluting 1000 or 10000ppm single stock standards into a 100X intermediate standard and then diluted 1/100 to obtain the MRL level. Note: The level used is that of the normal MRL used for both instruments.

8.1.7 The solutions and materials used for the LCS and matrix spikes are described in the applicable digestion SOP.

8.1.8 Standard Log

The analyte, source, initial volume, final volume, final concentration and expiration date are recorded in a standard logbook kept in the ICP lab. The operator who prepares the standard must date and initial the entry in the standards logbook. The operator also places his initials and the date prepared on the standard container. In addition to working standards used in calibration, all other standards used in the analytical run such as ICVs, MRL standards, and other project or client specific standards shall be documented in the standard logbook.

8.2 High Purity Argon.

8.3 Capillary, rinse and peristaltic pump tubing.

8.4 17 x 100mm polypropylene test tubes.

9 PREVENTIVE MAINTENANCE

9.1 All maintenance activities are recorded in a maintenance logbook kept for each instrument. Pertinent information (serial numbers, instrument I.D., etc.) must be in the logbook. This includes the routine maintenance described in section 9. The entry in the log must include: date of event, the initials of who performed the work, and a reference to analytical control.

9.2 Torch, nebulizer, and spray chambers are cleaned as required. All instrument filters are vacuumed monthly. Dirty ICP torches and mixing chambers are soaked in aqua regia overnight, rinsed and placed in a clean dry area. The conical nebulizer is back flushed with acid or DI water as needed. The microflow nebulizer is not back flushed. Use the obstruction removal kit with fused silica.

10 RESPONSIBILITIES

10.1 It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

10.2 It is the responsibility of the department supervisor/manager to document analyst training. Training and proficiency is documented in accordance with the SOP *ADM-TRANDOC*.

11 PROCEDURE

11.1 Operating Parameters

11.1.1 For each Thermo Scientific ICAP 6500, the operating parameters are defined in the *Method* file. Default operating parameters are given in *Tools/Options/New Method Parameters*. However, each unique set of operating parameters is saved as a new file and the analyst must select and use the correct *Method* file for the application. Refer to the method files on the workstation for a listing of parameters for each file. The interelement correction factors to be used are established for the ICAP 6500 and are saved on the workstation also. Since these parameters change with method and correction factor updates, and due to the large amount of hardcopy printout for listing these parameters, it is not practical to include the parameters in this SOP.

11.2 Calibration/Standardization

11.2.1 ICAP 6500

11.2.1.1 Plasma is ignited and instrument is allowed to warm up for at least 30 minutes.

11.2.1.2 An internal standard is used for routine analyses on this instrument. Yttrium and Indium are used as internal standards. The internal standard solution is introduced into the analyzed solutions (standards, blanks, QC, samples, etc.) at 0.8 ug/mL for Y, and 1.6 ug/mL for In.

11.2.1.3 Run a peak check standard and adjust peaks as needed.

11.2.1.4 Standardize by running a Blank and a High Standard for each element in the analytical method. Analyst will initial and date the first page of the standardization.

11.2.2 Standardization is completed by analyzing an ICV for each analyte to be determined. For method 200.7 the result must be within ± 5% of the true value. For method 6010B/C the result must be within ± 10% of the true value. If the ICV fails when running method 6010C, either the calibration standards or the ICV must be prepared fresh and the instrument re-standardized. If the ICV fails when running methods 200.7 and 6010B only re-standardization is necessary.

11.2.3 Method 6010C also requires a LLICV be analyzed at the MRL level. The result must be within ± 30% of the true value. The LLICV need not be made up with stock standards different than those of the calibration standards.

11.3 Analytical Run

11.3.1 Following standardization and ICV analysis, the remainder of the run is determined by what analytical method is being performed. These are listed below.

11.3.1.1 CLP ILM04.0: ICB, CCV, CCB, CRI, ICSA, ICSAB, CCV, CCB, routine samples. The CRI, ICSA, and ICSAB will be analyzed every 20 samples. They will be labeled with an F indicating Final. Each set will be numbered in increasing order, i.e. ICSAF1, ICSAF2.

11.3.1.2 Methods 200.7 and 6010B/C: ICB, LLICV or CRI, CCV, CCB, ICSA, ICSAB, routine samples.

11.3.2 Evaluate the initial QC using the following criteria:

11.3.2.1For methods 200.7 and 6010B/C, the following criteria apply:

- The ICB and CCB results are evaluated using method specified requirements. The following guidelines should also be used to determine acceptability:
- For 200.7, the result should be less than 3 times the standard deviation of the mean background signal.
- For method 6010B, the result should be less than the Method Detection Limit (MDL). In cases where the associated sample results are being reported to the Method Reporting Limit (MRL) the result may be greater than the MDL if the result does not adversely impact data quality.
- For method 6010C, the result should be less than the Lower Limit of Quantitation (LOQ).
- Where project specifications allow, the result may be over the MDL if the result does not adversely impact data quality.
- The CCV immediately following standardization must verify within ± 10% of the true values with a relative standard deviation of <5% from 2 replicate integrations for methods 6010B/C. For 200.7, the first CCV must verify within ± 5% with a RSD of <3% from 4 replicates. Calculate %RSD as follows:

$$\%RSD = \frac{StdDev_{CCV}}{Average_{CCV}} x\,100$$

where: $StdDev_{ccv}$ = Standard deviation of the replicate integrations
$Average_{ccv}$ = Average of the replicate CCV integrations

- The LLICV or CRI is a low level standard with concentrations at the RL. For DoD projects, the LLICV standard concentrations will be equal to the project RLs and results must verify within 20% of the true value. For 200.7 and 6010B the LLICV/CRI results should be greater than the MDL and less than 2X the MRL. The LLICV is used for Method 6010C.

- The ICSA is run to check the validity of the Interelement Correction Factors (IECs).

Note: DoD QSM requires this to be run at the beginning of each analytical run.

- The ICSAB must be within 20% of the expected value for the CLPP-ICS-B elements and Sb.

11.3.2.2 The ICV, LLICV, ICB, CCV, CCB, CRI, and ICSAB must meet the criteria listed. Reanalyze any elements that fail.

11.3.2.3 For CLP, refer to SOW ILM04.0 for acceptance criteria.

11.3.3 Continuing Calibration Verification

11.3.3.1 CCVs are analyzed after every 10 samples and at the end of the analytical run. They must verify within ±10% of the expected value with a RSD of <10%.

11.3.3.2 CCBs are analyzed after every 10 samples and at the end of the analytical run. CCBs are evaluated as in section 11.3.2.1.

11.3.3.3 Method 6010C requires a LLCCV be analyzed at the end of each analysis batch. The LLCCV is at the MRL level and must verify within ± 30% of the true value. Reanalyze any elements to be reported at low levels that are bracketed by the LLCCV if the standard fails.

11.3.4 If the CCV or CCB solutions fail, reanalyze any elements to be reported.

12 QA/QC REQUIREMENTS

12.1 Initial Precision and Recovery Validation

The accuracy and precision of the procedure must be validated before analysis of samples begins, or whenever significant changes to the procedures have been made. To do this, four LCS aliquots are prepared and analyzed. The average percent recovery for each analyte must meet LCS criteria and the RSD< 30%.

12.2 Method Detection Limits

12.2.1 A Method Detection Limit (MDL) study must be undertaken before analysis of samples can begin. To establish detection limits that are precise and accurate, the analyst must perform the following procedure. Spike a minimum of seven blank replicates at a level near or below the MRL. Follow the procedures in Section 11 to analyze the samples. Refer to the ALS SOP for *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantification (ADM-MDL.)*

12.2.2 Calculate the average concentration found (x) and the standard deviation of the concentrations for each analyte. Calculate the MDL for each analyte using the correct T value for the number of replicates. MDLs must be performed whenever there is a significant change in the background or instrument response.

12.2.3 A Limit of Detection (LOD) check must be performed after establishing the MDL and at least annually (quarterly if DoD) afterward. A blank is spiked with analytes at 1-4X the MDL and carried through the preparation and analytical procedure. The LOD is verified when the signal/noise ratio is > 3 for all analytes.

12.3 Limit of Quantitation Check(LOQ)/Lower Limit of Quantitation Check(LLQC)

For Method 6010C and drinking waters by method 200.7 a Lower Limit of Quantitation Check (LOQ/LLOQ) sample must be analyzed after establishing the MRL and at least annually (quarterly if DoD) afterward to demonstrate the desired detection capability. The LOQ/LLOQ sample is spiked at 1-2X the MRL and must be carried through the entire preparation and analytical procedure. Limits of quantitation are verified when all analytes are detected within 30% of their true value.

12.4 Linear Dynamic Range

The upper limit of the LDR must be established for each wavelength utilized. It must be determined from a linear calibration prepared in the normal manner using the established analytical operating procedure for the instrument. The LDR should be determined by analyzing at least three succeeding higher standard concentrations of the analyte until the observed analyte concentration is no more than 10% above or below the stated concentration of the standard. Determined LDRs must be documented and kept on file. The LDR which may be used for the analysis of samples should be judged by the analyst from the resulting data. Sample analyte concentrations that are greater than 90% of the determined upper LDR limit must be diluted and reanalyzed. The LDRs should be verified quarterly or whenever, in the judgment of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

12.5 Instrument Detection Limit

On a quarterly basis, the instrument detection limits for all analytes are determined as per procedures outlined in ILM04.0 (Section E, paragraph 10, 12 resp.). IDLs are determined using blanks and this data is kept on file.

12.6 Interelement Correction Factors

Semi-annually, instrument interferences are calculated as per ILM04.0 (Section E, paragraph 11) and Method 6010B/C. During the course of routine work, other interferences may be found. They

are verified by the operator during the analytical run and data is manually corrected. Copies of this data are kept on file. Data can be manually corrected or automatically corrected using iTEVA software.

12.7 Internal Standard

Internal standard values are tracked by the instrument software. Values should remain within 60-125% of the value found in the calibration blank. If a sample is found to have and internal standard outside this value, the sample will be diluted to bring the internal standard into range.

12.8 Ongoing QC Samples required are described in the ALS-Kelso Quality Assurance Manual and in the SOP for *Sample Batches*. Additional QC Samples may be required in project specific quality assurance plans (QAPP). For example projects managed under the DoD ELAP must follow requirements defined in the DoD *Quality Systems Manual for Environmental Laboratories.* General QA requirements for DoD QSM are defined in the laboratory SOP, Department *of Defense Projects – Laboratory Practices and Project Management (ADM-DOD).* General QC Samples are:

12.8.1 Each sample preparation batch must have a method blank associated with it. The method blank result should be < MRL. If the method blank is found to be contaminated, it may be reported if the concentration in the associated samples is at least 20 times the amount found in the method blank for methods 200.7 and 6010B, otherwise redigest the batch. For Method 6010C, the method blank may be reported if the concentration in the associated samples is at least 10 times the amount found in the method blank.A contaminated method blank (MB) may also be reported if all of the associated samples are non-detect (ND).

Note: DoD QSM requires contamination in the MB be <1/2 the RL or < 1/10 any sample amount.

12.8.2 A Laboratory Control Sample (LCS) is digested one per batch, or per 20 samples. For method 200.7, the LCS recovery criterion is 85-115% for water samples. For method 6010B/C, the control limits are 80-120% or in-house calculated limits. For soil samples, the recovery must fall within the ranges specified for the reference material. For CLP, use the prescribed limits for the SOW in use. In all cases, project-specific QC limits may be required. If the LCS fails the acceptance criteria, redigest the batch of samples. For specifics on the preparation and composition of LCS samples refer to the appropriate digestion SOP.

12.8.3 A Duplicate sample is digested one per batch, or per 20 samples (i.e. 5%) for 6010B/C analysis, or per 10 samples (i.e. 10%) for 200.7 analyses. The default criteria may be used if statistically generated criteria are broader or insufficient points are available for accurate statistical limits. Currently, statistically generated criteria are broader and the default is used for all elements but Manganese, for which the limit is 17% RPD. The RPD criteria are <30% for soil samples and <20% for water samples for methods 200.7 and 6010B. The RPD criteria is <20% for both soils and waters for method 6010C. Criteria are subject to change as statistical data are generated. If the RPD is outside acceptance limits, either redigest the sample batch or flag the data appropriately, depending on the physical nature of the samples (e.g. non-homogenous).

12.8.4 A Laboratory fortified Blank (LFB) at the MRL is digested and analyzed with every batch of drinking water samples (method 200.7). The default acceptance criteria of 50-150% are to be used until sufficient data points are acquired to calculate in-house control limits.

12.8.5 A Matrix Spike sample is digested one per batch, or per 20 samples (i.e. 5%) for 6010B/C analysis, or per 10 samples (i.e. 10%) for 200.7 analyses. Where specified by project requirements, a matrix spike duplicate may be required. Matrix spike recovery criteria for method 200.7 is 70-130% for both water and soil samples. For 6010B, the control limits are derived from lab data and are listed in Table 2. For 6010C, the control limits are 75-125% or in-house calculated limits. For CLP, use the prescribed limits for the SOW in use. In all cases, project-specific QC limits may be required. If the recovery is outside acceptance limits, either re-digest the sample batch or flag the data appropriately, depending on the physical nature of the samples (e.g. non-homogenous). If the sample concentration is >4x the spike level, no action is required and data is flagged accordingly. For specifics on the preparation and composition of matrix spike solutions refer to the appropriate digestion SOP.

12.8.6 A post spike shall be performed for 6010C - Tier III and Tier IV.

12.8.7 Matrix Interference

12.8.7.1 When an analyst suspects that there may be any matrix interferences present, a post digestion spike may be performed. The recovery should be ± 20%.

12.8.7.2 If the post spike fails, a 1:5 serial dilution test shall be performed. The dilution should be within ± 10% of the original result.

12.8.7.3 A 1:5 serial dilution shall be performed for all Tier III or IV deliverables.

Note: DoD QSM recovery acceptance limits are 75-125%.

12.9 Additional QC measures include control charting and compiling of QC data for generation of control limits.

12.10 CLP analyses are performed as per the QA/QC guidelines in the most current CLP SOW.

13 DATA REDUCTION, REVIEW, AND REPORTING

13.1 Calculate sample results using the data system printouts and digestion information. The digestion and dilution information is entered into the data system. The data system then uses the calculations below to generate a sample result. The wavelengths used to quantify each metal are summarized in Table 5 for the ICAP6500.

Aqueous samples are reported in µg/L:

$$\mu g/L\,(Sample) = C^{*}\ x\ Digestion\,Dilution\,Factor\ x\ Post\ Digestion\,Dilution\,Factor \times 1000 \mu g\ /\ mg$$

Solid samples are reported in mg/Kg:

$$mg/Kg(Sample) = C^{*} \; x \; PostDigestionDilutionFactor \; x \; \frac{DigestionVol(ml)}{Samplewt(g)} \; x \; \frac{1L}{1000ml} \; x \; \frac{1000g}{1Kg}$$

C*= Concentration of analyte as measured at the instrument in mg/L.

13.2 If total hardness is to be reported, use Calcium and Magnesium results to calculate as follows. For reporting calcium hardness, use only the calcium portion of the equation.

$$Hardness, mg\ equivalent CaCO_3/L = 2.497[Ca, mg/L] + 4.118[Mg, mg/L]$$

13.3 A daily run log of all samples analyzed is maintained. All CLP data should be printed and stored after operator has checked for evenness of burns. A copy of this document will go with each package of Tier III or higher data run that day.

13.4 Data Review and Reporting

13.4.1 It is the analyst's responsibility to review analytical data to ensure that all quality control requirements have been met for each analytical run. Results for QC analyses are calculated and recorded as specified in section 12. The data is then placed in a work order file until complete. When the work order is complete, a report is generated. A final review is performed and the data is delivered to the project management department.

14 CORRECTIVE ACTION

14.1 Refer to the SOP for *Non Conformity and Corrective Action* for procedures for corrective action. Personnel at all levels and positions in the laboratory are to be alert to identifying problems and nonconformities when errors, deficiencies, or out-of-control situations are detected.

14.2 Handling out-of-control or unacceptable data

14.2.1 On-the-spot corrective actions that are routinely made by analysts and result in acceptable analyses should be documented as normal operating procedures, and no specific documentation need be made other than notations in laboratory maintenance logbooks, runlogs, for example.

14.2.2 Documentation of a nonconformity must be done using a Nonconformity and Corrective Action Report (NCAR) when:

- Corrective action is not taken or not possible
- Corrective action fails to correct an out-of-control problem on a laboratory QC or calibration analysis.
- Reanalysis corrects the nonconformity but is not a procedurally compliant analysis.

15 METHOD PERFORMANCE

This method was validated through single laboratory studies of accuracy and precision. Refer to the reference method for additional available method performance data.

15.1 The method detection limit (MDL) is established using the procedure described in the SOP for *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantification (ADM-MDL).* Method Reporting Limits are established for this method based on MDL studies and as specified in the ALS Quality Assurance Manual.

16 POLLUTION PREVENTION AND WASTE MANAGEMENT

16.1 It is the laboratory's practice to minimize the amount of solvents, acids, and reagents used to perform this method wherever feasibly possible. Standards are prepared in volumes consistent with methodology and only the amount needed for routine laboratory use is kept on site. The threat to the environment from solvents and/or reagents used in this method can be minimized when recycled or disposed of properly.

16.2 The laboratory will comply with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the ALS Environmental Health and Safety Manual.

16.3 This method uses acid. Waste acid is hazardous to the sewer system and to the environment. All acid waste must be neutralized to a pH of 3-10 prior to disposal down the drain. The neutralization step is considered hazardous waste treatment and must be documented on the treatment by generator record. See the ALS EH&S Manual for details.

17 TRAINING

17.1 Refer to ADM-TRAIN for standard procedures.

17.2 Training outline

17.2.1 Review literature (see references section). Review the SOP. Also review the applicable MSDS for all reagents and standards used. Following these reviews, observe the procedure as performed by an experienced analyst at least three times.

17.2.2 The next training step is to assist in the procedure under the guidance of an experienced analyst for a period of approximately two weeks. During this period, the analyst is expected to transition from a role of assisting, to performing the procedure with minimal oversight from an experienced analyst.

17.2.3 Perform initial precision and recovery (IPR) study as described in Section 12.1 for water samples. Summaries of the IPR are reviewed and signed by the supervisor.

17.3 Training and proficiency is documented in accordance with the SOP ADM-TRAIN.

18 METHOD MODIFICATIONS

18.1 There are no known modifications in this laboratory standard operating procedure from the reference method.

19 CHANGES SINCE THE LAST REVISION

19.1 Sec 6.2: Changed hold time after preservation to minimum 24 hours.
19.2 Sec 7.1.1: Removed reference to IRIS.
19.3 Sec 7.1.2: Added Thermo Scientific ICAP 6500 (AES-04).
19.4 Sec 7.6: Removed reference to IRIS.
19.5 Sec 7.7: Removed reference to IRIS.
19.6 Sec 7.10: Removed section.
19.7 Sec 7.11: Removed section.
19.8 Sec. 8.1.2: Removed reference to IRIS.
19.9 Sec 9.3: Removed section.
19.10 Sec 11.1.1: Removed section.
19.11 Sec 11.1.2: Changed reference to include new ICAP 6500.
19.12 Sec 11.2.1: Removed section.
19.13 Sec 11.2.2.5: Removed section.
19.14 Sec 11.2.4: Removed LLICV text.
19.15 Sec 11.3.1.2: Revised QC list.
19.16 Sec 11.3.2.1: Added LLICV test.
19.17 Sec 11.3.4: Removed “or ICS”.
19.18 Sec 12: Added “Internal Standard” section.
19.19 Sec 12.6: Added manual/auto correction using iTEVA software.
19.20 Sec 12.8.2: Added 6010C default limits.
19.21 Sec 12.8.5: Added 6010C default limits.
19.22 Sec 12.8.6: Revised section; changed order in which post spikes and serial dilutions are performed.
19.23 Table 3: Removed.
19.24 Table 5: Revised boron prep instruction.
19.25 Table 7: Removed.

20 REFERENCES/ATTACHMENTS

20.1 USEPA, Contract Laboratory Program, SOW #ILM04.0
20.2 Thermo Jarrell Ash ICAP61 Manual
20.3 USEPA, Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Update III, Method 6010B, Revision 2, December 1996.
20.4 USEPA, Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Update III, Method 6010C, Revision 3, February 2007.
20.5 USEPA, Methods for Determination of Metals in Environmental Samples, Supplement I, EPA/600/R-94/111, Method 200.7, Revision 4.4, May 1994.
20.6 *Hardness by Calculation, Method 2340B,* Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998.
20.7 Table 1.1, ALS Kelso Data Quality Objectives, 200.7, soil.
20.8 Table 1.2, ALS Kelso Data Quality Objectives, 200.7, water.
20.9 Table 1.3, ALS Kelso Data Quality Objectives, 6010C, water.
20.10 Table 1.4, ALS Kelso Data Quality Objectives, 6010C, soil.
20.11 Table 1.5, ALS Kelso Data Quality Objectives, 6010C LL, soil.

20.12 Table 1.6, ALS Kelso Data Quality Objectives, 6010C LL, water.
20.13 Table 1.7, ALS Kelso Data Quality Objectives, 6010C/PSEP, tissue
20.14 Table 2, Standard A for ICAP 6500 ICP-OES.
20.15 Table 3, ICP ICV Standards.
20.16 Table 4, ICP Interference Check Solutions.
20.17 Table 5, ICAP 6500 Analytical Wavelengths.

ALS/KELSO DATA QUALITY OBJECTIVES

Table 1.1

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
200.7	Aluminum	7429-90-5	Soil	6	10	mg/kg	41-158	70-130	30
200.7	Antimony	7440-36-0	Soil	3	10	mg/kg	50-150	70-130	30
200.7	Arsenic	7440-38-2	Soil	4	20	mg/kg	75-125	70-130	30
200.7	Barium	7440-39-3	Soil	0.3	2	mg/kg	81-119	70-130	30
200.7	Beryllium	7440-41-7	Soil	0.03	1	mg/kg	83-117	70-130	30
200.7	Boron	7440-42-8	Soil	0.4	10	mg/kg	67-133	70-130	30
200.7	Cadmium	7440-43-9	Soil	0.2	1	mg/kg	81-119	70-130	30
200.7	Calcium	7440-70-2	Soil	2	10	mg/kg	79-121	70-130	30
200.7	Chromium	7440-47-3	Soil	0.4	2	mg/kg	80-119	70-130	30
200.7	Cobalt	7440-48-4	Soil	0.3	2	mg/kg	82-118	70-130	30
200.7	Copper	7440-50-8	Soil	0.6	2	mg/kg	83-116	70-130	30
200.7	Iron	7439-89-6	Soil	0.7	4	mg/kg	50-149	70-130	30
200.7	Lead	7439-92-1	Soil	3	20	mg/kg	79-121	70-130	30
200.7	Lithium	7439-93-2	Soil	0.5	2	mg/kg	75-125	70-130	30
200.7	Magnesium	7439-95-4	Soil	0.3	4	mg/kg	73-127	70-130	30
200.7	Manganese	7439-96-5	Soil	0.04	2	mg/kg	81-119	70-130	30
200.7	Molybdenum	7439-98-7	Soil	0.5	2	mg/kg	75-125	70-130	30
200.7	Nickel	7440-02-0	Soil	0.5	4	mg/kg	81-118	70-130	30
200.7	Phosphorus	7723-14-0	Soil	3	40	mg/kg	75-125	70-130	30
200.7	Potassium	7440-09-7	Soil	20	80	mg/kg	73-126	70-130	30
200.7	Selenium	7782-49-2	Soil	4	20	mg/kg	75-125	70-130	30
200.7	Silver	7440-22-4	Soil	0.4	2	mg/kg	66-134	70-130	30
200.7	Sodium	7440-23-5	Soil	4	40	mg/kg	74-126	70-130	30
200.7	Strontium	7440-24-6	Soil	0.02	2	mg/kg	79-121	70-130	30
200.7	Thallium	7440-28-0	Soil	3	20	mg/kg	75-125	70-130	30
200.7	Tin	7440-31-5	Soil	2	10	mg/kg	75-124	70-130	30

200.7	Titanium	7440-32-6	Soil	0.5	2			mg/kg	75-125	70-130	30
200.7	Vanadium	7440-62-2	Soil	0.4	2			mg/kg	79-121	70-130	30
200.7	Zinc	7440-66-6	Soil	0.3	2			mg/kg	73-121	70-130	30

a Method Detection Limits are subject to change as new MDL studies are completed.

ALS/KELSO DATA QUALITY OBJECTIVES — Table 1.2

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	LODb	LOQc	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
200.7	Aluminum	7429-90-5	Water	30	50	28	50	ug/L	85-115	70-130	20
200.7	Antimony	7440-36-0	Water	20	50	30	50	ug/L	85-115	70-130	20
200.7	Arsenic	7440-38-2	Water	20	100	30	100	ug/L	85-115	70-130	20
200.7	Barium	7440-39-3	Water	1	5	1.5	5	ug/L	85-115	70-130	20
200.7	Beryllium	7440-41-7	Water	0.2	5	0.3	5	ug/L	85-115	70-130	20
200.7	Boron	7440-42-8	Water	3	50		50	ug/L	85-115	70-130	20
200.7	Cadmium	7440-43-9	Water	0.8	5	2	5	ug/L	85-115	70-130	20
200.7	Calcium	7440-70-2	Water	10	50	25	50	ug/L	85-115	70-130	20
200.7	Chromium	7440-47-3	Water	3	5	2.5	5	ug/L	85-115	70-130	20
200.7	Cobalt	7440-48-4	Water	2	10	2.5	10	ug/L	85-115	70-130	20
200.7	Copper	7440-50-8	Water	5	10	4.5	10	ug/L	85-115	70-130	20
200.7	Iron	7439-89-6	Water	2	20	4	20	ug/L	85-115	70-130	20
200.7	Lead	7439-92-1	Water	8	50	30	50	ug/L	85-115	70-130	20
200.7	Lithium	7439-93-2	Water	2	10	3.5	10	ug/L	85-115	70-130	20
200.7	Magnesium	7439-95-4	Water	0.7	20	0.5	20	ug/L	85-115	70-130	20
200.7	Manganese	7439-96-5	Water	0.4	5	0.5	5	ug/L	85-115	70-130	20
200.7	Molybdenum	7439-98-7	Water	3	10	5	10	ug/L	85-115	70-130	20
200.7	Nickel	7440-02-0	Water	2	20	4	20	ug/L	85-115	70-130	20
200.7	Phosphorus	7723-14-0	Water	30	200	40	200	ug/L	85-115	70-130	20
200.7	Potassium	7440-09-7	Water	50	400	80	400	ug/L	85-115	70-130	20
200.7	Selenium	7782-49-2	Water	30	100	40	100	ug/L	85-115	70-130	20
200.7	Silicon	7440-21-3	Water	10	400		400	ug/L	85-115	70-130	20

200.7	Silver	7440-22-4	Water	5	10	5	10	ug/L	85-115	70-130	20
200.7	Sodium	7440-23-5	Water	30	200	20	200	ug/L	85-115	70-130	20
200.7	Strontium	7440-24-6	Water	0.06	10			ug/L	85-115	70-130	20
200.7	Thallium	7440-28-0	Water	30	100	60	100	ug/L	85-115	70-130	20
200.7	Tin	7440-31-5	Water	20	50	30	50	ug/L	85-115	70-130	20
200.7	Titanium	7440-32-6	Water	5	10	5	10	ug/L	85-115	70-130	20
200.7	Vanadium	7440-62-2	Water	5	10	5	10	ug/L	85-115	70-130	20
200.7	Zinc	7440-66-6	Water	2	10	2.5	10	ug/L	85-115	70-130	20

Table 1.3

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	LODb	LOQc	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
6010C	Aluminum	7429-90-5	Water	40	50	40	50	ug/L	92-112	75-125	20
6010C	Antimony	7440-36-0	Water	10	50	30	50	ug/L	90-113	75-125	20
6010C	Arsenic	7440-38-2	Water	20	100	30	100	ug/L	90-112	75-125	20
6010C	Barium	7440-39-3	Water	0.5	5	1.5	5	ug/L	91-113	75-125	20
6010C	Beryllium	7440-41-7	Water	0.2	5	0.3	5	ug/L	91-113	75-125	20
6010C	Boron	7440-42-8	Water	2	50	4	50	ug/L	91-112	75-125	20
6010C	Cadmium	7440-43-9	Water	0.9	5	2	5	ug/L	93-113	75-125	20
6010C	Calcium	7440-70-2	Water	9	50	25	50	ug/L	85-116	75-125	20
6010C	Chromium	7440-47-3	Water	2	5	5	5	ug/L	93-114	75-125	20
6010C	Cobalt	7440-48-4	Water	2	10	2.5	10	ug/L	93-114	75-125	20
6010C	Copper	7440-50-8	Water	5	10	9	10	ug/L	91-111	75-125	20
6010C	Iron	7439-89-6	Water	3	20	4	20	ug/L	92-111	75-125	20
6010C	Lead	7439-92-1	Water	8	50	30	50	ug/L	92-113	75-125	20
6010C	Lithium	7439-93-2	Water	2	10	3.5	10	ug/L	80-120	75-125	20
6010C	Magnesium	7439-95-4	Water	0.4	20	0.5	20	ug/L	86-115	75-125	20
6010C	Manganese	7439-96-5	Water	0.7	5	0.5	5	ug/L	92-112	75-125	20
6010C	Molybdenum	7439-98-7	Water	2	10	5	10	ug/L	92-113	75-125	20
6010C	Nickel	7440-02-0	Water	3	20	4	20	ug/L	91-118	75-125	20
6010C	Phosphorus	7723-14-0	Water	60	200	40	200	ug/L	80-120	75-125	20
6010C	Potassium	7440-09-7	Water	40	400	80	400	ug/L	89-114	75-125	20
6010C	Selenium	7782-49-2	Water	20	100	40	100	ug/L	88-113	75-125	20
6010C	Silicon	7440-21-3	Water	6	400	8	400	ug/L	80-120	75-125	20
6010C	Silver	7440-22-4	Water	5	10	10	10	ug/L	93-110	75-125	20
6010C	Sodium	7440-23-5	Water	20	200	20	200	ug/L	80-120	75-125	20
6010C	Strontium	7440-24-6	Water	0.9	10	0.25	10	ug/L	80-120	75-125	20
6010C	Thallium	7440-28-0	Water	30	100	60	100	ug/L	80-120	75-125	20
6010C	Tin	7440-31-5	Water	9	50	30	50	ug/L	80-120	75-125	20
6010C	Titanium	7440-32-6	Water	4	10	10	10	ug/L	80-120	75-125	20

6010C	Vanadium	7440-62-2	Water	6	10	6.25	10	ug/L	92-111	75-125	20
6010C	Zinc	7440-66-6	Water	2	10	2.5	10	ug/L	92-112	75-125	20

Table 1.4

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	LODb	LOQc	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
6010C	Aluminum	7429-90-5	Soil	6	10	10	10	mg/kg	41-158	75-125	20
6010C	Antimony	7440-36-0	Soil	3	10	6	10	mg/kg	50-150	75-125	20
6010C	Arsenic	7440-38-2	Soil	4	20	8	20	mg/kg	78-122	75-125	20
6010C	Barium	7440-39-3	Soil	0.08	2	0.16	2	mg/kg	81-119	75-125	20
6010C	Beryllium	7440-41-7	Soil	0.02	1	0.04	1	mg/kg	83-117	75-125	20
6010C	Boron	7440-42-8	Soil	0.4	10	0.8	10	mg/kg	67-133	75-125	20
6010C	Cadmium	7440-43-9	Soil	0.3	1	0.6	1	mg/kg	81-119	75-125	20
6010C	Calcium	7440-70-2	Soil	2	10	4	10	mg/kg	79-121	75-125	20
6010C	Chromium	7440-47-3	Soil	0.5	2	1	2	mg/kg	80-119	75-125	20
6010C	Cobalt	7440-48-4	Soil	0.4	2	0.8	2	mg/kg	82-118	75-125	20
6010C	Copper	7440-50-8	Soil	0.7	2	1.4	2	mg/kg	83-116	75-125	20
6010C	Iron	7439-89-6	Soil	0.7	4	1.4	4	mg/kg	50-149	75-125	20
6010C	Lead	7439-92-1	Soil	3	20	6	20	mg/kg	79-121	75-125	20
6010C	Lithium	7439-93-2	Soil	0.5	2	0.8	2	mg/kg	75-125	75-125	20
6010C	Magnesium	7439-95-4	Soil	0.08	4	0.16	4	mg/kg	73-127	75-125	20
6010C	Manganese	7439-96-5	Soil	0.04	2	0.08	2	mg/kg	81-119	75-125	20
6010C	Molybdenum	7439-98-7	Soil	0.7	2	1.4	4.5	mg/kg	75-125	75-125	20
6010C	Nickel	7440-02-0	Soil	0.6	4	1.2	4	mg/kg	81-118	75-125	20
6010C	Phosphorus	7723-14-0	Soil	4	40	8	40	mg/kg	75-125	75-125	20
6010C	Potassium	7440-09-7	Soil	20	80	40	80	mg/kg	73-126	75-125	20
6010C	Selenium	7782-49-2	Soil	5	20	10	20	mg/kg	80-120	75-125	20
6010C	Silver	7440-22-4	Soil	2	2	4	4	mg/kg	66-134	75-125	20
6010C	Sodium	7440-23-5	Soil	4	40	8	40	mg/kg	74-126	75-125	20
6010C	Strontium	7440-24-6	Soil	0.02	2	0.04	2	mg/kg	79-121	75-125	20
6010C	Thallium	7440-28-0	Soil	7	20	14	20	mg/kg	79-120	75-125	20
6010C	Tin	7440-31-5	Soil	4	10	8	10	mg/kg	75-124	75-125	20
6010C	Titanium	7440-32-6	Soil	0.8	2	1.6	2	mg/kg	75-125	75-125	20

6010C	Vanadium	7440-62-2	Soil	2	2	2	2	mg/kg	79-121	75-125	20
6010C	Zinc	7440-66-6	Soil	0.3	2	0.6	2	mg/kg	73-121	75-125	20

ALS/KELSO DATA QUALITY OBJECTIVES

Table 1.5

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	LODb	LOQc	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
6010C LL	Aluminum	7429-90-5	Soil	0.4	1	0.8	2	mg/kg	41-158	75-125	20
6010C LL	Antimony	7440-36-0	Soil	0.5	2	1	3	mg/kg	50-150	75-125	20
6010C LL	Arsenic	7440-38-2	Soil	0.9	2	1.8	5	mg/kg	78-122	75-125	20
6010C LL	Barium	7440-39-3	Soil	0.06	0.5	0.12	0.5	mg/kg	81-119	75-125	20
6010C LL	Beryllium	7440-41-7	Soil	0.03	0.1	0.06	0.2	mg/kg	83-117	75-125	20
6010C LL	Boron	7440-42-8	Soil	0.4	2	1.6	10	mg/kg	67-133	75-125	20
6010C LL	Cadmium	7440-43-9	Soil	0.03	0.1	0.06	0.18	mg/kg	81-119	75-125	20
6010C LL	Calcium	7440-70-2	Soil	0.6	2	1.2	3.6	mg/kg	79-121	75-125	20
6010C LL	Chromium	7440-47-3	Soil	0.2	0.5	0.4	1.2	mg/kg	80-119	75-125	20
6010C LL	Cobalt	7440-48-4	Soil	0.2	0.5	0.4	1.2	mg/kg	82-118	75-125	20
6010C LL	Copper	7440-50-8	Soil	0.3	0.6	0.6	1.8	mg/kg	83-116	75-125	20
6010C LL	Iron	7439-89-6	Soil	0.7	2	1.4	4.2	mg/kg	50-149	75-125	20
6010C LL	Lead	7439-92-1	Soil	0.4	2	0.8	2	mg/kg	79-121	75-125	20
6010C LL	Lithium	7439-93-2	Soil	0.5	2	1	3	mg/kg	80-120	75-125	20
6010C LL	Magnesium	7439-95-4	Soil	0.06	0.5	0.12	0.5	mg/kg	73-127	75-125	20
6010C LL	Manganese	7439-96-5	Soil	0.02	0.2	0.04	0.2	mg/kg	81-119	75-125	20
6010C LL	Molybdenum	7439-98-7	Soil	0.08	0.4	0.06	0.4	mg/kg	75-125	75-125	20
6010C LL	Nickel	7440-02-0	Soil	0.07	0.4	0.14	0.4	mg/kg	81-118	75-125	20
6010C LL	Phosphorus	7723-14-0	Soil	3	6	6	40	mg/kg	80-120	75-125	20
6010C LL	Potassium	7440-09-7	Soil	20	60	40	120	mg/kg	73-126	75-125	20
6010C LL	Selenium	7782-49-2	Soil	0.7	4	1.4	4.2	mg/kg	80-120	75-125	20
6010C LL	Silver	7440-22-4	Soil	0.2	0.5	0.4	1.2	mg/kg	66-134	75-125	20
6010C LL	Sodium	7440-23-5	Soil	4	40	8	40	mg/kg	74-126	75-125	20
6010C LL	Strontium	7440-24-6	Soil	0.02	2	0.06	2	mg/kg	80-120	75-125	20
6010C LL	Thallium	7440-28-0	Soil	0.4	2	0.4	20	mg/kg	79-120	75-125	20
6010C LL	Tin	7440-31-5	Soil	0.7	10	1.6	10	mg/kg	75-124	75-125	20
6010C LL	Titanium	7440-32-6	Soil	0.05	0.2	0.16	2	mg/kg	80-120	75-125	20

6010C LL	Vanadium	7440-62-2	Soil	0.3	1	0.6	2	mg/kg	79-121	75-125	20
6010C LL	Zinc	7440-66-6	Soil	0.3	1	0.6	2	mg/kg	73-121	75-125	20

Table 1.6

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	LODb	LOQc	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
6010C LL	Aluminum	7429-90-5	Water	0.5	2	6	18	ug/L	92-112	75-125	20
6010C LL	Antimony	7440-36-0	Water	3	10	6	18	ug/L	90-113	75-125	20
6010C LL	Arsenic	7440-38-2	Water	4	10	8	24	ug/L	90-112	75-125	20
6010C LL	Barium	7440-39-3	Water	0.4	2	0.8	2.4	ug/L	91-113	75-125	20
6010C LL	Beryllium	7440-41-7	Water	0.09	0.2	0.18	0.6	ug/L	91-113	75-125	20
6010C LL	Boron	7440-42-8	Water	2	10	8	50	ug/L	91-112	75-125	20
6010C LL	Cadmium	7440-43-9	Water	0.3	0.5	0.6	1.8	ug/L	93-113	75-125	20
6010C LL	Calcium	7440-70-2	Water	2	4	20	50	ug/L	85-116	75-125	20
6010C LL	Chromium	7440-47-3	Water	0.4	2	0.8	2.4	ug/L	93-114	75-125	20
6010C LL	Cobalt	7440-48-4	Water	0.4	1	0.8	2.4	ug/L	93-114	75-125	20
6010C LL	Copper	7440-50-8	Water	2	2	4	12	ug/L	91-111	75-125	20
6010C LL	Iron	7439-89-6	Water	3	10	6	18	ug/L	92-111	75-125	20
6010C LL	Lead	7439-92-1	Water	4	10	8	24	ug/L	92-113	75-125	20
6010C LL	Lithium	7439-93-2	Water	2	10	4	12	ug/L	80-120	75-125	20
6010C LL	Magnesium	7439-95-4	Water	0.4	2	6	20	ug/L	86-115	75-125	20
6010C LL	Manganese	7439-96-5	Water	0.2	0.6	0.4	2.4	ug/L	92-112	75-125	20
6010C LL	Molybdenum	7439-98-7	Water	0.6	2	1.2	3.6	ug/L	92-113	75-125	20
6010C LL	Nickel	7440-02-0	Water	0.7	2	1.4	4.2	ug/L	91-118	75-125	20
6010C LL	Phosphorus	7723-14-0	Water	7	20	7	400	ug/L	80-120	75-125	20
6010C LL	Potassium	7440-09-7	Water	50	100	100	300	ug/L	89-114	75-125	20
6010C LL	Selenium	7782-49-2	Water	5	20	10	30	ug/L	88-113	75-125	20
6010C LL	Silicon	7440-21-3	Water	10	50	10	400	ug/L	80-120	75-125	20
6010C LL	Silver	7440-22-4	Water	0.7	2	1.4	4.2	ug/L	93-110	75-125	20
6010C LL	Sodium	7440-23-5	Water	70	200	140	420	ug/L	80-120	75-125	20

6010C LL	Strontium	7440-24-6	Water	0.07	0.2	0.07	10	ug/L	80-120	75-125	20
6010C LL	Thallium	7440-28-0	Water	2	10	6	18	ug/L	80-120	75-125	20
6010C LL	Tin	7440-31-5	Water	2	10	2	10	ug/L	80-120	75-125	20
6010C LL	Titanium	7440-32-6	Water	0.2	1	0.8	10	ug/L	80-120	75-125	20
6010C LL	Vanadium	7440-62-2	Water	1	2	2	6	ug/L	92-111	75-125	20
6010C LL	Zinc	7440-66-6	Water	0.7	2	1.4	4.2	ug/L	92-112	75-125	20

ALS/KELSO DATA QUALITY OBJECTIVES

Table 1.7

METHOD	ANALYTE	CAS No.	MATRIX	MDLa	MRL	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)
6010C/PSEP	Aluminum	7429-90-5	Tissue	0.07	1	mg/kg	75-125	70-130	30
6010C/PSEP	Antimony	7440-36-0	Tissue	0.4	5	mg/kg	75-125	70-130	30
6010C/PSEP	Arsenic		Tissue	0.6	10	mg/kg	75-125	70-130	30
6010C/PSEP	Barium	7440-39-3	Tissue	0.04	0.5	mg/kg	75-125	70-130	30
6010C/PSEP	Beryllium		Tissue	0.02	0.5	mg/kg	75-125	70-130	30
6010C/PSEP	Boron	7440-42-8	Tissue	0.2	5	mg/kg	75-125	70-130	30
6010C/PSEP	Cadmium	7440-43-9	Tissue	3	5	mg/kg	75-125	70-130	30
6010C/PSEP	Calcium	7440-70-2	Tissue	2	5	mg/kg	75-125	70-130	30
6010C/PSEP	Chromium	7440-47-3	Tissue	0.08	0.2	mg/kg	75-125	70-130	30
6010C/PSEP	Cobalt		Tissue	0.05	1	mg/kg	75-125	70-130	30
6010C/PSEP	Copper	7440-50-8	Tissue	0.2	1	mg/kg	75-125	70-130	30
6010C/PSEP	Iron	7439-89-6	Tissue	0.4	2	mg/kg	75-125	70-130	30
6010C/PSEP	Lead		Tissue	0.2	5	mg/kg	75-125	70-130	30
6010C/PSEP	Lithium	7439-93-2	Tissue	0.3	0.5	mg/kg	75-125	70-130	30
6010C/PSEP	Magnesium	7439-95-4	Tissue	0.4	2	mg/kg	75-125	70-130	30
6010C/PSEP	Manganese	7439-96-5	Tissue	0.03	0.5	mg/kg	75-125	70-130	30
6010C/PSEP	Molybdenum	7439-98-7	Tissue	0.05	1	mg/kg	75-125	70-130	30
6010C/PSEP	Nickel	7440-02-0	Tissue	0.06	2	mg/kg	75-125	70-130	30
6010C/PSEP	Phosphorus	7723-14-0	Tissue	2	20	mg/kg	75-125	70-130	30
6010C/PSEP	Potassium	7440-09-7	Tissue	6	40	mg/kg	75-125	70-130	30
6010C/PSEP	Selenium	7782-49-2	Tissue	0.7	10	mg/kg	75-125	70-130	30
6010C/PSEP	Silver	7440-22-4	Tissue	0.1	1	mg/kg	75-125	70-130	30
6010C/PSEP	Sodium	7440-23-5	Tissue	4	20	mg/kg	75-125	70-130	30
6010C/PSEP	Strontium	7440-24-6	Tissue	0.02	1	mg/kg	75-125	70-130	30
6010C/PSEP	Thallium	7440-28-0	Tissue	0.3	10	mg/kg	75-125	70-130	30

6010C/PSEP	Tin	7440-31-5	Tissue	0.3	5		mg/kg	75-125	70-130	30
6010C/PSEP	Titanium	7440-32-6	Tissue	0.09	1		mg/kg	75-125	70-130	30
6010C/PSEP	Vanadium	7440-62-2	Tissue	0.07	1		mg/kg	75-125	70-130	30
6010C/PSEP	Zinc	7440-66-6	Tissue	0.06	1		mg/kg	75-125	70-130	30

TABLE 2
Standard A for ICAP 6500 ICP-OES

Analyte	Source	Source Concentration (ppm)	Aliquot (mL)	Final Volume (mL)	Final Concentration (ppm)
Antimony	(1)	100	5	1000	0.5
Beryllium	(1)	100	5	1000	0.5
Boron	(1)	100	5	1000	0.5
Cadmium	(1)	100	5	1000	0.5
Calcium	(1)	100	5	1000	0.5
Chromium	(1)	100	5	1000	0.5
Cobalt	(1)	100	5	1000	0.5
Copper	(1)	100	5	1000	0.5
Iron	(1)	100	5	1000	0.5
Lead	(1)	100	5	1000	0.5
Magnesium	(1)	100	5	1000	0.5
Manganese	(1)	100	5	1000	0.5
Molybdenum	(1)	100	5	1000	0.5
Nickel	(1)	100	5	1000	0.5
Selenium	(1)	100	5	1000	0.5
Silver	(1)	100	5	1000	0.5
Tin	Elemental Stock	1000	0.5	1000	0.5
Thallium	(1)	100	5	1000	0.5
Titanium	(1)	100	5	1000	0.5
Vanadium	(1)	100	5	1000	0.5
Zinc	(1)	100	5	1000	0.5
Hydrochloric Acid	-	-	50	1000	5%
Nitric Acid	-	-	10	1000	1%

(1) Mixed Standard, QCS-26

Standard B for ICAP 6500 ICP-OES

Analyte	Source	Source Concentration (ppm)	Aliquot (mL)	Final Volume (mL)	Final Concentration (ppm)
Aluminum	Elemental Stock	10000	2	1000	20
Arsenic	Elemental Stock	1000	2	1000	2
Barium	Elemental Stock	10000	2	1000	20
Calcium	Elemental Stock	10000	2	1000	20
Iron	Elemental Stock	10000	2	1000	20
Lithium	Elemental Stock	1000	2	1000	2
Manganese	Elemental Stock	1000	2	1000	2
Magnesium	Elemental Stock	10000	2	1000	20
Phosphorus	Elemental Stock	10000	2	1000	20
Potassium	Elemental Stock	10000	2	1000	20
Silicon	Elemental Stock	10000	2	1000	20
Sodium	Elemental Stock	10000	2	1000	20
Strontium	Elemental Stock	1000	2	1000	2
HCl	-	-	50	1000	5%
HNO3	-	-	10	1000	1%

TABLE 3
ICP ICV Standards

ICV1 Solution

Analyte	Source	Source Concentration (ppm)	Aliquot (mL)	Final Volume (mL)	Final Concentration (ppm)
Aluminum	QCP-CICV-1	1000	2.5	500	5.0
Antimony	QCP-CICV-2	500	2.5	500	2.5
Arsenic	QCP-CICV-3	500	2.5	500	2.5
Barium	QCP-CICV-1	1000	2.5	500	5.0
Beryllium	QCP-CICV-1	25	2.5	500	0.125
Cadmium	QCP-CICV-3	250	2.5	500	1.25
Calcium	QCP-CICV-1	2500	2.5	500	12.5
Chromium	QCP-CICV-1	100	2.5	500	0.5
Cobalt	QCP-CICV-1	250	2.5	500	1.25
Copper	QCP-CICV-1	125	2.5	500	0.625
Iron	QCP-CICV-1	500	2.5	500	2.5
Lead	QCP-CICV-3	500	2.5	500	2.5
Magnesium	QCP-CICV-1	2500	2.5	500	12.5
Manganese	QCP-CICV-1	250	2.5	500	1.25
Molybdenum	Elemental Stock	1000	1.0	500	2.0
Nickel	QCP-CICV-1	250	2.5	500	1.25
Potassium	QCP-CICV-1	2500	2.5	500	12.5
Selenium	QCP-CICV-3	500	2.5	500	2.5
Silver	QCP-CICV-1	125	2.5	500	0.625
Sodium	QCP-CICV-1	2500	2.5	500	12.5
Thallium	QCP-CICV-3	500	2.5	500	2.5
Titanium	Elemental Stock	1000	1.0	500	2.0
Vanadium	QCP-CICV-1	250	2.5	500	1.25
Zinc	QCP-CICV-1	250	2.5	500	1.25
Hydrochloric Acid	-	-	25	500	5%
Nitric Acid	-	-	5	500	1%

ICVB Solution

Analyte	Source	Source Concentration	Aliquot	Final Volume	Final Concentration

		(ppm)	(mL)	(mL)	(ppm)
Aluminum	Elemental Stock	1000	0.5	500	1
Boron	Elemental Stock	1000	1	500	2
Calcium	Elemental Stock	1000	2.5	500	5
Iron	Elemental Stock	1000	5	500	10
Lithium	Elemental Stock	1000	1	500	2
Magnesium	Elemental Stock	1000	2.5	500	5
Manganese	Elemental Stock	1000	5	500	10
Phosphorus	Elemental Stock	1000	2.5	500	5
Silicon	Elemental Stock	1000	2.5	500	5
Strontium	Elemental Stock	1000	1	500	2
Tin	Elemental Stock	1000	2.5	500	5
Hydrochloric Acid	-		25	500	5%
Nitric Acid	-		5	500	1%

TABLE 4
ICP Interference Check Solutions

ICSA Solution

Analyte	Source	Source Concentration (ppm)	Aliquot (mL)	Final Volume (mL)	Final Concentration (ppm)
Aluminum	CLPP-ICS-A	5000	50	500	500
Calcium	CLPP-ICS-A	5000	50	500	500
Iron	CLPP-ICS-A	2000	50	500	200
Magnesium	CLPP-ICS-A	5000	50	500	500
Hydrochloric Acid	-	-	25	500	5%
Nitric Acid	-	-	5	500	1%

ICSAB Solution

Analyte	Source	Source Concentration (ppm)	Aliquot (mL)	Final Volume (mL)	Final Concentration (ppm)
Aluminum	CLPP-ICS-A	5000	50	500	500
Antimony	Elemental Stock	1000	0.5	500	1
Barium	CLPP-ICS-B	50	5	500	0.5
Beryllium	CLPP-ICS-B	50	5	500	0.5
Cadmium	CLPP-ICS-B	100	5	500	1
Calcium	CLPP-ICS-A	5000	50	500	500
Chromium	CLPP-ICS-B	50	5	500	0.5
Cobalt	CLPP-ICS-B	50	5	500	0.5
Copper	CLPP-ICS-B	50	5	500	0.5
Iron	CLPP-ICS-A	2000	50	500	200
Lead	CLPP-ICS-B	100	5	500	1
Magnesium	CLPP-ICS-A	5000	50	500	500
Manganese	CLPP-ICS-B	50	5	500	0.5
Nickel	CLPP-ICS-B	100	5	500	1
Silver	CLPP-ICS-B	100	5	500	1
Vanadium	CLPP-ICS-B	50	5	500	0.5
Zinc	CLPP-ICS-B	100	5	500	1

HCl	-	-	25	500	0.05
HNO3	-	-	5	500	0.01

ICAP 6500 Analytical Wavelengths

Analyte	Wavelength	
Aluminum	167.0	Low Line
Aluminum	394.4	
Antimony	206.8	
Antimony	217.5	Alternate
Arsenic	189.0	
Barium	455.4	
Beryllium	234.8	
Boron	249.6	
Cadmium	226.5	
Cadmium	214.4	Alternate
Calcium	315.8	
Calcium	393.3	Low Line
Chromium	267.7	
Cobalt	230.7	
Cobalt	228.6	Alternate
Copper	327.3	
Copper	224.7	Alternate
Iron	259.9	
Lead	220.3	
Lithium	670.7	
Magnesium	279.0	High Line
Magnesium	279.5	Low Line
Magnesium	285.2	
Manganese	257.6	
Manganese	260.5	High Line
Molybdenum	202.0	
Nickel	221.6	
Nickel	231.6	Alternate
Phosphorus	214.9	
Phosphorus	178.2	Alternate
Potassium	766.4	
Selenium	196.0	
Silicon	251.6	
Silver	328.0	
Sodium	588.9	Alternate

Sodium	589.5	

TABLE 5
ICAP 6500 Analytical Wavelengths, continued

Strontium	407.7	
Thallium	190.8	
Tin	189.9	
Titanium	336.1	
Vanadium	292.4	
Zinc	206.2	
Zinc	213.8	Alternate

ATTACHMENT G: LABORATORY QUALITY ASSURANCE MANUAL

QUALITY ASSURANCE MANUAL

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QUALITY ASSURANCE MANUAL

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Current Data Quality Objectives (DQOs) may be requested from the laboratory for specified methods or projects.

QA MANUAL CROSS REFERENCE TABLE

ALS QA Manual	ISO 17025:2005 Section	TNI Standard 2009 Volume 1, Module 2 Section
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14	5.9	5.9
21	5.10	5.10

1) Introduction and Scope

ALS Environmental, Kelso is a professional analytical services laboratory which performs chemical and microbiological analyses on a wide variety of sample matrices, including drinking water, groundwater, surface water, wastewater, soil, sludge, sediment, tissue, industrial and hazardous waste, air, and other material.

We recognize that quality assurance requires a commitment to quality by everyone in the organization - individually, within each operating unit, and throughout the entire laboratory. Laboratory management is committed to ensuring the effectiveness of its quality systems and to ensure that all tests are carried out in accordance to customer requirements. Key elements of this commitment are set forth in SOP CE-GEN001, *Laboratory Ethics and Data Integrity* and in this Quality Assurance Manual. ALS - Kelso is committed to operate in accordance with these requirements and those of regulatory agencies, accrediting authorities, and certifying organizations. The laboratory also strives for improvement through varying continuous improvement initiatives and projects.

Quality Management Systems are established, implemented and maintained by management. Policies and procedures are established in order to meet requirements of accreditation bodies and applicable programs, such as the Department of Defense (DOD) Environmental Laboratory Accreditation Program, as well as client's quality objectives. Systems are designed so that there will be sufficient Quality Assurance (QA) activities conducted in the laboratory to ensure that all analytical data generated and processed will be scientifically sound, legally defensible, of known and documented quality, and will accurately reflect the material being tested. Quality Systems are applicable to all fields of testing in which the laboratory in involved.

Quality Control (QC) procedures are used to continually assess performance of the laboratory and quality systems. The laboratory maintains control of analytical results by adhering to written standard operating procedures (SOPs), using analytical control parameters with all analyses, and by observing sample custody requirements. All analytical results are calculated and reported in units consistent with project specifications to allow comparability of data.

This QAM is applicable to the facility listed on the title page. The information in this manual has been organized according to requirements found in the National Environmental Laboratory Accreditation Program (NELAP) Quality Systems Standards (2003 and 2009), the EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, USEPA, 2001; and General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC 17025:2005. A glossary of pertinent terms and acronyms is included in Appendix A.

2) Organization

The ALS Environmental, Kelso staff, consisting of approximately 130 employees, includes chemists, technicians and support personnel. They represent diverse educational backgrounds and experience, and provide the comprehensive skills that the laboratory requires. During seasonal workload increases, additional temporary employees may be hired to perform specific tasks. All employees share the responsibility for maintaining and improving the quality of our analytical services.

ALS – Kelso is legally identifiable as ALS Group USA, Corp., dba ALS Environmental. ALS Group USA, Corp. is a component of ALS Limited, a publicly held Australian company. The ALS global website may be referred to for corporate ownership information (www.alsglobal.com/Our-Company). The laboratory is divided into operational and managerial units based upon specific disciplines. Each department is responsible for establishing, maintaining and documenting QA and QC practices meeting laboratory needs. Organizational charts of the laboratory, as well as the resumes of these key personnel, can be found in Appendix B. This laboratory organization is designed so that potential conflict of interest is avoided, and such

that an adequate amount of supervisory personnel are in place to provide oversight and supervision of day to day operations.

3) Management

The purpose of the QA program at ALS Environmental, Kelso is to ensure that our clients are provided with analytical data that is scientifically sound, legally defensible, and of known and documented quality. The concept of Quality Assurance can be extended, and is expressed in the mission statement:

> "The mission of ALS Environmental, Kelso is to provide high quality, cost-effective, and timely professional testing services to our customers. We recognize that our success as a company is based on our ability to maintain customer satisfaction. To do this requires constant attention to customer needs, maintenance of state-of-the-art testing capabilities and successful management of our most important asset - our people - in a way that encourages professional growth, personal development and company commitment."

3.1 Quality Management Systems

In support of this mission, the laboratory has developed a Quality Management System to ensure all products and services meet our client's needs. The system is implemented and maintained by the Quality Assurance Manager with corporate oversight by the Manager of Quality Assurance, USA. These systems are based upon ISO 17025:2005 standards, upon which fundamental programs (NELAC 2003, 2009 and DoD QSM) are based. Implementation and documentation against these standards are communicated in corporate policy statements, this QAM, and SOPs. Actual procedures, actions and documentation are defined in both administrative and technical SOPs. Quality systems include:

- Accreditation and certification program compliance
- Standard Operating Procedures
- Sample management and Chain of Custody procedures
- Document control
- Demonstration of Capability
- Analytical traceability
- Ethics training and data integrity processes
- Corrective action procedures
- Statistical control charting
- Management reviews

The effectiveness of the quality system is assessed in several ways, including:

- Internal and external audits
- Periodic reports to management
- Analysis of customer feedback
- Proficiency testing

The responsibilities of key positions within the laboratory are described below. Table 3-1 lists the ALS - Kelso personnel assigned to these key positions. Managerial staff members are provided the authority and resources needed to perform their duties. In the event that work is stopped in response to quality problems, as described below, only the Laboratory Director or Quality Assurance Manager has the authority to resume work.

Laboratory Director – The role of the Laboratory Director is to provide technical, operational, and administrative leadership through planning, allocation and management of personnel and equipment resources. The Laboratory Director provides leadership and support for the QA program and is responsible for overall laboratory efficiency and financial performance. The Laboratory Director has the authority to stop work in response to quality problems. The Laboratory Director also provides resources for implementation of the QA program, reviews and approves this QA Manual, reviews and approves standard operating procedures (SOPs), and provides support for business development by identifying and developing new markets through continuing support of the management of existing client activities.

Quality Assurance Manager (QAM) – The Quality Assurance Manager has the authority and responsibility for implementing, maintaining, and improving the quality system. This includes coordination of QA activities in the laboratory, ensuring that personnel understand the quality system, ensuring communication takes place in the laboratory regarding implementation of the quality system, ensuring adequate staff training, and monitoring overall quality system compliance. The QAM continually evaluates potential improvements in the quality system. Audit and surveillance results, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback, and management reviews are used to support quality system implementation. The QAM is responsible for ensuring compliance with all applicable regulatory compliance quality standards (i.e. NELAP/TNI, ISO, DoD QSM, etc.). The QAM works with laboratory staff to establish effective quality control and assessment processes and has the authority to stop work in response to quality problems. The QAM is responsible for maintaining the laboratory's certifications and approvals, for maintaining the QA Manual and performing an annual review of it, reviewing and approving SOPs and ensuring the annual review of technical SOPs, maintaining QA records (metrological records, archived logbooks, PT results, etc.), document control, conducting proficiency testing studies, approving nonconformity and corrective action reports, and performing internal QA audits.

The QAM reports directly to the Laboratory Director and reports indirectly to the ALS Manager of Quality Assurance, USA. It is important to note that when evaluating data, the QAM does so in an objective manner and free of outside, or managerial, influence.

The Manager of Quality Assurance, USA is responsible for the overall QA program at all the ALS Environmental Group laboratories. The Manager of Quality Assurance, USA is responsible for oversight of QAM's regulatory compliance efforts (NELAC, ISO, DOD, etc.) and may perform internal audits to evaluate compliance. The Manager of Quality Assurance, USA approves company-wide SOPs and provides assistance to the laboratory QA staff and laboratory managers as necessary.

Deputy Laboratory Director and QA Manager – In the case of absence of the Laboratory Director or QAM, deputies are assigned to act in that role. Default deputies for these positions are the Client Services Manager or Metals Department Manager (for the Laboratory Director) and the Laboratory Director (for the QAM).

Environmental Health and Safety (EH&S) Officer – The EH&S officer is responsible for the administration of the laboratory health and safety policies. This includes the formulation and implementation of safety policies, the supervision of new-employee safety training, the review of accidents, incidents and prevention plans, the monitoring

of hazardous waste disposal and the conducting of departmental safety inspections. The EH&S officer is also designated as the Chemical Hygiene Officer. The EH&S Officer has a dotted-line reporting responsibility to the ALS North America EH&S Manager.

Client Services Manager (CSM) – The CSM is responsible for the Client Services Department defined for the laboratory. This includes management and oversight of Project Managers, electronic deliverables, and support functions. The Client Services Department provides a complete interface with clients from initial project specification to final deliverables. The Client Services Manager has the responsibility and authority to stop work in response to accreditation/certification or quality problems, or in response to similar subcontractor quality problems.

Department Managers and Supervisors – Each manager or supervisor has the responsibility to ensure that QA and QC functions are carried out as specified when executing the analyses and related tasks and to ensure the production of high quality data. Managers and bench-level supervisors monitor the day-to-day operations to ensure that productivity and data quality objectives are met. A department manager has the authority to stop work in response to quality problems in their area. Managers and supervisors are responsible for ensuring that analysts perform testing according to applied methods, SOPs, and QC guidelines particular to the laboratory department.

Sample Management Office (SMO) – The Sample Management Office plays a key role in the laboratory QA program by handling all activities associated with receiving, storage, and disposal of samples, and maintaining documentation for all samples received. SMO staff is also responsible for the proper disposal of samples after analysis. The Support Services Manager oversees SMO and bottle preparation functions.

Information Technology (IT) – IT staff is responsible for the administration of the Laboratory Information Management System (LIMS) and other necessary support services. Other functions of the IT staff include laboratory network maintenance, IT systems development and implementation, education of analytical staff in the use of scientific software, Electronic Data Deliverable (EDD) support, and data back-up, archival and integrity operations.

3.2 Ethics, Professional Conduct and Data Integrity

One of the most important aspects of the success of ALS - Kelso is the emphasis placed on the integrity of the data provided and the services rendered. This success is reliant on both the professional conduct of all employees within ALS - Kelso as well as established laboratory practices. All personnel involved with environmental testing and calibration activities must familiarize themselves with the quality documentation and implement the policies and procedures in their work.

All employees are required to sign and adhere to the requirements set forth in the *ALS Code of Conduct Policy* and agree to the *Confidentiality Agreement (*Appendix C).

3.2.1 Professional Conduct

To promote quality ALS - Kelso requires certain standards of conduct and ethical performance among employees. The following examples of documented ALS policy are representative of these standards, and are not intended to be limiting or all-inclusive:

- Under no circumstances is the willful act of fraudulent manipulation of analytical data condoned. Such acts are to be reported immediately to senior management for appropriate corrective action.

- Unless specifically required in writing by a client, alteration, deviation or omission of written contractual requirements is not permitted. Such changes must be in writing and approved by senior management.
- Falsification of data in any form will not be tolerated. While much analytical data is subject to professional judgment and interpretation, outright falsification, whenever observed or discovered, will be documented, and appropriate remedies and punitive measures will be taken toward those individuals responsible.

3.2.2 Confidentiality

It is the responsibility of all laboratory employees to safeguard sensitive company information, client data, records, and information; and matters of national security concern should they arise. The nature of our business and the well-being of our company and of our clients is dependent upon protecting and maintaining confidential and/or proprietary company and client information. All information, data, and reports (except that in the public domain) collected or assembled on behalf of a client is treated as confidential.

Information may not be given to third parties without the consent of the client. Unauthorized release of confidential information about the company or its clients is taken seriously and is subject to formal disciplinary action. All employees sign a confidentiality agreement upon hire to protect the company and client's confidentiality and proprietary rights.

3.2.3 Prevention and Detection of Improper, Unethical or Illegal Actions

It is the intention of ALS - Kelso to proactively prevent and/or detect any improper, unethical or illegal action conducted within the laboratory. This is performed by the implementation of a program designed for not only the detection but also prevention. Prevention consists of educating all laboratory personnel in their roles and duties as employees, company policies, inappropriate practices, and their corresponding implications as described here.

In addition to education, appropriate and inappropriate practices are included in SOPs such as manual integration, data review and specific method procedures. Electronic and hardcopy data audits are performed regularly, including periodic audits of chromatographic electronic data. Requirements for internal QA audits are described in SOP CE-QA001, Internal Audits. All aspects of this program are documented and retained on file according to the company policy on record retention.

The ALS Employee Handbook also contains information on the ALS ethics and data integrity program, including mechanisms for reporting and seeking advice on ethical decisions.

3.2.4 Laboratory Data Integrity and Ethics Training

Each employee receives in-depth "core" Data Integrity/Ethics Training. New employees are given a QA and Ethics orientation within the first month of hire, followed by the core training within 1 year of hire. On an ongoing basis, all employees receive annual ethics refresher training. Topics covered are documented all training participation is documented. It is the responsibility of the QAM to ensure that the training is conducted as described.

Key topics covered are the organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting, record

keeping, and reporting data integrity issues. Training includes discussion regarding all data integrity procedures, data integrity training documentation, in-depth data monitoring and data integrity procedures. Training topics also cover examples of improper actions, legal and liability implications (company and personal), causes, prevention, awareness, and reporting options.

Trainees are required to understand that any infraction of the laboratory data integrity procedures will result in an investigation that could lead to serious consequences including immediate termination, or civil/criminal prosecution.

3.2.5 Management and Employee Commitment

ALS - Kelso makes every attempt to ensure that employees are free from any commercial, financial, or other undue pressures that might affect their quality of work. Related policies are described in the ALS Employee Handbook. This includes:

- ALS Open Door Policy (ALS Employee Handbook) – Employees are encouraged to bring any work related problems or concerns to the attention of local management or their Human Resources representative. However, depending on the extent or sensitivity of the concern, employees are encouraged to directly contact any member of upper management.
- Faircall – An anonymous and confidential reporting system available to all employees that is used to communicate misconduct and other concerns. The program shall help minimize negative morale, promote a positive work place, and encourage reporting suspected misconduct without retribution. Associated upper management is notified and the investigations are documented.
- Use of flexible work hours. Within reason and as approved by supervisors, employees are allowed flexible work hours in order to help ease schedule pressures which could impact decision-making and work quality.
- Operational and project scheduling assessments are continually made to ensure that project planning is performed and that adequate resources are available during anticipated periods of increased workloads. Procedures for subcontracting work are established, and within the ALS Environmental laboratory network additional capacity is typically available for subcontracting, if necessary.
- Gifts and Favors (ALS Employee Handbook) – To avoid possible conflict of interest implications, employees do not receive unusual gifts or favors to, nor accept such gifts or favors from, persons outside the Company who are, or may be, in any way concerned with the projects on which the Company is professionally engaged.

Table 3-1
Summary of Technical Experience and Qualifications – Key Personnel

Personnel	Years of Experience	Project Role
Jeff Grindstaff, B.S.	25	Laboratory Director
Lee Wolf, B.S.	28	Quality Assurance Manager, Regulatory Affairs Manager
Gregory Salata, Ph.D.	27	Client Services Manager
Jeff Coronado, B.S.	24	Metals Department Manager
Harvey Jacky, B.S.	25	General Chemistry Department Manager
Loren Portwood	25	Semi-Volatile Organics Department Manager
Jon James, B.A.	23	HPLC, GC/MS Organics Department Manager
Christina Kerksieck, B.S.	6	Microbiology Technical Manager
Les Kennedy	16	Support Services and Sample Management Office Manager
Eileen Arnold, B.A.	32	Environmental Health and Safety Officer
Mike Sullivan, B.S.	14	Information Technology
Jeff Christian, B.S.	35	Director of Operations, Western USA

4) Document Control

Procedures for control and maintenance of documents are described in SOP CE-GEN005, *Document Control*. The requirements of the SOP apply to all laboratory logbooks (standards, maintenance, run logbooks, etc.), certificates of analysis, SOPs, QAMs, quality assurance project plans (QAPPs), Environmental Health & Safety (EHS) manuals, and other controlled ALS Environmental documents.

Each controlled copy of a controlled document is released after a document control number is assigned and the recipient is recorded on a document distribution list. Filing and distribution is performed by the QAM, or designee, and ensure that only the most current version of the document is distributed and in use. A document control number is assigned to logbooks. Completed logbooks that are no longer in use are archived in a master logbook file. Logbook entries are standardized following SOP CE-QA007, *Making Entries onto Analytical Records*. The logbook entries are reviewed and approved at a regular interval (quarterly).

A records system is used which ensures all laboratory records (including raw data, reports, and supporting records) are retained and available. The archiving system is described in SOP ADM-ARCH, *Data Archiving*.

External documents relative to the management system are managed by the QAM. To prevent the use of invalid and/or outdated external documents, the laboratory maintains a master list of current documents and their availability. The list is reviewed before making the documents available. External documents are not issued to personnel.

5) Review of Requests, Tenders and Contracts

Requests for new work are reviewed prior to signing any contracts or otherwise agreeing to perform the work. The specific methods to be used are agreed upon between the laboratory and the client. A capability review is performed to determine if the laboratory has or needs to obtain certification to perform the work, to determine if the laboratory has the resources (personnel, equipment, materials, capacity, skills, expertise) to perform the work, and if the laboratory is able to meet the client's required reporting and QC limits. The results of this review are communicated to the client and any potential conflict, deficiency, lack of appropriate accreditation status, or concerns of the ability to complete the client's work are resolved. Any differences between the request or tender and the contract shall be resolved before any work commences. The client should be notified at this time if work is expected to be subcontracted. Each contract shall be acceptable both to the laboratory and the client. Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work. If a contract needs to be amended after work has commenced, the contract review process is repeated and any amendments are communicated to all affected personnel. Changes in accreditation status affecting ongoing projects must be reported to the client.

6) Subcontracting of Tests

Analytical services are subcontracted when the laboratory needs to balance workload or when the requested analyses are not performed by the laboratory. Subcontracting is only done with the knowledge and approval of the client and to qualified laboratories. Subcontracting to another ALS Environmental Group laboratory is preferred over external-laboratory subcontracting. Further, subcontracting is done using capable and qualified laboratories. Established procedures are used to qualify external subcontract laboratories. These procedures are described in SOP CE-QA004, *Qualification of Subcontract Laboratories*. The Quality Assurance staff is responsible for maintaining a list of qualified subcontract laboratories.

7) Purchasing Services and Supplies

The quality level of reagents and materials (grade, traceability, etc.) required is specified in analytical SOPs. Department supervisors ensure that the proper materials are purchased. Inspection and verification of material ordered is performed at the time of receipt by receiving personnel. The receiving staff labels the material with the date received. Expiration dates are assigned as appropriate for the material. Storage conditions and expiration dates are specified in the analytical SOP. CE-QA012, Quality of Reagents and Standards and ADM-RLT, Reagent and Standards Login and Tracking provides default expiration requirements. Supplies and services that are critical in maintaining the quality of laboratory testing are procured from pre-approved vendors. The policy and procedure for purchasing and procurement are described in SOP CE-GEN007, *Procurement and Control of Laboratory Services and Supplies*.

Receipt procedures include technical review of the purchase order/request to verify that what was received is identical to the item ordered. The laboratory checks new lots of reagents for unacceptable levels of contamination prior to use in sample preservation, sample preparation, and sample analysis by following SOP ADM-RLT, *Reagent and Standards Login and Tracking*.

8) Service to the Client

ALS - Kelso utilizes a number of processes to ensure that adequate resources exist to meet service demands. Senior staff meetings, tracking of outstanding proposals, and a current synopsis of incoming work all assist the senior staff in properly allocating sufficient resources. Status/production meetings are conducted regularly with the laboratory and Project Managers to inform the staff of the status of incoming work, future projects, or project requirements.

The Project Manager is a scientist assigned to each client to act as a technical liaison between the client and the laboratory. The Project Manager is responsible for ensuring that the analyses performed by the laboratory meet all project and contract requirements. This entails coordinating with the laboratory staff to ensure that client-specific needs are understood and that the services provided are properly executed and satisfy the requirements of the client.

Laboratory management also monitors a number of other indicators to assess the overall ability of the laboratory to successfully perform analyses for its clients. This includes on-time performance, customer complaints, training reports and non-conformity reports. A frequent assessment is made of the laboratory's facilities and resources in anticipation of accepting an additional or increased workload.

All Requests for Proposal (RFP) documents are reviewed by the Project Manager and appropriate managerial staff to identify any project specific requirements that differ from the standard practices of the laboratory. Any requirements that potentially cannot be met are noted and communicated to the client, as well as requesting the client to provide any applicable project specific Quality Assurance Project Plans (QAPPs).

When a client requests a modification to an SOP, policy, or standard specification the Project Manager will discuss the proposed deviation with the Client Services Manager, Laboratory Director, and department manager to obtain approval for the deviation. The QAM may also be involved. All project-specific requirements must be on-file and with the service request upon logging in the samples. The modification or deviation must be documented. A Project-Specific Communication Form, Form V, or similar, may be used to document such deviations.

The laboratory affords clients cooperation to clarify the client's request and to monitor the laboratory's performance in relation to the work performed, provided that the laboratory ensures confidentiality to other clients. The laboratory maintains and documents timely communication with the client for the purposes of seeking feedback and clarifying customer requests. Feedback is used and analyzed to improve the quality of services. The SOP CE-GEN010, *Handling Customer Feedback* is in place for these events.

9) Complaints

In addition to project communication and internal communication of data issues, the laboratory also maintains a system for dealing with customer complaints. The procedure is described in CE-GEN010, Handling Customer Feedback. The person who initially receives feedback in the form of a complaint (typically the Project Manager) is responsible for documenting the complaint. If the Project Manager is unable to satisfy the customer, the complaint is brought to the attention of the Client Services Manager, Laboratory Director, or QAM for final resolution. The complaint and resolution are documented.

10) Facilities and Equipment

The ALS Environmental Kelso laboratory features over 45,000 square feet of laboratory and administrative workspace. The laboratory has been designed and constructed to provide safeguards against cross-contamination of samples and is arranged according to work function, which enhances the efficiency of analytical operations. The ventilation system has been specially designed to meet the needs of the analyses performed in each work space. Also, ALS - Kelso minimizes laboratory contamination sources by employing janitorial and maintenance staff to ensure that good housekeeping and facilities maintenance are performed. In addition, the segregated laboratory areas are designed for safe and efficient handling of a variety of sample types. These specialized areas (and access restrictions) include:

- Shipping and Receiving/Purchasing
- Sample Management Office, including controlled-access sample storage areas
- Inorganic/Metals Sample Preparation Laboratories (2)
- Inorganic/Metals “clean room” sample preparation laboratory
- ICP-AES Laboratory
- ICP-MS Laboratory
- Low-level Mercury Laboratory
- Water Chemistry & General Chemistry Laboratories (3)
- Semi-volatile Organics Sample Preparation Laboratory
- Gas Chromatography and High Performance Liquid Chromatography Laboratories
- Gas Chromatography/Mass Spectrometry Laboratories (2)
- Semi-volatile Organics Drinking Water Laboratory
- Volatile Organics Laboratory
    - Separate sample preparation laboratory
    - Access by semi-volatile sample preparation staff only after removing lab coat and solvent-contaminated gloves, etc.
- Microbiology Laboratory
- Laboratory Deionized Water Systems (2)
- Laboratory Management, Client Service, Report Generation and Administration
- Data Archival, Data Review and support functions areas

In addition, the designated areas for sample receiving, refrigerated sample storage and dedicated sample container preparation and shipping areas provide for the efficient and safe handling of a variety of sample types. The laboratory is equipped with state-of-the-art analytical and administrative support equipment. The equipment and instrumentation are appropriate for the procedures in use. Refer to Appendix D for a Laboratory Floor Plan and Appendix E for a list of major equipment, illustrating the laboratory's overall capabilities and depth.

11) Sample Management

11.1 Sampling and Sample Preservation

The quality of analytical results is highly dependent upon the quality of the procedures used to collect, preserve and store samples. ALS - Kelso recommends that clients follow sampling guidelines described in 40 CFR 136, 40 CFR 141, USEPA SW 846, and state-specific sampling guidelines, if applicable. Sampling factors that must be taken into account to insure accurate, defensible analytical results include:

- Amount of sample taken
- Type of container used
- Type of sample preservation
- Sample storage time
- Proper custodial documentation

The laboratory uses the sample preservation, container, and holding-time recommendations published in a number of documents. The primary documents of reference are: USEPA SW-846, Third Edition and Updates I, II, IIA, IIB, III, IV for hazardous waste samples; USEPA 600/4-79-020, 600/4-91-010, 600/4-82-057, 600/R-93/100, 600/4-88-039, 600/R-94-111, and Supplements; EPA 40CFR parts 136 and 141 and associated Method Update Rules; and Standard Methods for the Examination of Water and Wastewater for water and wastewater samples (see Section 23 for complete references). The container, preservation and holding time information for these references is summarized in Appendix F for soil, water, and drinking water. The current EPA CLP Statement of Work should be referred to for CLP procedures. Where allowed by project sampling and analysis protocols (such as Puget Sound Protocols) the holding time for sediment, soil, and tissue samples may be extended for a defined period when stored frozen at -20˚C.

ALS - Kelso provides clients with sample containers with applicable preservatives. Containers are purchased as pre-cleaned to a level 1 status, and conform to the requirements for samples established by the USEPA. Certificates of analysis for sample containers are available upon request. Reagent water used for sampling blanks (trip blanks, etc.) and chemical preservation reagents are tested by the laboratory to ensure that they are free of interferences and documented. Our sample kits typically consist of pre-cleaned, rinsed, and air-dried shipping coolers with foam liners, specially prepared and labeled sample containers individually wrapped in protective material (VOC vials are placed in a specially made foam holder), chain-of-custody (COC) forms, and custody seals. Container labels and custody seals are provided for each container. Figure 11-1 shows the chain-of-custody form routinely used at ALS - Kelso and included with sample kits. Dry ice or gel ice is the only temperature preservative used. For large sample container shipments the containers may be shipped in their original boxes. Such shipments will consist of labeled and preserved sample containers and sufficient materials (bubble wrap, COC forms, custody seals, shipping coolers, etc.) for return to ALS, unless otherwise instructed by the client.

ALS - Kelso also provides courier service that makes regularly scheduled trips on the I-5 corridor between the Greater Portland, Oregon area and the Great Seattle/Tacoma area, and nearby communities and facilities.

Returning shipping coolers are cleaned and decontaminated. If any such cooler exhibits an odor or other abnormality after receipt and cleaning, a more vigorous decontamination process is employed. Containers which cannot be decontaminated are discarded. ALS - Kelso keeps client-specific shipping requirements on file and utilizes major transportation carriers to necessary to meet sample shipping requirements (same-day, overnight, etc.).

When ALS - Kelso ships samples to other laboratories for analysis, similar sample integrity processes are used to ensure preservation and proper sample handling, and to avoid any possible breakage, cross-contamination of samples, or identification problems. Alternatively, the receiving laboratory's procedures may be specified. Chain of custody is maintained during the process.

11.2 Sample Receipt and Handling

Standard procedures are established for the receiving of samples into the laboratory and are found in SOP SMO-GEN, *Sample Receiving*. These procedures ensure that samples are received and properly logged into the laboratory, and that all associated documentation, including chain of custody forms, is complete and consistent with the samples received.

Once samples are received or delivered to the laboratory the sample management office uses a Cooler Receipt and Preservation Check Form (CRF - Figure 11-2) is used to assess the shipping cooler and its contents as received by the laboratory. Any anomalies or discrepancies observed during the initial assessment are recorded on the CRF and COC documents. Verification of sample integrity includes the following activities:

- Assessment of custody seal presence/absence, location and signature;
- Temperature of sample containers upon receipt;
- Chain of custody documents properly used (entries in ink, signature present, etc.);
- Sample containers checked for integrity (broken, leaking, etc.);
- Sample is clearly marked and dated (bottle labels complete with required information);
- Appropriate containers (size, type) are received for the requested analyses;
- The minimum amount of sample material is provided for the analysis.
- Sample container labels and/or tags agree with chain of custody entries (identification, required analyses, etc.);
- Assessment of proper sample preservation (if inadequate, corrective action is employed); and
- VOC containers are inspected for the presence/absence of bubbles. (Assessment of proper preservation of VOC containers is performed by lab personnel).

Samples are logged into a Laboratory Information Management System (LIMS). Potential problems with a sample shipment are addressed by contacting the client and discussing the pertinent issues. When the Project Manager and client have reached a

satisfactory resolution, the login process may continue and analysis may begin. During the login process each sample container is given a unique laboratory code and a Service Request form is generated which contains client information, sample descriptions, sample matrix information, required analyses, sample collection dates, analysis due dates and other pertinent information. The service request is reviewed by the applicable Project Manager for accuracy and completeness.

Samples are stored as per method requirements until analysis, unless otherwise specified, using various refrigerators, freezers, or designated secure areas. ALS - Kelso has multiple walk-in and refrigerator cold storage units which house the majority of samples, including dedicated refrigerated storage of VOC samples. The VOC storage units are monitored using storage blanks as described in SOP VOC-BLAN, *VOA Storage Blanks*. ALS - Kelso also has multiple sub-zero freezers capable of storing samples at -10 to -30˚C primarily used for tissue and sediment samples. The temperature of each sample storage unit is monitored real time with an electronic temperature monitoring system.

ALS - Kelso adheres to the method-prescribed or project-specified holding times for all analyses. Analysts monitor holding times by obtaining analysis-specific reports from the LIMS. These reports provide holding time information on all samples for the analysis, calculated from the sampling date and the holding time requirement. To document holding time compliance, the date and time analyzed is printed or written on the analytical raw data. Unless other arrangements have been made in advance, upon completion of all analyses and submittal of the final report, aqueous samples are retained at ambient temperature for 30 days, soil samples are retained at ambient temperature for 60 days, and tissue samples are retained frozen for 3 months. Upon expiration of these time limits, the samples are either returned to the client or disposed of according to approved disposal practices. Sample extracts are retained as specified in analytical SOPs. All samples are characterized according to hazardous/non-hazardous waste criteria and are segregated accordingly. All hazardous waste samples are disposed of according to formal procedures outlined in the ALS Environmental Health and Safety Manual and in accordance with applicable laws. Documentation is maintained for each sample from initial receipt through final disposal to ensure that an accurate history of the sample from “cradle to grave” is available.

11.3 Sample Custody

Sample custody transfer at the time of sample receipt is documented using chain-of-custody (COC) forms accompanying the samples. During sample receipt, it is also noted if custody seals were present.

Facility security and access is important in maintaining the integrity of samples received at ALS - Kelso. Access to the laboratory facility is limited by use of locked exterior doors with a coded/card entry, except for the reception area and sample receiving doors, which are staffed during business hours and locked at all other times. In addition, the sample storage area within the laboratory is a controlled access area with locked doors with a coded entry. The facility is equipped with an alarm system and the laboratory employs a private security firm to provide nighttime and weekend security.

A barcoding system is used to document internal sample custody. Each person removing or returning samples from/to sample storage while performing analysis is required to document this custody transfer. The system uniquely identifies the sample container and provides an electronic record of the custody of each sample. For sample extracts and digestates the analyst documents custody of the sample extract or digestate by signing on the benchsheet, or custody record, that they have accepted

custody. The procedures are described in the SOP SMO-SCOC, *Sample Tracking and Internal Chain of Custody*.

11.4 Project Setup

The analytical method(s) used for sample analysis are chosen based on the client's requirements. LIMS codes are chosen to identify the analysis method used for analysis. The Project Manager ensures that the correct methods are selected for analysis, deliverable requirements are identified, and due dates are specified on the Service Request. For SW-846 methods, some projects may require the most recent promulgated version, and some projects may require the most recent published version. The Project Manager will ensure that the correct method version is used. To communicate and specify project-specific requirements, a Tier V form (Figure 11-3) is used and accompanies the Service Request form.

Figure 11-1

ALS Environmental Standard Chain of Custody Form

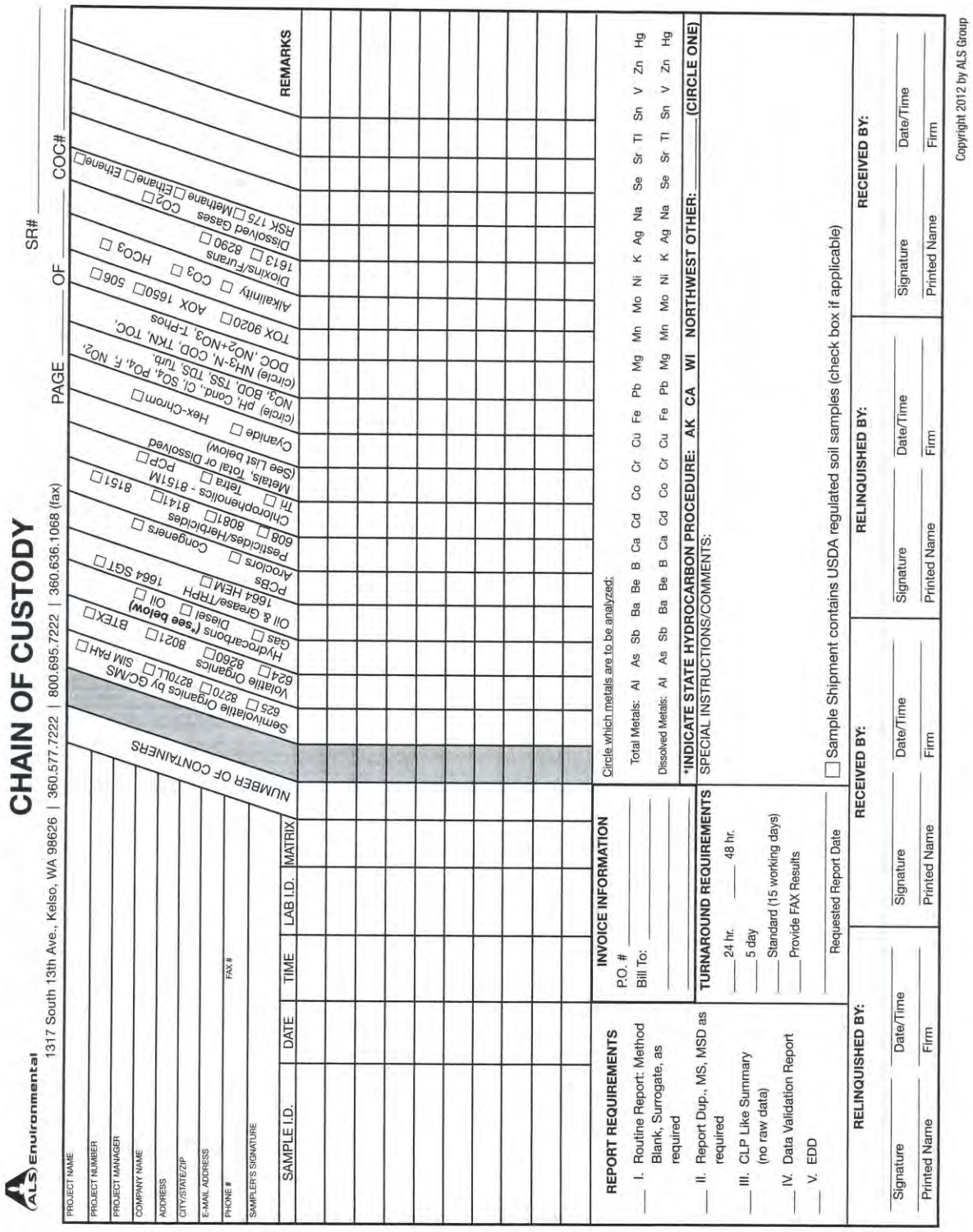


Figure 11-2

ALS Environmental Cooler Receipt and Preservation Form

PC_____

Cooler Receipt and Preservation Form

Client / Project:_____ Service Request *K14*_____

Received:_____ Opened:_____ By:_____ Unloaded:_____ By:_____

1. Samples were received via? ***Mail*** ***Fed Ex*** ***UPS*** ***DHL*** ***PDX*** ***Courier*** ***Hand Delivered***
2. Samples were received in: (circle) ***Cooler*** ***Box*** ***Envelope*** ***Other***_____ ***NA***
3. Were custody seals on coolers? NA Y N If yes, how many and where?_____
   If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected. Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number NA	Filed

4. Packing material: ***Inserts*** ***Baggies*** ***Bubble Wrap*** ***Gel Packs*** ***Wet Ice*** ***Dry Ice*** ***Sleeves*** _____
5. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
6. Did all bottles arrive in good condition (unbroken)? *Indicate in the table below.* NA Y N
7. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
8. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
9. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
10. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
11. Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
12. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions:_____

_____

_____

_____

Page_____of_____

Figure 11-3

ALS Environmental Tier V Project Specification Form

Client:
Project Name:
Project Number:
Project Description:

Project Chemist:
Service Request:
LIMS Template ID:

QAPP/SOW Information:

Reporting

Tier Level:
In results field use:
Flagging Requirements:
Other Requirements:

PFD:

Report to:

Sample Considerations:

Sample Limitations:
Sample Prep/Analysis:
Non-Standard Hold times:
Historical Data:
Comments:

12) Analytical Procedures

ALS - Kelso employs methods and analytical procedures from a variety of external sources. The primary method references are: USEPA SW-846, Third Edition and Updates I, II, IIA, IIB, III, IVA, IVB, and online updates for hazardous waste samples, and USEPA 600/4-79-020, 600/4-91-010, 600/4-82-057, 600/R-93/100, 600/4-88-039, 600/R-94-111, EPA 40CFR parts 136 and 141 and associated Method Update Rules and Supplements; and Standard Methods for the Examination of Water and Wastewater for water and wastewater samples. Complete citations for these references can be found in Section 23. Other published procedures, such as state-specific methods, program-specific methods (such as Puget Sound Protocols), or in-house methods may be used. Several factors are involved with the selection of analytical methods to be used in the laboratory. These include the method detection/reporting limit, the expected concentration of the analyte(s) being measured, method selectivity, accuracy and precision of the method, the type of sample being analyzed, and the regulatory compliance objectives. The implementation of methods by ALS - Kelso is described in SOPs specific to each method. A list of NELAP-accredited methods is given in Appendix J.

12.1 Standard Operating Procedures (SOPs) and Laboratory Notebooks.

ALS Environmental, Kelso maintains SOPs for use in both technical and administrative functions. SOPs are written following standardized format and content requirements as described in CE-GEN009, *Preparation of Standard Operating Procedures*. Each SOP is reviewed and approved by a minimum of two managers (the Laboratory Director and/or Department Manager and the Quality Assurance Manager). All SOPs undergo a documented annual review to make sure current practices are described. The QAM maintains a comprehensive list of current SOPs. The document control process ensures that only the most currently approved version of an SOP is being used. The procedures for document control are described in CE-GEN005, *Document Control*. In addition to SOPs, each laboratory department maintains the current methods used to perform analyses accessible to all laboratory staff. Laboratory notebook entries are standardized using the procedure in SOP CE-QA007, *Making Entries onto Analytical Records*. Laboratory notebook entries are reviewed and approved by the appropriate supervisor at a regular interval. A list of current SOPs is given in Appendix G.

12.2 Deviation from Standard Operating Procedures

When a client requests a modification to an SOP (such as a change in reporting limit, addition or deletion of target analyte(s), etc.), the Project Manager handling that project must discuss the proposed deviation with the department manager in charge of the analysis and obtain their approval to accept the project. The Project Manager is responsible for documenting the approved or allowed deviation from the SOP by placing a description of the deviation attached with the project documents and also providing an instructional comment with the Service Request.

For circumstances when a deviation or departure from company policies or procedures involving any non-technical function is found necessary, approval must be obtained from the appropriate supervisor, manager, the Laboratory Director, or other level of authority. Frequent departure from policy is not encouraged. However, if frequent departure from any policy is noted, the laboratory director will address the possible need for a change in policy.

12.3 Modified Procedures

ALS - Kelso strives to perform published methods as described in the referenced documents. If there is a material deviation from the published method, the method is cited as a “Modified” method in the analytical report. Modifications to the published methods are listed in the standard operating procedure. Standard operating

procedures are available to analysts and are also available to our clients for review. Client approval is obtained for the use of "Modified" methods prior to the performance of the analysis.

12.4 Analytical Batch

The basic unit for analytical quality control is the analytical batch. The definition that ALS - Kelso has adopted for the analytical batch is listed below. The overriding principle for describing an analytical batch is that all the samples in a batch, both field samples and quality control samples are to be handled exactly the same way, and all of the data from each analysis is to be manipulated in exactly the same manner. The minimum requirements of an analytical batch are:

1) The number of (field) samples in a batch is not to exceed 20.

2) All (field) samples in a batch are of the same matrix.

3) The QC samples to be processed with the (field) samples include:

- Method Blank (a.k.a. Laboratory Reagent Blank)
- Laboratory Control Sample
- Matrix Spiked (field) Sample (a.k.a. Laboratory Fortified Sample Matrix)*
- Duplicate Matrix Spiked (field) Sample or Duplicate (field) Sample (a.k.a. Laboratory Duplicate)*

* A sample identified as a field blank, an equipment blank, or a trip blank is not to be matrix spiked or duplicated.

4) A single lot of reagents is used to process the batch of samples.

5) Each operation within the analysis is performed by a single analyst, technician, chemist, or by a team of analysts/technicians/chemists.

6) Samples are analyzed in a continuous manner over a timeframe not to exceed 24-hours between the start of processing of the first and last sample of the batch.

7) Samples are analyzed in a continuous manner over a timeframe not to exceed 24-hours.

8) Field samples are assigned to batches commencing at the time that sample processing begins.

9) The QC samples are to be analyzed in conjunction with the associated field samples prepared with them. However, for tests which have a separate sample preparation step that defines a batch (digestion, extraction, etc.), the QC samples in the batch do not require analysis each time a field sample within the preparation batch is analyzed (multiple instrument sequences to analyze all field samples in the batch need not include re-analyses of the QC samples).

10) The batch is to be assigned a unique identification number that can be used to correlate the QC samples with the field samples.

11) Batch QC refers to the QC samples that are analyzed in a batch of (field) samples.

12) Project-specific requirements may be exceptions. If project, program, or method requirements are more stringent than these laboratory minimum requirements, then the project, program, or method requirements will take

precedence. However, if the project, program, or method requirements are less stringent than these laboratory minimum requirements, these laboratory minimum requirements will take precedence.

12.5 Specialized Procedures

ALS - Kelso not only strives to provide results that are scientifically sound, legally defensible, and of known and documented quality; but also strives to provide the best solution to analytical challenges. Procedures using specialized instrumentation and methodology have been developed to improve sensitivity (provide lower detection limits), selectivity (minimize interferences while maintaining sensitivity), and overall data quality for low concentration applications. Examples are trace-level Mercury and Methyl mercury analyses, reductive precipitation metals analysis, specialized GC/MS analyses, LC/MS analyses, and ultra-low level organics analyses (including PAHs, pesticides and PCBs).

12.6 Sample Cleanup

The laboratory commonly employs several cleanup procedures to minimize known common interferences prior to analysis. EPA methods (3620, 3630, 3640, 3660, and 3665) for cleanup of sample extracts for organics analysis are routinely used to minimize or eliminate interferences that may adversely affect sample results and data usability.

13) Measurement Traceability and Calibration

All equipment and instruments used at ALS - Kelso are operated, maintained and calibrated according to the manufacturer's guidelines and recommendations, as well as to criteria set forth in the applicable analytical methodology. All analytical measurements generated are performed using materials that are traceable to a reference material, unless unavailable. Operation and calibration are performed by personnel who have been properly trained in these procedures. Documentation of calibration information is maintained in appropriate reference files. Brief descriptions of the calibration procedures for our major laboratory equipment are described below. Calibration verification is performed according to the analytical methods and SOPs, and criteria are listed in the SOPs. Documentation of calibration verification is maintained in appropriate reference files. Records are maintained to provide traceability of reference materials and reference equipment.

Laboratory support equipment (thermometers, balances, and weights) are routinely verified on an annual basis by a vendor accredited to ISO/IEC 17025:2005, or more frequently if program-specified. Metrology equipment (analytical balances, thermometers, etc.) is calibrated using reference materials traceable to the National Institute of Standards and Technology (NIST). These primary reference materials are themselves recertified on an annual basis. Vendors used for metrology support are required to verify compliance to International Standards by supplying the laboratory with a copy of their scope of accreditation.

Equipment shown by verification to be malfunctioning or defective is taken out of service until it is repaired. When an instrument is taken out of service, an Out of Service sign is placed by the laboratory on the instrument. The equipment is placed back in service only after verifying, by calibration, that the equipment performs satisfactorily.

13.1 Temperature Control Devices

Temperatures are monitored and recorded each day for all of the temperature-regulating support equipment such as sample refrigerators, freezers, and standards refrigerators/freezers. Temperatures are recorded in either laboratory logbook or through Check Point® Wireless Monitoring System. During weekends and holidays a min/max thermometer may be used.

Laboratory records contain the recorded temperature, identification and location of equipment, acceptance criteria and the initials of the technician who performed the checks. The procedure for performing these measurements is provided in the SOP ADM-SEMC, *Support Equipment Monitoring and Calibration*.

Where the operating temperature is specified as a test condition (such as ovens, incubators, evaporators) the temperature is recorded on the raw data. All thermometers are identified according to serial number, and the calibration is checked annually against a National Institute of Standards and Technology (NIST) certified thermometer. The NIST thermometer is recertified by a vendor accredited to ISO/IEC 17025:2005 on an annual basis.

13.2 Analytical Balances

The calibration of each analytical balance is checked by the user each day of use with three Class S or S-1 weights, which assess the accuracy of the balance at low, mid-level and high levels bracketing the working range. Records are kept which contain the recorded measurements, identification of the balance, acceptance criteria, and the initials of user who performed the check. The procedure for performing these measurements and use of acceptance criteria is described in the SOP ADM-SEMC. The weights are recertified using NIST traceable standards by an accredited metrology organization on an annual basis. As needed, the balances are recalibrated using the manufacturers recommended operating procedures. Analytical balances are serviced on a semi-annual basis by an accredited metrology organization.

13.3 Water Purification Systems

ALS - Kelso uses two independent water purification systems is designed to produce deionized water meeting method specifications. One system consists of a series of pumps, filters, and resin beds designed to yield deionized water meeting the specifications of ASTM Type II water, and Standard Methods for the Examination of Water and Wastewater (SM1080, 20th Ed.) High Quality water. Activated carbon filters are also in series with the demineralizers to produce "organic-free" water. A second system consists of pumps, filters, and treatment components designed to yield deionized water meeting the specifications of ASTM Type I water, and Standard Methods for the Examination of Water and Wastewater (SM1080, 20th Ed.) High Quality water. The status of each system is monitored continuously for conductivity and resistivity with an on-line meter and indicator light, and readings recorded daily. The meter accuracy is verified annually. Deionizers are rotated and replaced on a regular schedule. Microbiology water is checked on a daily basis at a point downstream of the purification system at a tap in the laboratory.

13.4 Standards and Reference Materials

Consumable reference materials routinely purchased by the laboratories (e.g., analytical standards) are purchased from nationally recognized, reputable vendors. All vendors where possible have fulfilled the requirements for 9001 certification and/or are ISO 17025 accredited. ALS - Kelso relies on a primary vendor for the majority of its analytical supplies. Consumable primary stock standards are obtained from certified commercial sources or from sources referenced in a specific method. Supelco, Ultra Scientific, AccuStandard, Chem Services, Inc., Aldrich Chemical Co., Baker, Spex, etc. are examples of the vendors used. Reference material information is recorded in the appropriate logbook(s) and materials are stored under conditions that provide maximum protection against deterioration and contamination. The logbook entry includes such information as an assigned logbook identification code, the source of the material (i.e. vendor identification), solvent (if applicable) and concentration of analyte(s), reference to the certificate of analysis and an assigned expiration date. The

date that the standard is received in the laboratory is marked on the container. When the reference material is used for the first time, the date of usage and the initials of the analyst are also recorded on the container.

Stock solutions and calibration standard solutions are prepared fresh as often as necessary according to their stability. All standard solutions are properly labeled as to analyte concentration, solvent, date, preparer, and expiration date; these entries are also recorded in the appropriate notebook(s) following the SOP for *Reagent Login and Tracking* (SOP ADM-RTL). Prior to sample analysis, all calibration reference materials are verified with a second, independent source of the material.

13.5 Inductively Coupled Plasma-Atomic Emission Spectrograph (ICP-AES)

Each emission line on the ICP is calibrated daily against a blank and against standards whose concentrations fall within the instruments linear range. Analyses of calibration standards, initial and continuing calibration verification standards, and inter-element interference check samples are carried out as specified in the applicable method SOP and analytical method (i.e. EPA 200.7, 6010B, 6010C, CLP SOW, etc.).

13.6 Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)

Each element of interest is calibrated for using a blank and a single standard. Prior to calibration, a short-term stability check is performed on the system. Following calibration, an independent check standard is analyzed, and a continuing calibration verification standard (CCV) is analyzed with every ten samples.

13.7 Atomic Absorption Spectrophotometers (AAS)

These instruments are calibrated daily using a minimum of four standards and a blank. Calibration is validated using reference standards, and is verified at a minimum frequency of once every ten samples. Initial calibration points cannot be “dropped” from the resulting calibration curve.

13.8 GC/MS Systems

All GC/MS instruments are calibrated at multiple concentration levels for the analytes of interest (unless specified otherwise) using procedures outlined in Standard Operating Procedures and/or appropriate USEPA method citations. All reference materials used for this function are vendor-certified standards. Calibration verification is performed at method-specified intervals following the procedures in the SOP. For internal standard and isotope dilution procedures, the internal standard response and/or labeled compound recovery must meet method criteria. Method-specific instrument tuning is regularly checked the method-specified compounds. Mass spectra for the tuning compounds must meet method/SOP criteria before analyses can proceed. Calibration policies for organics chromatographic analyses are described in the SOP SOC-CAL, *Calibration of Instruments for Organics Chromatographic Analyses*.

13.9 Gas Chromatographs and High Performance Liquid Chromatographs

Calibration and standardization follow SOP guidelines and/or appropriate USEPA method citations. All GC and HPLC instruments are calibrated at a minimum of five different concentration levels for the analytes of interest (unless specified otherwise). The lowest standard is equivalent to the method reporting limit; additional standards define the working range of the GC or LC detector. Results are used to establish response factors (or calibration curves) and retention-time windows for each analyte. Calibration is verified at a minimum frequency of once every ten samples, unless otherwise specified by the reference method. Calibration policies for organics chromatographic analyses are described in the SOP SOC-CAL, *Calibration of Instruments for Organics Chromatographic Analyses*.

LC/MS Systems:

Calibration and tuning procedures are included in analytical SOPs written specifically for these tests. In general, multiple concentration levels for the analytes of interest are used to generate calibration curves. All reference materials used for this function are vendor-certified standards. Calibration and tuning verification is performed at SOP-defined intervals. Any other system performance checks are described in the applicable SOP. Calibration policies for organics chromatographic analyses are described in the SOP SOC-CAL, *Calibration of Instruments for Organics Chromatographic Analyses*.

13.10 UV-Visible Spectrophotometer (manual colorimetric analyses)

Routine calibrations for colorimetric and turbidimetric analyses involve generating a 5 point calibration curve including a blank. Initial calibration points cannot be "dropped" from the resulting calibration curve. Correlation coefficients must meet method or SOP specifications before analysis can proceed. Independent calibration verification standards (ICVs) are analyzed with each batch of samples. Continuing calibration is verified at a minimum frequency of once every ten samples. Typical UV-Visible spectrophotometric methods at ALS Environmental, Kelso include total phenolics, phosphates, surfactants and tannin-lignin.

13.11 Flow Injection Analyzer (automated colorimetric analysis)

A minimum of six standards and a blank are used to calibrate the instrument for cyanide analysis. A blank and (minimum of) five standards are used to calibrate the instrument for all other automated chemistries. Initial calibration points cannot be "dropped" from the resulting calibration curve. Standard ALS Environmental, Kelso acceptance limits are used to evaluate the calibration curve prior to sample analysis.

13.12 Discrete Auto-Analyzer (automated absorbance analysis)

A minimum of five standards and a blank are used to calibrate the instrument. Initial calibration points cannot be "dropped" from the resulting calibration curve. Method specific acceptance limits are used to evaluate the calibration curve prior to sample analysis.

13.13 Ion Chromatographs

Calibration of the ion chromatograph (IC) involves generating a calibration curve with the method-specified number of points (or more). Initial calibration points cannot be "dropped" from the resulting calibration curve. A correlation coefficient of > 0.995 for the curve is required before analysis can proceed. Quality Control (QC) samples that are routinely analyzed include blanks and laboratory control samples. The target analytes typically determined by the IC include nitrate, nitrite, chloride, fluoride, sulfate and drinking water inorganic disinfection byproducts. Calibration verification is performed at method-specified intervals following the procedures in the SOP and reference method.

13.14 Turbidimeter

Calibration of the turbidimeter requires analysis of three Nephelometric Turbidity Unit (NTU) formazin standards. Quality Control samples that are routinely analyzed include blanks, Environmental Resource Associates QC samples (or equivalent) and duplicates.

13.15 Ion-selective electrode

The method-prescribed numbers of standards are used to calibrate the electrodes before analysis. The slope of the curve must be within acceptance limits before analysis can proceed. Quality Control samples that are routinely analyzed include blanks, LCSs and duplicates.

13.16 Pipets

The calibration of pipets and autopipettors used to make critical-volume measurements is verified following SOP ADM-VOLWARE, *Checking Volumetric Labware*. Both accuracy and precision verifications are performed, at intervals applicable to the pipet and use. The results of all calibration verifications are recorded in bound logbooks.

13.17 Other Instruments

Calibration for the total organic carbon (TOC), total organic halogen (TOX), and other instruments is performed following manufacturer's recommendations and applicable SOPs.

14) Assuring the Quality of Results

A primary focus of ALS - Kelso's QA Program is to ensure the accuracy, precision and comparability of all analytical results. Prior to using a procedure for the analysis on field samples, acceptable method performance is established by performing demonstration of capability analyses. Performance characteristics are established by performing method detection limit studies and assessing accuracy and precision according to the reference method. ALS - Kelso has established Quality Control (QC) objectives for precision and accuracy that are used to determine the acceptability of the data that is generated. These QC limits are either specified in the test methodology or are statistically derived based on the laboratory's historical data. Quality Control objectives are defined below.

14.1 Quality Control Objectives

14.1.1 Demonstration of Capability - A demonstration of capability (DOC) is made prior to using any new test method or when a technician is new to the method. This demonstration is made following regulatory, accreditation, or method specified procedures. In general, this demonstration does not test the performance of the method in real world samples, but in the applicable clean matrix free of target analytes and interferences.

A quality control sample material may be obtained from an outside source or may be prepared in the laboratory. The analyte(s) is (are) diluted in a volume of clean matrix (for analytes which do not lend themselves to spiking, e.g., TSS, the demonstration of capability may be performed using quality control samples). Where specified, the method-required concentration levels are used. Four aliquots are prepared and analyzed according to the test procedure. The mean recovery and standard deviations are calculated and compared to the corresponding acceptance criteria for precision and accuracy in the test method or laboratory-generated acceptance criteria (if there are not established mandatory criteria). All parameters must meet the acceptance criteria. Where spike levels are not specified, actual Laboratory Control Sample results may be used to meet this requirement, provided acceptance criteria is met.

14.1.2 Accuracy - A measure of the closeness of an individual measurement (or an average of multiple measurements) to a true or expected value and expressed as percent recovery (% REC.) of the measured value, relative to the true or expected value. If a measurement process produces results whose mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis or caused by an artifact of the measurement system (e.g., contamination). Ongoing accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory control sample, standard reference materials, or standard

solutions. In addition, matrix-spiked samples are also measured and recovery indicates the accuracy or bias in the actual sample matrix.

ALS - Kelso utilizes several quality control measures to eliminate analytical bias, including systematic analysis of method blanks, laboratory control samples and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

14.1.3 Precision - Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling and in laboratory analysis. The American Society of Testing and Materials (ASTM) recognizes two levels of precision: repeatability - the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions, and reproducibility - the random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material.

"Within-batch" precision is measured using replicate sample or QC analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

14.1.4 Control Limits - The control limits for accuracy and precision originate from two different sources. For analyses having enough QC data, control limits are calculated at the 99% confidence limits. For analyses not having enough QC data, or where the method is prescriptive, control limits are taken from the method on which the procedure is based. If the method does not have stated control limits, then control limits are assigned method-default or reasonable values based on similar methods. Control limits are reviewed each year and may be updated if new statistical limits are generated for the appropriate surrogate, laboratory control sample, and matrix spike compounds (typically once a year) or when method prescribed limits change. The updated limits are reviewed by the QAM. The new control limits replace the previous limits and data is assessed using the new values. Current *Data Quality Objectives*, including acceptance limits for accuracy and precision are available from the laboratory. For inorganics, the precision limit values listed are for laboratory duplicates. For organics, the precision limit values listed are for duplicate laboratory control samples or duplicate matrix spike analyses. Procedures for establishing control limits are found in SOP CE-QA009, *Control Limits*.

14.1.5 Representativeness - The degree to which the field sample, being properly preserved, free of contamination, and properly analyzed, represents the overall sample site or material. This can be extended to the sample itself, in that representativeness is the degree to which the subsample that is analyzed represents the entire field sample submitted for analysis. ALS - Kelso has sample handling procedures to ensure that the sample used for analysis is representative of the entire sample. These include the SOP for *Subsampling and Compositing of Samples* (GEN-SUBS) and the SOP for *Tissue Sample Preparation* (MET-TISP). Further, analytical SOPs specify sample handling and sample sizes to further ensure the sample aliquot that is analyzed is representative in entire sample.

14.1.6 Comparability – Comparability expresses the confidence with which one data set can be compared to another and is directly affected by data quality (accuracy and precision) and sample handling (sampling, preservation, etc.). Only data of known quality can be compared. The objective is to generate data of known quality with the highest level of comparability, completeness, and usability. This is achieved by employing the quality controls listed below and standard operating procedures for the handling and analysis of all samples. Data is reported in units specified by the client and using ALS Environmental, Kelso or project-specified data qualifiers.

14.2 Method Detection Limits, Method Reporting Limits, Limits of Detection, and Limits of Quantitation

Method Detection Limits (MDL) for methods performed at ALS - Kelso are determined during initial method set up and when significant changes are made. If an MDL study is not performed annually, the established MDL is verified by performing a Limit of Detection (LOD) verification on every instrument used in the analysis. The MDLs are determined by following the SOP CE-QA011, *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation*, which is based on the procedure in 40 CFR Part 136, Appendix B. As required by NELAP and DoD protocols, the validity of MDLs is verified using LOD verification samples.

The Method Reporting Limit (MRL) is the lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions (i.e. Limit of Quantitation- LOQ). LOQ are analyzed at the frequency specified in the SOP CE-QA011, and at specified concentrations (not lower than the lowest calibration standard). Current MDL/LOD and MRL/LOQ values are available from the laboratory.

14.3 Quality Control Procedures

The specific types, frequencies, and processes for quality control sample analysis are described in detail in method-specific standard operating procedures and listed below. These sample types and frequencies have been adopted for each method and a definition of each type of QC sample is provided below. Unique test-specific requirements may also exist and are found in the laboratory SOP.

14.3.1 Method Blank (a.k.a. Laboratory Reagent Blank)

The method blank is an analyte-free matrix (water, soil, etc.) subjected to the entire analytical process. When analyte-free soil is not available, anhydrous sodium sulfate, organic-free sand, or an acceptable substitute is used. The method blank is analyzed to demonstrate that the analytical system itself does not introduce contamination. The method blank results should be below the Method Reporting Limit (MRL) or, if required for DoD projects, < ½ MRL for the analyte(s) being tested. Otherwise, corrective action must be taken. A method blank is included with the analysis of every sample preparation batch, every 20 samples, or as stated in the method, whichever is more frequent.

14.3.2 Calibration Blank

For some methods, calibration blanks are prepared along with calibration standards in order to create a calibration curve. Calibration blanks are free of the analyte of interest and, where applicable, provide the zero point of the calibration curve. Additional project-specific requirements may also apply to calibration blanks.

14.3.3 Continuing Calibration Blank

Continuing calibration blanks (CCBs) are solutions of analyte-free water, reagent, or solvent that are analyzed in order to verify the system is contamination-free when CCV standards are analyzed. The frequency of CCB analysis is either once every ten samples or as indicated in the method, whichever is greater. Additional project-specific requirements may also apply to continuing calibration blanks.

14.3.4 Calibration Standards

Calibration standards are solutions of known concentration prepared from primary standard or stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration. Standards are analyzed in accordance with the requirements stated in the particular method being used.

14.3.5 Initial (or Independent) Calibration Verification Standard (ICV)

The ICV standard is prepared from materials obtained from a source independent of that used for preparing the calibration standards ("second-source"). The ICV is analyzed after calibration but prior to sample analysis in order to verify the validity and accuracy of the standards used in calibration. Once it is determined that there is no defect or error in the calibration standard(s), the standards are considered valid and may be used for subsequent calibrations and quantitative determinations (as expiration dates and methods allow). ICVs are also analyzed in accordance with method-specific requirements.

14.3.6 Continuing Calibration Verification Standard

Continuing calibration verification (CCV) standards are midrange standards that are analyzed in order to verify that the calibration of the analytical system is still acceptable. The frequency of CCV analysis is either once every ten samples, or as indicated in the method.

14.3.7 Internal Standards

Internal standards are known amounts of specific compounds that are added to each sample prior to instrument analysis. Internal standards are generally used for GC/MS and ICP/MS procedures to correct sample results that have been affected by changes in instrument conditions or changes caused by matrix effects. The requirements for evaluation of internal standards are specified in each method and SOP.

14.3.8 Surrogates

Surrogates are organic compounds which are similar in chemical composition and analytical behavior to the analytes of interest, but which are not normally found in environmental samples. Depending on the analytical method, one or more of these compounds is added to method blanks, calibration and check standards, and samples (including duplicates, matrix spike samples, duplicate matrix spike samples and laboratory control samples) prior to extraction and analysis in order to monitor the method performance on each sample. The percent recovery is calculated for each surrogate, and the recovery is a measurement of the overall method performance.

$$\text{Recovery (\%)} = (M/T) \times 100$$

Where: M = The measured concentration of analyte,
T = The known concentration of analyte added.

14.3.9 Laboratory Control Samples (a.k.a Laboratory Fortified Blank – LFB)

The laboratory control sample (LCS) is an aliquot of analyte-free water or analyte-free solid (or anhydrous sodium sulfate or equivalent) to which known amounts of the method analyte(s) is (are) added. A reference material of known matrix type, containing certified amounts of target analytes, may also be used as an LCS. An LCS is prepared and analyzed at a minimum frequency of one LCS per 20 samples, with every analytical batch or as stated in the method, whichever is more frequent. The LCS sample is prepared and analyzed in exactly the same manner as the field samples.

The percent recovery of the target analytes in the LCS is compared to established control limits and assists in determining whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements at the required reporting limit. Comparison of batch-to-batch LCS analyses enables the laboratory to evaluate batch-to-batch precision and accuracy.

$$\text{Recovery (\%)} = (M/T) \times 100$$

Where: M = The measured analyte concentration,
T = The known analyte concentration added.

14.3.10 Laboratory Fortified Blank – MRL Level

A laboratory blank fortified at the MRL used to verify that the method reporting limit can be achieved. This LFB is carried through the entire extraction and analytical procedure. A MRL LFB is required with every batch of drinking water samples.

14.3.11 Matrix Spikes (MS)

Matrix spiked samples are aliquots of samples to which a known amount of the target analyte (or analytes) is (are) added. The samples are then prepared and analyzed in the same analytical batch, and in exactly the same manner as are routine samples. For the appropriate methods, matrix spiked samples are prepared and analyzed and at a minimum frequency of one spiked sample (and one duplicate spiked sample, if appropriate) per twenty samples. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for the particular matrix in question. Spike recoveries are calculated as follows:

$$\text{Recovery (\%)} = (S - A)/T \times 100$$

Where: S = The measured analyte concentration in the spiked sample,
A = The measured analyte concentration in the parent sample,
T = The known analyte concentration added to the spiked sample.

14.3.12 Laboratory Duplicates and Duplicate Matrix Spikes

Duplicates are additional replicates of samples that are subjected to the same preparation and analytical scheme as the original sample. Depending on the method of analysis, either a duplicate analysis (and/or a matrix spiked sample) or a matrix spiked sample and duplicate matrix spiked sample

(MS/DMS) are analyzed. The relative percent difference between duplicate analyses or between an MS and DMS is a measure of the precision for a given method and analytical batch. The relative percent difference (RPD) for these analyses is calculated as follows:

Relative Percent Difference (RPD) = (S1 - S2) x 100 ÷ S_{ave}

Where:

S1 and S2 = The analyte concentrations in the sample and its duplicate, or in the matrix spike and its duplicate matrix spike, and,

S_{ave} = The average of analyte concentrations in the sample and its duplicate, or in the matrix spike and its duplicate matrix spike.

Depending on the method of analysis, either duplicates (and/or matrix spikes) or MS/DMS analyses are performed at a minimum frequency of one set per 20 samples. If an insufficient quantity of sample is available to perform a laboratory duplicate or duplicate matrix spikes, duplicate LCSs will be prepared and analyzed.

14.3.13 Interference Check Samples (ICS)

An ICS is a solution containing both interfering and analyte elements of known concentration that can be analyzed to verify background and interelement correction factors in metals analyses. The ICS is prepared to contain known concentrations (method or program specific) of elements that will provide an adequate test of the correction factors. The ICS is analyzed at the beginning and end of an analytical run or at a method-specified frequency. Results must meet method criteria and any project-specific criteria.

14.3.14 Post Digestion Spikes

Post digestion spikes are samples prepared for metals analyses that have an analyte spike added to determine if matrix effects may be a factor in the results. The spike addition should produce a method-specified minimum concentration above the method reporting limit. A post digestion spike is analyzed with each batch of samples and recovery criteria are specified for each method.

14.3.15 Control Charting

The generation of control charts is routinely performed at ALS. Surrogate, Matrix Spike and LCS recoveries are all monitored and charted. In addition, the laboratory also monitors the Relative Percent Difference (RPD) measurement of precision. Control charts are available to each individual laboratory unit to monitor the data generated in its facility using control charts that have been programmed to identify various trends in the analytical results. If trends in the data are perceived, various means of corrective action may then be employed in order to prevent future problems with the analytical system(s). Finally, data quality reports using control charts are generated for specific clients and projects pursuant to contract requirements. The control charting procedure is described in SOP CE-QA009, *Control Limits*.

14.3.16 Glassware Washing

Glassware washing and maintenance play a crucial role in the daily operation of a laboratory. The glassware used at ALS - Kelso undergoes a rigorous cleansing procedure prior to every usage. A number of SOPs have been generated that outline the various procedures used at ALS; each is specific to the end-use of the equipment as well as to the overall analytical requirements of the project. In addition, other equipment that may be routinely used at the laboratory is also cleaned following instructions in the appropriate SOP.

14.3.17 Uncertainty

Measurement uncertainty is associated with most of the results obtained in laboratory testing. It may be meaningful to estimate the extent of the uncertainty associated with each result generated by the laboratory. It is also useful to recognize that this measurement uncertainty is likely to be much less than that associated with sample collection activities. The uncertainty associated with the analytical measurement processes can be estimated from quality control data. When requested, the laboratory provides uncertainty information as described in the SOP CE-QA010, *Estimate of Uncertainty of Analytical Measurements*. The estimation of uncertainty relates only to measurements conducted in the laboratory.

14.4 When data quality objectives or quality control measures are not met, due to the sample matrix or anomalies, incompatibility of the methodology and sample type, statistical outliers, random error, or other factors, it may be necessary to apply data qualifiers to reported data. A list of standard data qualifiers is given in Appendix H.

15) Control of Non-Conforming Environmental Testing Work

The laboratory takes all appropriate steps necessary to ensure all sample results are reported with acceptable quality control results. When sample results do not conform to established quality control procedures, responsible management will evaluate the significance of the nonconforming work and take corrective action to address the nonconformance.

Nonconforming events such as errors, deficiencies, deviations from SOP, proficiency (PT) failure or results that fall outside of established QC limits are documented using the NCAR database. The procedure and responsibilities for addressing nonconforming work is defined in SOP CE-QA008, *Nonconformance and Corrective Action*. Nonconformances are reported to the client using various means (voice, email, narrative, etc.). When a nonconformance occurs that casts doubt on the validity of the test results or additional client instructions are needed, the Project Manager notifies the client the same business day that the nonconformance is confirmed and reported. The QAM reviews each problem, ensuring that appropriate corrective action has been taken by the appropriate personnel. The QAM periodically reviews all NCARs looking for chronic, systematic problems that need more in-depth investigation and alternative corrective action consideration. In addition, the appropriate Project Manager is promptly notified of any problems in order to inform the client and proceed with any action the client may want to initiate.

Results from non-conforming environmental testing work generally require the need for qualified data on analytical reports. A list of standard data qualifiers is given in Appendix H. Additionally, the report narrative will provide an explanation of the nonconformance and potential impact on results.

16) Corrective Action, Preventive Action, and Improvement

If a quality control measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure shall be reported with the appropriate data qualifier(s). Failure to meet established analytical controls, such as the

quality control objectives, prompts corrective action. Corrective action may take several forms and may involve a review of the calculations, a check of the instrument maintenance and operation, a review of analytical technique and methodology, and reanalysis of quality control and field samples. If a potential problem develops that cannot be solved directly by the responsible analyst, the supervisor, team leader, the department manager, and/or the QAM may examine and pursue alternative solutions. In addition, the appropriate Project Manager is notified in order to ascertain if the client needs to be notified.

Part of the corrective action process involves determining the root cause. Identifying the root cause of a nonconformance can be difficult, but important for implementing effective corrective action. Root cause principles are used to determine assignable causes, which leads to corrective action taken to prevent recurrence. Various preventive action processes are used for eliminating a potential problem or averting a problem before it occurs. This is explained in CE-QA008, *Nonconformance and Corrective Action*.

Preventive action is focused on using existing information or experiences to anticipate potential problems and eliminating the likely causes of them. Preventive action is a pro-active process and tied to results from corrective action as well as opportunities for improvement. ALS – Kelso used preventive action processes to avoid errors and implement improvements. The SOP CE-GEN004, *Preventive Action*, describes procedures used. Examples of preventive action are given in the SOP. The laboratory also uses ideas from staff, client feedback, and other input mechanisms to identify potential improvements. The monthly lab-wide meeting regularly includes reports on improvements made or underway.

16.1 Preventive maintenance

Preventive maintenance is a crucial element of the QA program. Equipment and instruments at ALS - Kelso are regularly maintained by qualified laboratory staff or under commercial service contracts. All instruments are operated and maintained according to the instrument operating manuals. All routine and special maintenance activities pertaining to the instruments are recorded in instrument maintenance logbooks. The maintenance logbooks used at ALS Environmental, Kelso contain extensive information about the instruments used at the laboratory, including:

- The equipment's serial number;
- Date the equipment was received;
- Date the equipment was placed into service;
- Condition of equipment when received (new, used, reconditioned, etc.); and
- Prior history of damage, malfunction, modification or repair (if known).

Preventive maintenance procedures, frequencies, etc. are available for each instrument used at ALS. They may be found in the various SOPs for routine methods performed on an instrument and may also be found in the operating or maintenance manuals provided with the equipment at the time of purchase.

Responsibility for ensuring that routine maintenance is performed lies with the section supervisor. In the case of non-routine repair of capital equipment, the section supervisor is responsible for providing the repair, either by performing the repair themselves with manufacturer guidance or by acquiring on-site manufacturer repair. Each laboratory section maintains a critical parts inventory. This inventory or "parts list" also includes the items needed to perform any other routine maintenance and certain in-house non-routine repairs such as gas chromatography/mass spectrometry jet separators and electron multipliers and ICP/MS nebulizer. When performing maintenance on an instrument (whether preventive or corrective), additional

information about the problem, attempted repairs, etc. is also recorded in the notebook. Typical logbook entries include the following information:

- Details and symptoms of the problem;
- Repairs and/or maintenance performed;
- Description and/or part number of replaced parts;
- Source(s) of the replaced parts;
- Analyst's signature and date; and
- Demonstration of return to analytical control.

See the Appendix E for a list of equipment and whether primarily maintained by laboratory of service providers.

17) Control of Records

ALS - Kelso maintains a records system which ensures that all laboratory records of analysis data retained and available. Analysis data is retained for 5 years from the report date unless contractual terms or regulations specify a longer retention time. The archiving system is described in the SOP for *Data Archiving* (ADM-ARCH).

17.1 Documentation and Archiving of Sample Analysis Data

The archiving system includes the following items for each set of analyses performed:

- Benchsheets describing sample preparation (if appropriate) and analysis;
- Instrument parameters (or reference to the data acquisition method);
- Sample analysis sequence;
- Instrument printouts, including chromatograms and peak integration reports for all samples, standards, blanks, spikes and reruns;
- Logbook ID number for the appropriate standards;
- Copies of report sheets submitted to the work request file; and
- Copies of Nonconformity and Corrective Action Reports, if necessary.

Individual sets of analyses are identified by analysis date and service request number. Since many analyses are performed with computer-based data systems, the final sample concentrations can be automatically calculated. If additional calculations are needed, they are written on the integration report or securely stapled to the chromatogram, if done on a separate sheet.

For organics analysis, data applicable to all analyses within the batch, such as GCMS tunes, CCVs, batch QC, and analysis sequences; are kept using a separate documentation system. This system is used to archive data on a batch-specific basis and is segregated according to the date of analysis. This system also includes results for the most recent calibration curves, as well as method validation results.

18) Audits

Quality audits are an essential part of the Quality Assurance program. There are two types of audits used at the facility: System Audits are conducted to qualitatively evaluate the operational details of the QA program, while Performance Audits are conducted by analyzing proficiency testing samples in order to quantitatively evaluate the outputs of the various measurement systems.

18.1 System Audits

The system audit examines the presence and appropriateness of laboratory systems. External system audits of ALS/Kelso are conducted regularly by various regulatory agencies and clients. Appendix J lists the certification and accreditation programs in which ALS/Kelso participates. Programs and certifications are added as required.

Internal system audits of ALS/Kelso are conducted regularly under the direction of the Quality Assurance Manager. The internal audit procedures are described in SOP CE-QA001, *Internal Audits*. The internal audits are performed as follows:

- System audit – this is an annual audit of the implementation of the quality system in the laboratory.
- Process audit – this is an audit of all operational areas in the laboratory to evaluate compliance with operational and technical procedures. Focus is on sample handling, preparation and analysis and technically sound practices. Three primary concepts are 1) is the procedure in use the same as that described in the SOP, 2) the use of sound analytical techniques and practices, and 3) sample handling/preparation. Topics as calibration, sample/analytical batching, standards traceability, QC criteria, instrument operation/maintenance, data interpretation, and reporting results are included. Hardcopy data and/or report audits may be included.

  Process audits may be one larger audit event or a series of audits such that all areas of the laboratory are audited over a year. Process audits conducted over the four calendar quarters will follow the schedules listed in an audit plan.
- Electronic data audits focus on organic chromatographic data and include an examination of audit trails, peak integrations, calibration practices, GCMS tuning data, use of appropriate files, and other components of the analysis. Each applicable instrument is periodically audited using audit software and randomly selected data files.

All audit findings and corrective actions are documented. The results of each audit are reported to the Laboratory Director and Department Managers for review. Any deficiencies identified are summarized in the audit report. Managers must respond with corrective actions correcting the deficiency within a defined timeframe. Should problems impacting data quality be found during an internal audit, any client whose data is adversely impacted will be given written notification within the corrective action period (if not already provided).

Additional internal audits or data evaluations may be performed as needed to address any potential data integrity issues that may arise.

18.2 Performance Audits

ALS - Kelso participates in the analysis of interlaboratory proficiency testing (PT) samples. Participation in PT studies is performed on a regular basis and is designed to evaluate all analytical areas of the laboratory. General procedures for these analyses are described in SOP CE-QA006, *Proficiency Sample Testing Analysis*. ALS - Kelso routinely participates in the following studies:

- Water Pollution (WP) and additional water parameters, 2 per year.
- Water Supply (WS) PT studies, 2 per year.
- Hazardous Waste/Soil/UST PT studies, 2 per year.
- Microbiology (WS and WP) PT studies, 2 per year.

- Underground Storage Tank PT studies, minimum 1 per year, or as specified for accreditation for state-specific methods.
- Other studies as required for certifications, accreditations, or validations.

PT samples are processed by entering them into the LIMS system as samples and are processed the same as field samples (following the PT provider instructions). The laboratory sections handle samples the same as field samples, performing the analyses following method requirements and performing data review. The laboratory sections submit results to the QA Manager for subsequent reporting to the appropriate agencies or study provider. Results of the performance evaluation samples and audits are reviewed by the QAM, Laboratory Director, the laboratory staff, and the Manager of Quality Assurance, USA. For any results outside acceptance criteria, the analysis data is reviewed to identify a root cause for the deficiency, and corrective action is taken and documented through nonconformance (NCAR) procedures.

19) Management Review

An annual Review of the laboratory's quality system and testing activities is conducted by the laboratory's management team to ensure the continuing suitability and effectiveness of the quality system and testing activities and to introduce any necessary changes or improvements. The review ensures that the quality system of the laboratory continues to conform to the requirements of the ISO 17025:2005 and various accrediting authorities, including NELAP/TNI.

General procedures for the Review are described in SOP CE-QA005, *Laboratory Management Review*. When conducting the review a standard list of items and categories is evaluated. The quality policies and their relation to testing activities are reviewed and any changes that are necessary are identified. The review also notes significant changes that have taken place or need to take place in the quality system; and the organization, facilities, equipment, procedures, and activities of the laboratory.

The Review is documented by the laboratory QA Manager. Action items, including preventive actions and improvements, should be identified. Results should feed into the laboratory's planning process planning.

20) Personnel

20.1 Personnel Training

Job descriptions, including technical position descriptions, are used for all employees, regardless of position or level of seniority. These documents are maintained by the Human Resources personnel and are available for review. In order to assess the technical capabilities and qualifications of a potential employee, all candidates for employment are evaluated, in part, against the appropriate technical description.

Training begins the first day of employment at ALS - Kelso when the company policies are presented and discussed. Safety and Quality System requirements are integral parts of initial and ongoing training processes at the laboratory. Safety training begins with the reading of the ALS Environmental Health and Safety Manual. Employees are also required to attend periodic safety meetings where additional safety training may be performed by the Environmental, Health and Safety Officer.

Quality Systems training begins with QA orientation for new employees which includes and reading the Quality Assurance Manual and ethics/data integrity introductory training. During the employee's first year the employee attends additional core ethics training and further learns about the laboratory quality systems as they relate to job functions. Each employee participates in annual ethics refresher training.

Employees are responsible for complying with the requirements of the QA Manual and QA/QC requirements associated with their function(s). ALS - Kelso also encourages its personnel to continue to learn and develop new skills that will enhance their performance and value to the company. Ongoing training occurs for all employees through a variety of mechanisms. The corporate, company-wide training and development program, external and internal technical seminars and training courses, and laboratory-specific training exercises are all used to provide employees with professional growth opportunities.

All technical training is documented and records are maintained in the QA department. Training requirements and its documentation are described in SOP ADM-TRAIN, *ALS-Kelso Training Procedure*. A training plan is developed whenever an employee starts a new procedure to new position. The training plan includes a description of the step-by-step process for training an employee and for initial demonstration of capability. Where the analyst performs the entire procedure, a generic training plan may be used.

20.2 Initial Demonstration of Capability (IDOC)

Training in analytical procedures typically begins with the reading of the SOP for the method. Hands-on training begins with the observation of an experienced analyst performing the method, followed by the trainee performing the method under close supervision, and culminating with independent performance of the method on quality control samples. Successful completion of the applicable Demonstration of Capability analysis qualifies the analyst to perform the method independently. Demonstration of Capability is performed by one of the following:

- Successful completion of an Initial Precision and Recovery (IPR) study (required where mandated by the method).
- Analysis of 4 consecutive Laboratory Control Samples, with acceptable accuracy and precision.
- Where spiking is not possible but QC standards are used ("non-spiked" LCS), analysis of 4 consecutive LCS analyses with acceptable accuracy and precision.
- Where one of the three above is not possible, special requirements are as follows:
    - Total Settleable Solids: Successful single-blind PT sample analysis and duplicate results with RPD<10%.
    - Color: Four consecutive prepared LCSs with acceptable accuracy and precision of <10% RSD.
    - Physical Tests (Grain size, Corrosivity to Steel, etc.): Supervisor acknowledgement of training and approval.

A flowchart identifying the Demonstration of Proficiency requirements is given in Figure 20-1. The flowchart identifies allowed approaches to assessing Demonstration of Capability when a 4-replicate study is not mandated by the method, when spiking is not an option, or when QC samples are not readily available.

20.3 Continuing Demonstration of Proficiency

A periodic demonstration of proficiency is required to maintain continuing qualification. Continuing Demonstration of Proficiency is required each year, and may be performed one of the following ways:

- Successful performance on external (independent) single-blind sample analyses using the test method, or a similar test method using the same technology. I.e. PT sample or QC sample blind to the analyst.

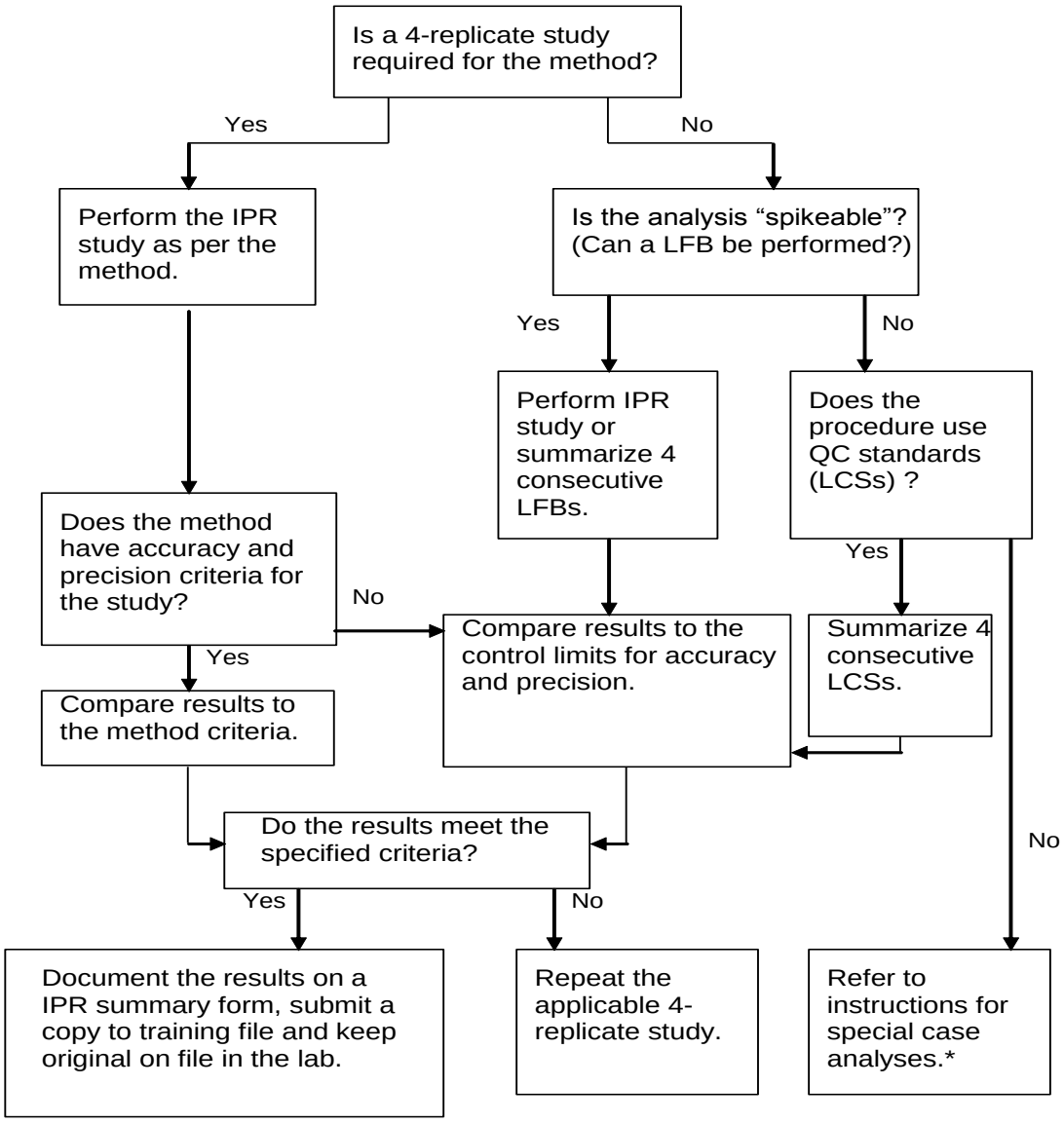
- Performing Initial Demonstration of Capability as described above, with acceptable levels of precision and accuracy.
- Analysis of at least 4 consecutive LCSs with acceptable levels of accuracy and precision from in-control analytical batches.
- If the above cannot be performed, analysis of authentic samples with results statistically indistinguishable from those obtained by another trained analyst.
- For methods for which PT samples are not available and a spiked analysis (LFB, MDL, etc.) is not possible, analysis of field samples that have been analyzed by another analyst with statistically indistinguishable results.

20.4 Documentation of Training

Records are maintained to indicate the employee has the necessary training, education, and experience to perform their functions. Information of previously acquired skills and abilities for a new employee is maintained in Human Resources personnel files and internal resumes. The QA department maintains a record of the various technical skills and training acquired while employed by ALS. Information includes the employee's name, a description of the skill including the appropriate method and SOP reference, the mechanism used to document proficiency, and the date the training was completed. General procedures for documenting technical training are described in SOP ADM-TRAIN, *ALS-Kelso Training Procedure*.

Figure 20-1

Demonstration of Proficiency Flowchart



21) Reporting of Results

ALS - Kelso reports the analytical data produced in its laboratories to the client via the Analytical Report. This report includes a transmittal letter, a case narrative, client project information, sample receipt and chain of custody information, specific test results, quality control data (as requested), and any other project-specific support documentation. The following procedures describe the procedures used for data reduction, validation and reporting.

21.1 Data Reduction and Review

Results are generated by the analyst who performs the analysis and works up the raw data. All data is initially reviewed and processed by analysts using appropriate methods (e.g., chromatographic software, instrument printouts, hand calculation, etc.). Equations used for calculation of results are found in the applicable analytical SOPs. Policies and procedures for manual editing of data are established. The analyst making the change must initial and date the edited data entry, without obliteration of the original entry. The policies and procedures are described in the SOP CE-QA007, *Making Entries onto Analytical Records*.

The resulting data set is either manually entered (e.g., titrimetric or microbiological data) into an electronic report form or is electronically transferred into the report. Once the complete data set has been transferred into the proper electronic report form(s), it is then printed. The resulting hardcopy version of the electronic report is then reviewed by the analyst for accuracy. Once the primary analyst has checked the data for accuracy and acceptability, the data and report hardcopy is forwarded to the supervisor or second qualified analyst who reviews the data. Where calculations are not performed using a validated software system, the reviewer rechecks a minimum of 10% of the calculations. Analysts performing routine testing are responsible for generating a data quality narrative or data review document with every analytical batch processed. This report also allows the analyst to provide appropriate notes and/or a narrative if problems were encountered with the analyses. A Nonconformance and Corrective Action Report (NCAR) may also be attached to the data prior to review. Supervisors or qualified analysts review all of the completed analytical batches to ensure that all QC criteria have been examined and any deficiencies noted and addressed. Data review procedures are described in the SOP for *Laboratory Data Review Process* (ADM-DREV).

Policies and procedures for electronic manual integration of chromatographic data are established. The analyst performing the integration must document the integration change by printing both the “before” and “after” integrations and including them in the raw data records. The policies and procedures are described in SOP CE-QA002, *Manual Integration Policy* and SOP ADM-MI, *Manual Integration of Chromatographic Peaks*.

21.1.1 Validation of Results

The validity of the data generated is assessed through the evaluation of the sample results, calibrations, and QC samples (method blanks, laboratory control samples, sample duplicates, matrix spikes, trip blanks, etc.). A brief description of the evaluation of these analyses is described below, with details listed in applicable SOPs. The criteria for evaluation of QC samples are listed within each method-specific SOP. Other data evaluation measures may include (as necessary) a check of the accuracy check of the QC standards and a check of the system sensitivity. Data transcriptions and calculations are also reviewed.

Note: Within the scope of this document, all possible data assessment requirements for various project protocols cannot be included in the listing below. This listing gives a general description of data evaluation practices used in the laboratory in compliance with NELAP Quality Systems requirements. Additional requirements exist for certain programs, such as projects under the DoD QSM protocols, and project-specific QAPPs.

- Initial Calibration – Following the analysis of calibration standards according to the applicable SOP the data is fit to an applicable and allowed calibration model (correlation coefficient, linear, average response factor, quadratic, etc.) and the resulting calibration is compared to specified criteria. If the calibration meets criteria analysis may continue. If the calibration fails, any problems are isolated and corrected and the calibration standards reanalyzed. Following calibration and analysis of the independent calibration verification standard(s) the percent difference for the ICV is calculated. If the percent difference is within the specified limits the calibration is complete. If not, the problem associated with the calibration and/or ICV are isolated and corrected and verification and/or calibration is repeated.
- Continuing Calibration Verification (CCV) – Following the analysis of the CCV standard the percent difference is calculated and compared to specified criteria. If the CCV meets the criteria analysis may continue. If the CCV fails, routine corrective action is performed and documented and a 2nd CCV is analyzed. If this CCV meets criteria, analysis may continue, including any reanalysis of samples that were associated with a failing CCV. If the routine corrective action failed to produce an immediate CCV within criteria, then either acceptable performance is demonstrated (after additional corrective action) with two consecutive calibration verifications or a new initial calibration is performed.
- Method Blank – Results for the method blank are calculated as performed for samples. If results are less than the MRL (<½ MRL for DoD projects), the blank may be reported. If not, associated sample results are evaluated to determine the impact of the blank result. If possible, the source of the contamination is determined. If the contamination has affected sample results the blank and samples are reanalyzed. If positive blank results are reported, the blank (and sample) results are flagged with an appropriate flag, qualifier, or footnote.
- Sample Results (Inorganic) – Following sample analysis and calculations (including any dilutions made due to the sample matrix) the result is verified to fall within the calibration range. If not, the sample is diluted and analyzed to bring the result into calibration range. When sample and sample duplicates are analyzed for precision, the calculated RPD is compared to the specified limits. The sample and duplicate are reanalyzed if the criteria are exceeded. The samples may require re-preparation and reanalysis. For metals, additional measures as described in the applicable SOP may be taken to further evaluate results (dilution tests and/or post-digestion spikes). Results are reported when within the calibration range, or as estimates when outside the calibration range. When dilutions are performed the MRL is elevated accordingly and qualified. Efforts are made to meet the project MRL's including alternative analysis.

- Sample Results (Organic) – For GC/MS analyses, it is verified that the analysis was within the prescribed tune window. If not, the sample is reanalyzed. Following sample analysis and calculations (including any dilutions made due to the sample matrix) peak integrations, retention times, and spectra are evaluated to confirm qualitative identification. Internal standard responses and surrogate recoveries are evaluated against specified criteria. If internal standard response does not meet criteria, the sample is diluted and reanalyzed. Results outside of the calibration range are diluted to within the calibration range. For GC and HPLC tests, results from confirmation analysis are evaluated to confirm positive results and to determine the reported value. The procedure to determine which result to report is described in the SOP for Confirmation Procedure for GC and HPLC Analysis (SOC-CONF). If obvious matrix interferences are present, additional cleanup of the sample using appropriate procedures may be necessary and the sample is reanalyzed. When dilutions are performed the MRL is elevated accordingly and qualified. Efforts are made to meet the project MRL's including additional cleanup.
- Surrogate Results (Organic) – The percent recovery of each surrogate is compared to specified control limits. If recoveries are acceptable, the results are reported. If recoveries do not fall within control limits, the sample matrix is evaluated. When matrix interferences are present or documented, the results are reported with a qualifier that matrix interferences are present. If no matrix interferences are present and there is no cause for the outlier, the sample is reprepared and reanalyzed. However, if the recovery is above the upper control limit with non-detected target analytes, the sample may be reported. All surrogate recovery outliers are appropriately qualified on the report.
- Duplicate Sample and/or Duplicate Matrix Spike Results – The RPD is calculated and compared to the specified control limits. If the RPD is within the control limits the result is reported. If not, an evaluation of the sample is made to verify that a homogenous sample was used. Despite the use of homogenizing procedures prior to sample preparation or analysis, the sample may not be homogenous or duplicate sample containers may not have been sample consistently. If non-homogenous, the result is reported with a qualifier about the homogeneity of the sample. Also, the results are compared to the MRL. If the results are less than five times the MRL, the results are reported with a qualifier that the high RPD is due to the results being near the MRL. If the sample is homogenous and results above five times the MRL, the samples and duplicates are reanalyzed. If re-analysis also produces out-of-control results, the results are reported with an appropriate qualifier.
- Laboratory Control Sample Results – The LCS percent recovery is calculated and compared to specified control limits. If the recovery is within control limits, the analysis is in control and results may be reported. If not, this indicates that the analysis is not in control. Samples associated with the 'out of control' LCS, shall be considered suspect and the samples re-extracted or re-analyzed or the data reported with the appropriate qualifiers. For analysis where a large number of analytes are in the LCS, it becomes more likely that some analytes (marginal exceedences) will be outside the control limits. The

procedure described in the 2003 NELAC standards, Appendix D.1.1.2.1 are used to determine if the LCS is effective in validating the analytical system and the associated samples.

- Matrix Spike Results – The MS percent recovery is calculated and compared to specified control limits. If the recovery is within control limits the results are reported. If not, and the LCS is within control limits, this indicates that the matrix potentially biases analyte recovery. It is verified that the spike level is at least five times the background level. If not, the results are reported with a qualifier that the background level is too high for accurate recovery determination. If matrix interferences are present or results indicate a potential problem with sample preparation, steps may be taken to improve results; such as performing any additional cleanups, dilution and reanalysis, or re-preparation and reanalysis. Results that do not meet acceptance limits are reported with an appropriate qualifier.

21.1.2 Qualitative Data Evaluation

All sample results and QC results are reviewed to ensure correct identification of target analytes, when not inherent to the test method. Details particular to each analysis are given in the analytical SOP.

Identification criteria for GC, LC or GC/MS methods are summarized below:

- GC and LC Methods
  - The analyte must fall within the retention time window specified in the applicable SOP. The retention time window is established prior to analysis and documented.
  - For analyses all positive results are confirmed by a second column, a second detector, a second wavelength (HPLC/UV), or by GC/MS analysis. Details for confirmation analysis are described in the SOP SOC-CONF, *Confirmation Procedures for GC and HPLC Analyses*. Confirmation Data Confirmation data will be provided as specified in the method.
  - When sample results are confirmed by two dissimilar columns or detectors, the agreement between quantitative results must be evaluated. The relative percent difference between the two results is calculated and evaluated against SOP and/or method criteria.
- GC/MS and LC/MS Methods - Two criteria are used to verify identification:
  - Elution of the analyte is at the same relative retention time (as defined by the method) as demonstrated in the standard.
  - The mass spectrum of the analyte in the sample must, in the opinion of a qualified analyst or the department manager, correspond to the spectrum of the analyte in the standard or the current GC/MS reference library.
  - When Tentatively Identified Compounds are to be reported for GC/MS, the spectrum for non-target peaks is compared to the current GC/MS reference library.

21.2 Data Reporting

It is the responsibility of each laboratory unit to provide the Project Manager with a final report of the data for each analysis, accompanied by signature approval. When the entire data set has been found to be acceptable, a final copy of the report is generated and approved by the laboratory supervisor, departmental manager or designated laboratory staff. The entire data package for the analysis is then placed into the service request file, and an electronic copy of the final data package is forwarded to the appropriate personnel for archival. Footnotes and/or narrative notes must accompany any data package if problems were encountered that require further explanation to the client. Each data package is submitted to the appropriate Project Manager.

When all analyses and departmental reports are completed the Project Manager reviews the entire collection of analytical data for completeness and to ensure that any and all client-specified objectives were successfully achieved. A report narrative is written by the Project Manager to explain any unusual problems with a specific analysis or sample, etc. Prior to release of the report to the client, the Project Manager reviews and approves the entire report for completeness and to ensure that any and all client-specified objectives were successfully achieved. The original raw data, along with a copy of the final report, is scanned and archived by service request number.

To the extent possible, samples shall be reported only if all QC measures are acceptable. If a QC measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure shall be reported with the appropriate data qualifier(s). The SOP for *Data Reporting and Report Generation* (ADM-RG) addresses the flagging and qualification of data. The ALS-defined data qualifiers, state-specific data qualifiers, or project-defined data qualifiers are used depending on project requirements. A case narrative may be written by the Project Manager to explain problems with a specific analysis or sample, etc.

When requested by the client or relevant to the validity of reported results, the estimation of measurement uncertainty will be provided to a client or regulatory agency. How the uncertainty will be reported may be dictated by the client's reporting specifications. Procedures for determining and reporting uncertainty are given in SOP CE-QA010, *Estimation of Uncertainty of Analytical Measurements*.

For subcontracted analyses, the Project Manager verifies that the report received from the subcontractor is complete. This includes checking that the correct analyses were performed, the analyses were performed for each sample as requested, a report is provided for each analysis, and the report is signed. The Project Manager accepts the report if all verification items are complete. Acceptance is demonstrated by forwarding the report to the client.

21.3 Deliverables

In order to meet individual project needs, ALS - Kelso provides several levels of analytical reports. Standard specifications for each level of deliverable are described in Table 21-1. Variations may be provided based on client or project specifications. This includes (but is not limited to) deliverables for DoD QSM projects and state-specific drinking water formats.

When requested, ALS - Kelso provides Electronic Data Deliverables (EDDs) in the format specified by client need or project specification. ALS - Kelso is capable of generating EDDs with many different formats and specifications. The EDD is prepared by report production staff using the electronic version of the laboratory report to minimize transcription errors. User guides and EDD specification outlines are used in preparing the EDD. The EDD is reviewed and compared to the hard-copy report for accuracy.

Table 21-1
Descriptions of ALS Environmental - Kelso Standard Data Deliverables*
Tier I. Routine Analytical Report includes the following:
• Transmittal letter
• Chain of custody documents and sample/cooler receipt documentation
• Sample analytical results
• Method blank results
• Surrogate recovery results and acceptance criteria for applicable organic methods
• Dates of sample preparation and analysis for all tests
• Case narrative - optional
Tier II. In addition to the Tier I Deliverables, this Analytical Report includes the following:
• Laboratory Control Sample results with calculated recovery and associated acceptance criteria
• Matrix spike results with calculated recovery and associated acceptance criteria
• Duplicate or duplicate matrix spike result(s) (as appropriate to method), with calculated relative percent difference
• Case narrative - optional
Tier III. Data Validation Package. In addition to the Tier II Deliverables, this CAR includes the following:
• Case narrative - required
• Summary forms for all associated QC and Calibration parameters, with associated control criteria/acceptance limits
• Other summary forms specified in QAPPs or project/program protocols, or those related to specialized analyses such as HRGC/MS are included.
Tier IV. Full Data Validation Package.
• All raw data associated with the sample analysis, including but not limited to: • Preparation and analysis bench sheets and instrument printouts, • For organics analyses, all applicable chromatograms, spectral, confirmation, and manual integration raw data. For GC/MS this includes tuning results, mass spectra of all positive results, and the results and spectra of TIC compounds when requested.
• QC data
• Calibration data (initial, verification, continuing, etc.),
• Calibration blanks or instrument blanks (as appropriate to method).

* If a project QAPP or program reporting protocol applies the report will be presented as required for the project.

22) Summary of Changes and Document History

Revision Number	Effective Date	Document Editor	Description of Changes
23.0	5/1/2014	L. Wolf	Reformatted to current ALS style. Updated key personnel, Organization charts, and equipment. Updated and reorganized appendices. Removed remaining CAS references and updated Kelso and corporate SOP references. Minor changes to text in several areas to improve readability and presentation, without changing concept.

23) References for Quality System Standards, External Documents, Manuals, and Test Procedures

The analytical methods used at ALS Environmental, Kelso generally depend upon the end-use of the data. Since most of our work involves the analysis of environmental samples for regulatory purposes, specified federal and/or state testing methodologies are used and followed closely. Typical methods used at ALS Environmental, Kelso are taken from the following references:

- National Environmental Laboratory Accreditation Program (NELAP), 2003 Quality Standards.
- TNI Standard – Environmental Laboratory Sector, Volume 1, *Management and Technical Requirements for Laboratories Performing Environmental Analysis,* EL-V1-2009.
- Quality Standards. American National Standard *General requirements for the competence of testing and calibration laboratories,* ANSI/ISO/IEC 17025:2005(E)
- *DoD Quality Systems Manual for Environmental Laboratories,* Versions 4.2 and 5.0
- *Good Automated Laboratory Practices, Principles and Guidance to Regulations For Ensuring Data Integrity In Automated Laboratory Operations*, EPA 2185 (August 1995).
- *Manual for the Certification of Laboratories Analyzing Drinking Water*, 5th Edition, EPA 815-B-97-001 (January 2005).
- *Procedure Manual for the Environmental Laboratory Accreditation Program,* Washington Department of Ecology, 10-03-048, September 2010.
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, (September 1986) and Updates I (July 1992), II (September 1994), IIA (August 1993), IIB (January 1995), III (December 1996), Final Update IV (February 2007), and updates posted online at http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm. See Chapters 1, 2, 3, and 4.
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, (Revised March 1983).
- *Methods for the Determination of Inorganic Substances in Environmental Samples*, EPA/600/R-93/100 (August 1993).
- *Methods for the Determination of Metals in Environmental Samples*, EPA/600/4-91/010 (June 1991) and Supplements.

- *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, EPA 600/4-82-057 (July 1982) and 40 CFR Part 136, Appendix A.
- *Methods for the Determination of Organic Compounds in Drinking Water*, EPA/600/4-88/039 (December 1988) and Supplements.
- Standard Methods for the Examination of Water and Wastewater, 20th Edition (1998) and SM On-Line. See Introduction in Part 1000.
- 40 CFR Part 136, Guidelines for Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and EPA Method Update Rule 2007 and 2012.
- 40 CFR Part 141, National Primary Drinking Water Regulations and EPA Method Update Rule 2007.
- Analytical Methods for Petroleum Hydrocarbons, ECY 97-602, Washington State Department of Ecology, June 1997.
- State-specific total petroleum hydrocarbon methods for the analysis of samples for gasoline, diesel, and other petroleum hydrocarbon products (Alaska, Arizona, California, Oregon, Washington, Wisconsin, etc.).
- Annual Book of ASTM Standards, Part 31, Water.
- U. S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-94/012 (February 1993).
- U. S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94/013 (February 1994).
- Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, for USEPA and USACE (March 1986), with revisions through April 1997.
- WDOE 83-13, Chemical Testing Methods for Complying with the State of Washington Dangerous Waste Regulations (March 1982) and as Revised (July 1983 and April 1991).
- Identification and Listing of Hazardous Waste, California Code of Regulations, Title 22, Division 4.5, Chapter 11.
- Analytical Methods for the Determination of Pollutants in Pulp and Paper Industry Wastewater, EPA 821-R-93-017 (October 1993).
- Analytical Methods for the Determination of Pollutants in Pharmaceutical Manufacturing Industry Wastewaters, EPA 821-B-98-016 (July 1998).
- National Council of the Pulp and Paper Industry for Air and Stream Improvement (NCASI).

Internal program-level QA documents are listed in Appendix I.

APPENDIX A – Glossary

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accreditation Body: The territorial, state or federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.

Accreditation Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.

Analysis Date: The calendar date of analysis associated with the analytical result reported for an accreditation or experimental field of proficiency testing.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation).

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Bias: The systematic distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

Calibration Standard: A substance or reference material used for calibration.

Certified Reference Material (CRM): Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability to a national metrology institute.

Chain of Custody: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more useful form.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT): Analytes for which a laboratory is required to successfully analyze a PT sample in order to obtain or maintain accreditation, collectively defined as: matrix, technology/method, analyte.

Finding: An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.

Holding Time: The specified maximum time that can elapse between two specified sampling and/or analytical activities.

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish evaluate accuracy and bias for associated sample analyses.

Legal Chain of Custody Protocols: Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit of Detection (LOD): A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect.

Limit of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

Matrix: The substrate of a test sample.

Matrix Duplicate: A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Measurement System: A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

Method: A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

National Institute of Standards and Technology (NIST): A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States National Metrology Institute (NMI).

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator.

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis.

Primary Accreditation Body (Primary AB): The TNI-NELAP accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.

Procedure: A specified way to carry out an activity or process. Procedures can be documented or not.

Proficiency Testing (PT): A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.

Proficiency Testing Provider (PTP): A person or organization accredited by the TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT program.

Proficiency Testing Sample (PT Sample): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.

Proficiency Testing Study (PT Study): A single complete sequence of circulation of proficiency testing samples to all participants in a proficiency test program.

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Control: The overall system of technical activities that continually measures the performance of a process, item, or service against defined standards to verify that they meet the stated requirements. Also, the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system.

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC) activities.

Quality System Matrix: These matrix definitions be used for purposes of batch and quality control requirements:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples are grouped according to type of tissue (i.e. marine vs. plant).

Chemical Waste: A product or by-product of an industrial process that results in a matrix not otherwise defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid, product, or solvent not miscible in water and with <15% settleable solids.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

Raw Data: The documentation generated during sampling and analysis that records the original work steps, observations, and measurements, whether performed by an analyst or instrument. This documentation includes, but is not limited to field notes, electronic data, analysis bench sheets, run/injection logs, printouts, chromatograms, instrument outputs, and handwritten records for calibration, sample preparation, and sample analysis for field samples and QC samples.

Reference Material: Material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or at a given location.

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Secondary Accreditation Body (Primary AB): A TNI-NELAP accreditation body responsible that accredits the laboratory based on the Primary AB accreditation and procedures.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

Standard Operating Procedure (SOP): A written document that details the process for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the procedures for performing certain routine or repetitive tasks.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

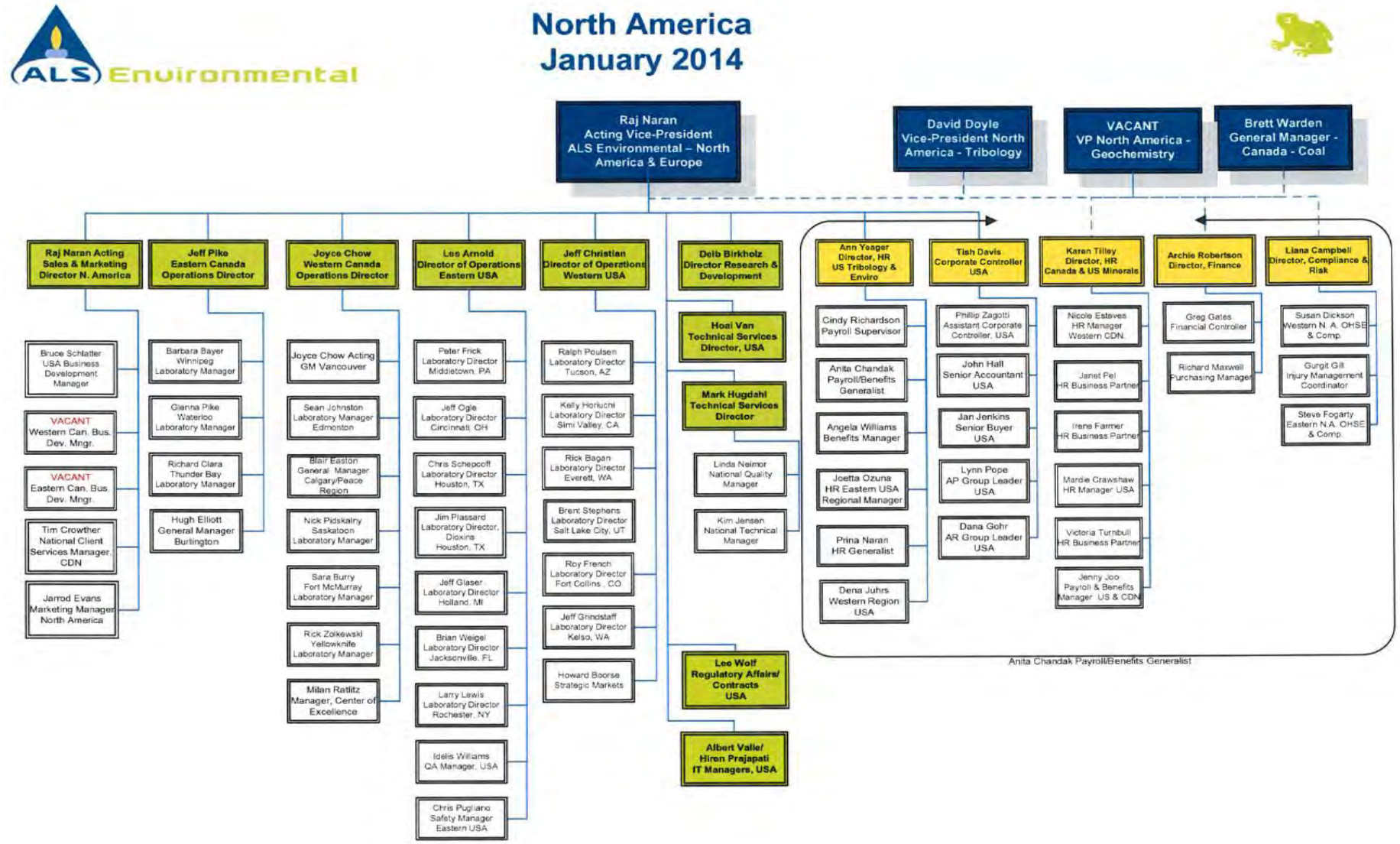
Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

Verification: Confirmation by examination and objective evidence that specified requirements have been met.

Acronyms

ASTM - American Society for Testing and Materials
A2LA - American Association for Laboratory Accreditation
CARB - California Air Resources Board
CAS - Number Chemical Abstract Service registry Number
CFC - Chlorofluorocarbon
CFU - Colony-Forming Unit
DEC - Department of Environmental Conservation
DEQ - Department of Environmental Quality
DHS - Department of Health Services
DOE - Department of Ecology
DOH - Department of Health
EPA - U. S. Environmental Protection Agency
ELAP - Environmental Laboratory Accreditation Program
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
LOD - Limit of Detection
LOQ - Limit of Quantitation
LUFT - Leaking Underground Fuel Tank
M - Modified
MCL - Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL - Method Detection Limit
MPN - Most Probable Number
MRL - Method Reporting Limit
NA - Not Applicable
NC - Not Calculated
NCASI - National Council of the Paper Industry for Air and Stream Improvement
ND Not Detected
NIOSH - National Institute for Occupational Safety and Health
PQL - Practical Quantitation Limit
RCRA - Resource Conservation and Recovery Act
SIM - Selected Ion Monitoring
TNI – The NELAC Institute
TPH - Total Petroleum Hydrocarbons

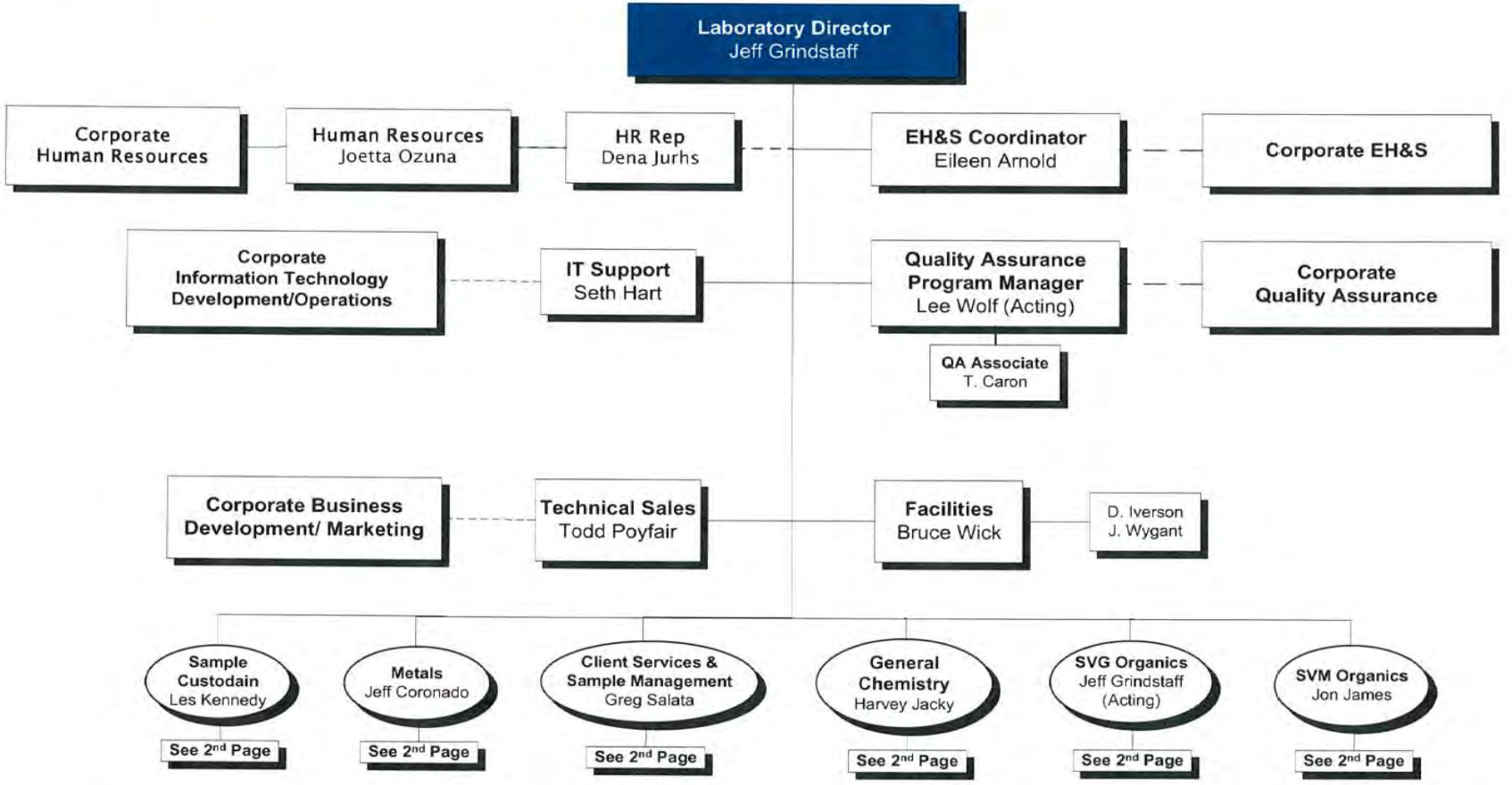
APPENDIX B – Organization Charts, Key Personnel, and Report Signatories


ALS Environmental
North America
January 2014
Raj Naran
Acting Vice-President
ALS Environmental – North America & Europe
David Doyle
Vice-President North America - Tribology
VACANT
VP North America - Geochemistry
Brett Warden
General Manager - Canada - Coal
Raj Naran Acting Sales & Marketing Director N. America
Bruce Schlatter USA Business Development Manager
VACANT Western Can. Bus. Dev. Mngr.
VACANT Eastern Can. Bus. Dev. Mngr.
Tim Crowther National Client Services Manager, CDN
Jarrod Evans Marketing Manager North America
Jeff Pike Eastern Canada Operations Director
Barbara Bayer Winnipeg Laboratory Manager
Gianna Pike Waterloo Laboratory Manager
Richard Clara Thunder Bay Laboratory Manager
Hugh Elliott General Manager Burlington
Joyce Chow Western Canada Operations Director
Joyce Chow Acting GM Vancouver
Sean Johnston Laboratory Manager Edmonton
Blair Easton General Manager Calgary/Peace Region
Nick Pidskalny Saskatoon Laboratory Manager
Sara Burry Fort McMurray Laboratory Manager
Rick Zolkewski Yellowknife Laboratory Manager
Milan Ratlitz Manager, Center of Excellence
Les Arnold Director of Operations Eastern USA
Peter Frick Laboratory Director Middletown, PA
Jeff Ogle Laboratory Director Cincinnati, OH
Chris Schepcoff Laboratory Director Houston, TX
Jim Plassard Laboratory Director, Dioxins Houston, TX
Jeff Glaser Laboratory Director Holland, MI
Brian Weigel Laboratory Director Jacksonville, FL
Larry Lewis Laboratory Director Rochester, NY
Idelis Williams QA Manager, USA
Chris Pugliano Safety Manager Eastern USA
Jeff Christian Director of Operations Western USA
Ralph Poulsen Laboratory Director Tucson, AZ
Kelly Horiuchi Laboratory Director Simi Valley, CA
Rick Bagan Laboratory Director Everett, WA
Brent Stephens Laboratory Director Salt Lake City, UT
Roy French Laboratory Director Fort Collins, CO
Jeff Grindstaff Laboratory Director Kelso, WA
Howard Boorse Strategic Markets
Deib Birkholz Director Research & Development
Hoai Van Technical Services Director, USA
Mark Hugdahl Technical Services Director
Linda Neimor National Quality Manager
Kim Jensen National Technical Manager
Lee Wolf Regulatory Affairs/ Contracts USA
Albert Valle/ Hiren Prajapati IT Managers, USA
Ann Yeager Director, HR US Tribology & Enviro
Cindy Richardson Payroll Supervisor
Anita Chandak Payroll/Benefits Generalist
Angela Williams Benefits Manager
Joetta Ozuna HR Eastern USA Regional Manager
Prina Naran HR Generalist
Dena Juhrs Western Region USA
Tish Davis Corporate Controller USA
Phillip Zagotti Assistant Corporate Controller, USA
John Hall Senior Accountant USA
Jan Jenkins Senior Buyer USA
Lynn Pope AP Group Leader USA
Dana Gohr AR Group Leader USA
Karen Tilley Director, HR Canada & US Minerals
Nicole Esteves HR Manager Western CDN.
Janet Pel HR Business Partner
Irene Farmer HR Business Partner
Mardie Crawshaw HR Manager USA
Victoria Turnbull HR Business Partner
Jenny Joo Payroll & Benefits Manager US & CDN
Archie Robertson Director, Finance
Greg Gates Financial Controller
Richard Maxwell Purchasing Manager
Liana Campbell Director, Compliance & Risk
Susan Dickson Western N. A. OHSE & Comp.
Gurgit Gill Injury Management Coordinator
Steve Fogarty Eastern N.A. OHSE & Comp.
Anita Chandak Payroll/Benefits Generalist

Kelso, Washington Laboratory

March 3, 2014

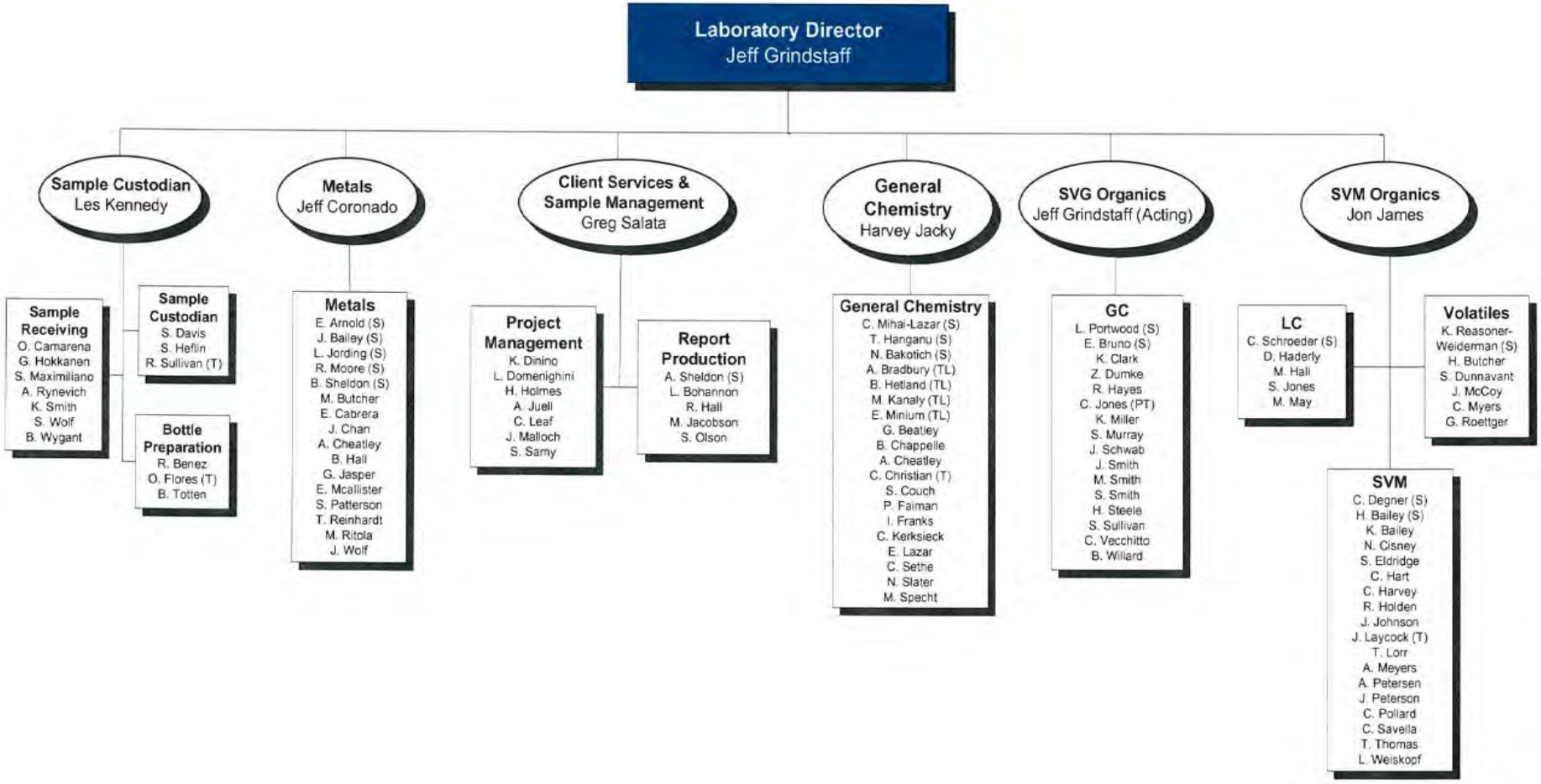
ALS Environmental



Kelso, Washington Laboratory

April 17, 2014
Operations

ALS Environmental



Jeffrey A. Grindstaff

1317 S. 13th Avenue • Kelso, WA 98626 • +1 360 577 7222

ALS Environmental

Education

Allan Hancock College.
Santa Maria, CA
AA, Liberal Arts, 1986

California Polytechnic State University
San Luis Obispo, CA
BS, Chemistry, 1989

Hewlett-Packard Analytical Education Center
Interpretation of Mass Spectra I, 1992

Hewlett-Packard Analytical Education Center
Mass Selective Detector Maintenance 1993

Richard Rogers Group
Leadership Training, 1996

PTI International
Sampling and Testing of Raw Materials, 2004

Affiliations

American Chemical Society, 1989

Publications

Mr. Grindstaff has a number of publications and presentations. For a complete list, contact ALS.

Laboratory Director

2011 - Present

Responsible for all phases of laboratory operations at the Kelso, (WA) facility, including project planning, budgeting and quality assurance. Primary duties include the direct management of the Kelso laboratory

Previous Experience

Columbia Analytical Services, Inc.
Kelso, WA
Laboratory Director, '10-'11

Responsibilities the same as above.

Columbia Analytical Services, Inc.
Kelso, WA
Technical Manager III, Pharmaceutical GC/MS, VOC and SVOC Laboratories, '97-'10

Primary responsibilities include leadership of the Pharmaceutical GC/MS, VOC and SVOC staff, management of method development, training, data review, tracking department workload, scheduling analyses. Responsible for ensuring data quality and timeliness. Also responsible for project management and coordination for pharmaceutical clients.

Columbia Analytical Services, Inc.
Kelso, WA
Manager, GC/MS VOA Laboratory, '94-'97

Responsible for supervision of GC/MS VOA staff development, method development, training, data review, tracking department workload, scheduling analyses, and general maintenance and troubleshooting of GC/MS systems.

Columbia Analytical Services, Inc.
Kelso, WA
Scientist III, GC/MS VOA Laboratory, '91-'94

Responsible included scheduling workload, data review, instrument maintenance and troubleshooting and personnel training and evaluation. Also responsible for supervision of extraction personnel and instrument analysts. Additional supervisory duties included report generation and data review for GC analyses. Responsibilities also included project management and client service.

Enseco-CRL
Ventura, CA
Chemist, '90-'91

Established GC/MS department including inventory maintenance, preparation of state certification data packages, method development, SOPs, and extended data programs. Performed daily maintenance and troubleshooting of GC and GC/MS instrumentation. Scheduled and performed routine and non-routine VOA analyses.

Coast to Coast Analytical Services.
San Luis Obispo, CA
GC/MS Chemist VOA Laboratory, '05-'07

Responsible for Standard Preparation for VOA analyses, instrument calibration, tuning and maintenance. Also implemented and further developed EPA methods for quantitative analysis of pesticides and priority pollutants

Gregory G. Salata, Ph.D.

1317 S. 13th Avenue | Kelso, WA 98626 | +1 360 577 7222

ALS Environmental

Education

University of California-San Diego, Revelle College, La Jolla, CA
BA, Chemistry, 1987

Texas A&M University, College Station, TX
MS, Oceanography, 1993

Texas A&M University, College Station, TX
Ph.D., Oceanography, 1999

Affiliations

Society of Environmental Toxicology and Chemistry (SETAC)

Publication

Dr. Salata has a number of publications and published abstracts. For a complete list, contact ALS|Kelso.

Client Services Manager

2013 – Present

Management of the Client Services Departments: Project Management, Electronic Data Deliverables and Report Generation, and Sample Management. Oversee the client services for approximately $15 million in revenue annually. Personally responsible for approximately $4 million of direct technical project management annually providing technical and regulatory interpretation assistance, as well as project organization of work received by the laboratory.

Previous Experience

ALS Group USA Corp dba ALS Environmental — **Project Manager V '11 -'13**
Kelso, WA

Responsible for technical project management, ensuring overall data quality and compliance with customer requirements. Provide technical support to clients regarding laboratory application to projects. Additionally, acts as a consultant to clients regarding industrial/environmental compliance issues; serving as liaison between clients and regulatory agencies. Responsible for direct technical project management annually providing technical and regulatory interpretation assistance, as well as project organization of work received and reported by the laboratory. Specializes in complex or highly sensitive projects which may involve difficult matrices and analytes..

Columbia Analytical Services, Inc. — **Project Manager V, '03 – '11**
Kelso, WA

Responsibilities include Project Management, including quotation preparation and data reporting, as well as providing technical support to the laboratory as needed. Responsibilities also include oversight of the organic extractions lab, managing resources and providing technical support for all organic preparation work flows

B&B Laboratories — **Project Manager, '99-'03**
College Station, TX

Supervisor/responsible for analysis of TPH (waters, tissues, sediments), organotins (waters, tissues, sediments), Atterberg Limits (sediments), and total organic/inorganic carbon (sediments, waters). Also responsible for report generation on specific projects. Instrumentation operated included GCs with FID and FPD detectors, Combustion TOC, Water TOC, and Dionex Accelerated Solvent Extractor.

Texas A&M University — **Graduate Student, '91-'99**
College Station, TX

While working toward MS in Oceanography, performed organic extractions for pesticides, PCBs, PAHs, and butyltins. While working toward Ph.D. in Oceanography determined stable carbon isotope ratios in sediments, waters, and bacterial phospholipid fatty acids. Other responsibilities included field sample collection, and operation/maintenance of FinniganMAT 252 isotope ratio MS.

Science Applications International — **Analytical Chemist, '89-'90**
San Diego, CA

Performed organic extraction and GC/FID analysis on sediment/rock samples for the Exxon Valdez oil spill.

Analytical Technologies — **GC Chemist, '87-'89**
San Diego, CA

Responsible for analysis of volatile organics using purge and trap and GC/PID/ELCD.

Lee E. Wolf

1317 S. 13th Avenue | Kelso, WA 98626 | +1 360 577 7222

ALS Environmental

Education

Eastern Washington University
Cheney, WA
BS, Chemistry, , 1985

Pharmaceutical Laboratory Control Systems, *Univ. of Wisconsin Short Course, Las Vegas,* **2004**
Test Method Validation in Pharmaceutical Development and Production, *Univ. of Wisconsin Short Course, Las Vegas,* **2004**
Documenting Your Quality System, *A2LA Short Course, Las Vegas, Nevada,* **1998.**
Internal Laboratory Audits, *A2LA Short Course, Las Vegas, Nevada,* **1998.**
Mass Spectra Interpretation, *ACS Short Course, Denver, Colorado,* **1992.**

Publications

Mr. Wolf has a number of publications and presentations. For a list of these publications and presentations, please contact ALS

Affiliations

American Society for Quality

The NELAC Institute – Chemistry Expert Committee member

Corporate Regulatory Affairs Manager, USA

2011 – Present

Serves as the focal point for regulatory matters and ensures that laboratories have the necessary quality programs and systems established in order to conduct laboratory activities in compliance with applicable regulations and project requirements. Serves as an authority on regulatory, agency, and accreditation programs such as TNI, DOD, DOE, EPA, Ohio VAP, AIHA and ISO. Responsible for providing current information related to regulatory compliance. Also responsible for the review of client contracts and MSAs and serves as an internal resource supporting operations, sales/marketing, project management, and QA. Responsible for conducting internal audits similar compliance evaluations. Assists in the development and ongoing implementation of QA procedures and policies.

Previous Experience

Columbia Analytical Services, Inc.
Kelso, WA
Chief Quality Officer/Vice President, '08 – '11

Directing the overall corporate-wide quality systems and ethics programs for all CAS facilities. Responsible for ensuring that CAS quality systems and data integrity standards are implemented at all facilities. Act as liaison with government entities involving quality, technical and operational issues. Provide QA input and policy as needed for operations, development initiatives, special projects, planning, and information technology implementation. Provide assistance to QA Program Managers

Columbia Analytical Services, Inc.
Kelso, WA
Quality Assurance Program Manager, '96 – '08

As part of the management team, responsibilities included the overall management and implementation of the laboratory QA program. This included maintaining accreditations and certifications, and maintaining all necessary documents (QA Manual, SOPs, and QA records). Acted as primary point of contact during laboratory audits and provided audit responses and corrective actions. Coordinated performance audits (PE/PT testing) and conducted internal audits..

Columbia Analytical Services, Inc.
Kelso, WA
Project Chemist/Principal Organic Scientist '94 – '96

Responsibilities included GC and GC/MS method development and special projects coordination. Acts as technical advisor to the GC and GC/MS laboratories and GC/MS interpretation specialist and CLP organics specialist. Also responsible for Project Chemist functions, including management of projects for clients, identifying client needs, and preparation of data reports.

Columbia Analytical Services, Inc.
Kelso, WA
Semivolatile Organics Department Manager, '88 – '94

Responsibilities included overall management of the department. Supervised GC/MS analyses, data review, reporting and related QA/QC functions. Responsible for supervision of staff, training, and scheduling. Beginning in 1992, responsibilities included being a Project Chemist for organics EPA-SAS and other clients. This involved scheduling projects for clients, identifying client requirements, and preparing data reports..

U.S. Testing Company.
Richland, Washington
GC/MS Chemist, '85 – '88

Responsibilities included GC and GC/MS analysis of water and soil samples for volatiles and semivolatiles by EPA protocol, including Methods 8240, 8270 and CLP. Coordinated extraction and GC-GC/MS areas to manage sample/data flow through the lab. Also performed HPLC analysis and pesticide analysis by GC using EPA Methods.

Eileen M. Arnold

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ALS Environmental

Education

Immaculata College, Immaculata, PA
BA, Chemistry, 1977

Affiliations

American Chemical Society, Member since 1987.

Scientist, Metals Laboratory/Kelso Health and Safety Officer

2011 - Present

Supervisor of the Metals reporting group responsible for ensuring timely, accurate reporting of all metals reports. Responsible for updating instrument specific data, such as MDL and control limits. Analyst for the Inductively Coupled Argon Plasma (ICAP) Emission Spectrometer. This involves digestion, instrumental analysis, and report generation for environmental samples using approved EPA techniques.

Environmental, Health and Safety Officer responsibilities include development and implementation of the Kelso Health and Safety program, including accident investigation and incident review, maintenance of all safety related equipment, review of monthly safety audits, and completion of all Federal and State mandated EH&S reports.

Previous Experience

Columbia Analytical Services, Inc.
Kelso, WA
Scientist IV Metals Laboratory/Kelso Health and Safety Officer, *'94-'11*
Duties as described above.

Columbia Analytical Services, Inc.
Kelso, WA
Project Chemist, '92-'94
Duties included technical project management and customer service. Responsible for meeting the clients' needs of timely and appropriate analyses, and to act as liaison for all client-related activities within Columbia Analytical Services, Inc.

Columbia Analytical Services, Inc.
Kelso, WA
Scientist IV Metals Laboratory, '87-'92
Duties include the operation and maintenance of the Inductively Coupled Argon Plasma (ICAP) Emission Spectrometer. This involves digestion, instrumental analysis, and report generation for environmental samples using approved EPA techniques.

Dow Corning Corporation.
Springfield, OR
Chemist, '86-'87
Responsibilities included ICP and atomic absorption work in silicon manufacturing. Methods development for ICP analysis of minor impurities found in silicon.

Ametek, Inc.
Harleysville, PA
Chemist, '86-'87
Responsibilities included product research and development chemist involved in production of thin-film semiconductors for use as solar cells. Work involved AA and SEM techniques

Janbridge, Inc..
Philadelphia, PA
Chemist, '78-'82
Responsibilities included maintaining electroplating process lines through wet chemical analysis techniques, and performed Quality Assurance testing on printed circuit boards.

Jeffrey A. Coronado

1317 S. 13th Avenue | Kelso, WA 98626 | +1 360 577 7222

ALS Environmental

Education

Western Washington University – Bellingham, WA
BS, Chemistry, 1988

Western Washington University – Bellingham, WA
BA, Business Administration, 1985

Winter Conference on Plasma Spectrochemistry – Tucson, AZ, 2012

LC/ICP-MS Training Course – PerkinElmer, 2008

Field Immunaossay Training Course – EnSys Inc., 1995

Winter Conference on Plasma Spectrochemistry – San Diego, CA, 1994

ICP-MS Training Course – VG-Elemental, 1992

Technical Manager IV, Metals Department Manager

1992 – Present

Management of the Kelso Metals Department with a staff of 22 chemists and technicians, and annual revenues approaching $4 million. Responsible for data quality and timeliness, annual budgeting, revenues, expenses, workload coordination, method development efforts, and resource allocation. 2001 to Present—Project Manager: Responsible for technical project management, ensuring overall data quality and compliance with customer requirements, and providing technical support to clients regarding laboratory application to projects.2008 to Present— Participation in the corporate Information Technology governance team ensuring software development activities are in line with the companies operational objectives.2010 to Present—Participation in multiple LIMS development teams responsible for defining the CAS product. Team leader for defining specifications of the Sample Preparation Module to capture preparation information across all laboratory departments.

Previous Experience

Columbia Analytical Services, Inc. Kelso, WA — **Metals Department Manager, '92 - present**

Responsibilities included management of all aspects of the metal laboratory operation, including personnel training and evaluation, review of all metals data, and report generation. Also responsible for client service on a number of ongoing CAS accounts. Technical duties include primary analytical responsibility for trace level metals analysis by ICP/MS. Analyses range from routine water and soil analysis, to marine tissues, as well as industrial applications such as ultra-trace QA/QC work for various semiconductor clients. Also responsible for a number of specialized sample preparation techniques including trace metals in seawater by reductive precipitation, and arsenic and selenium speciation by ion-exchange chromatography. Developed methodology for performing mercury analysis at low part per trillion levels by cold vapor atomic fluorescence.

Columbia Analytical Services, Inc. Kelso, WA — **Supervisor, GFAA Laboratory, '89 – '92**

Responsibilities included supervision of metals analysis by graphite furnace atomic absorption following SW 846 and EPA CLP methodologies. Duties include workload scheduling, data review, instrument maintenance, personnel training and evaluation.

Harvey Jacky

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ALS Environmental

Education

Oregon State University – Corvallis, OR
BS, Zoology, 1988

Oregon State University – Corvallis, OR
BS, General Science, 1988

Linfield College – McMinnville, OR
General Studies, 1981 - 1982

40-Hour Hazmat Certification, PBS Environmental, 1996

Industrial Emergency Response, SFSP Seminar, 1991

Presentations

American Chemical Society, Member since 1988

Biochemical and Physical Factors Involved in the Application and Measurement of a Soil Bioremediation System. Biogeochemistry, Portland State University, 1996

General Chemistry Department Manager

2008 – Present

Oversee the operation of the General Chemistry and Microbiology groups. Responsible for the quality and timeliness of the inorganic laboratories analytical reports, departmental budgets, workload coordination, method development efforts, cost-effectiveness, and resource allocation.

Previous Experience

Columbia Analytical Services, Inc. — **Project Manager III, '99 – '08**
Kelso, WA

Responsible for technical project management, ensuring overall data quality and compliance with customer requirements, and providing technical support to clients regarding laboratory application to projects. Additionally, acts as a consultant to clients regarding industrial/environmental compliance issues; serving as liaison between clients and regulatory agencies.

Coffey Laboratories — **Director of Project Management, '97 – '99**
Portland, OR

Responsible for technical project management. Communicated with clients to determine needs and expectations. Monitored laboratory production and ensured the timely completion of analytical projects. Technical consultant for clients regarding environmental compliance. Supervised and managed other members of the project management team. Served as a member of the senior management team for oversight of general operations, strategic planning, finances, and policy.

Coffey Laboratories — **Project Manager/Chemist, '97 – '99**
Portland, OR

Responsibilities: Served as primary liaison between Coffey Laboratories and major clients. Ensured that work was completed in a timely manner and done to client specifications. Served as technical consultant regarding environmental chemistry, soil remediation, and waste water industrial compliance. Clients included the Oregon Department of Transportation, Hazmat Unit, Portland, Oregon; Raythion Demilitarization Co., Umatilla, Oregon; Hydroblast - Wastewater Evaporator Systems, Vancouver, Washington; and Union Pacific Railroad, Northwest Region, Klamath Falls, Oregon.

Coffey Laboratories — **Technical Sales Representative, '95 – '97**
Portland, OR

Responsible for marketing and sales, including actively prospecting for new potential clients. Additional responsibilities included procurement and preparation of all major project bids; ensuring that client expectations were met; and maintaining customer satisfaction. Served as consultant regarding industrial compliance issues, environmental remediation projects, and hazardous waste management.

Coffey Laboratories — **Senior Chemist/Laboratory Chemical Hygiene Officer, '88 – '95**
Portland, OR

Responsibilities: Performed analytical tests including Anions by Ion Chromatography (EPA 300.0), PAHs by HPLC (EPA 8310), Cyanides (EPA 335), and other inorganic, wet chemistry, and organic analytical tests on a wide variety of sample matrices. Responsible for the initial quality assurance review of work performed, supervised and managed personnel. Developed and implemented Laboratory Chemical Hygiene Plan. Directed personnel in regards to safety issues and hazardous waste management. Served as consultant and teacher regarding analytical methodology, environmental compliance, and industrial hygiene.

Jonathan (Jon) James

1317 S. 13th Avenue | Kelso, WA 98626 | +1 360 577 7222

ALS Environmental

Education

Evergreen State College
Olympia, WA
BA, Chemistry/Biology
1991

Introduction to LC Methods Development & Troubleshooting, *Hewlett-Packard, Tacoma, WA,* **1995.**
HPLC Maintenance Seminar, *Waters, Portland, OR,* **1994.**
GC/HPLC Maintenance Seminar, *Hewlett-Packard, Olympia, WA,* **1993.**
Gas Chromatography Seminar, *Curtis Matheson Scientific, Kelso, WA,* **1992.**
HPLC Seminar, *Hewlett-Packard, Kelso, WA,* **1991.**

VOA/MS, GC/MS and HPLC Department Manager

2009 – Present

Oversee the operation of the Volatiles GC/MS, Semivolatile GC/MS and HPLC laboratories. Responsibilities include organizing and prioritizing workload, training and development of staff, working with PCs on client specific project requirements, departmental budgets, workload coordination, method development efforts and resource allocation. Responsible for the quality and timeliness of analytical reports. Other responsibilities include ensuring compliance with CAS QA protocols and assisting staff with troubleshooting equipment and procedural problems.

Previous Experience

Columbia Analytical Services, Inc.
Kelso, WA
Manager VOA and PHC/HPLC Laboratories, '04– '09

Oversee daily operation of the Volatiles GC/MS and PHC/HPLC laboratories. Responsibilities include organizing and prioritizing workload, initiating process improvements, training and development of staff and working wit PCs on client specific project requirements. Responsible for analytical duties as listed below for Scientist IV. Other responsibilities include ensuring compliance with CAS QA protocols and assisting staff with troubleshooting equipment and procedural problems.

Columbia Analytical Services, Inc.
Kelso, WA
Scientist IV, VOA Laboratory, '99 – '04

Perform sample analysis and data review for EPA methods 524.2, 624 and 8260. Duties also include Project Management.

Columbia Analytical Services, Inc.
Kelso, WA
Project Chemist, Supervisor Pesticides GC Laboratory, '98 – '99

Primary responsibilities included workload scheduling, data review, instrument maintenance and troubleshooting, and personnel training and evaluation. Also responsible for supervision of extraction personnel and instrument analysts.

Columbia Analytical Services, Inc.
Kelso, WA
Analyst, SVOC GC Lab '92 – '98

Primary responsibilities included analysis of samples using GC and HPLC techniques, report generation, data review, preparation of analytical standards, maintenance of instrumentation, Client Services and some Project Management. Routine duties included analysis of soil and water samples for pesticides, PCBs, CLP Pesticides, Explosives and PAHs using EPA methods.

Columbia Analytical Services, Inc.
Kelso, WA
Analyst, Organic Extractions Lab, '91 – '92

. Responsibilities included extraction of soil and water samples for various SVOCs, and TCLP extraction of SVOC and VOC compounds using TCLP equipment. Other duties included performing cleanup procedures, validation studies, MDL studies, and the training of employees in advanced extraction procedures and techniques..

Loren E. Portwood

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ALS Environmental

Education

Whitworth College
Spokane, WA
BS in Chemistry, Emphasis in Biochemistry 1990

HP 5890 GC Maintenance and Troubleshooting,
Hewlett Packard, 1993

Capilliary Chromatography
Restek, 1993

HP6890 – Fast GC
Hewlett Packard, 1996

HP5890-C+GC Advanced Operations
Hewlett Packard, 1996

Purge and Trap Theory and Troubleshooting, Full Spectrum Analytics, 2001

Comprehensive HPLC,
Restek, 2002

Technical Manager I, Semivolatile Organics Laboratory

2011 – Present

Responsible for the overall operation and supervision of the Semivolatile Organics Gas chromatograph department. Perform method development.

Previous Experience

ALS Group USA Corp.
Kelso, WA
Technical Manager I, DW Laboratory, '08 – '13

Columbia Analytical Services, Inc.
Kelso, WA

Responsible for management of the Semivolatile Organics Gas chromatograph and drinking water department. Also responsible for implementation and oversight of UCMR2 analyses. Perform method development. Project management of drinking water accounts. Develop SOPs for Drinking Water methods, EPA 600 methods and SW-846 methods. Operation of Varian GC/MS ion trap, Thermo GC/MS ion trap, Agilent GC/ECD, Agilent GC/FPD, Agilent GC/FID.

Columbia Analytical Services, Inc.
Kelso, WA
Technical Manager I, DW Laboratory, '08 – '11

Plan, conduct, and, as lead analyst, supervise analyses using advanced instrumentation such as HPLC with post column derivatization, GC/MS, and GC/ECD. Responsible for data interpretation, quality control and data reporting. Additional responsibilities include SOP generation; handling routine and advanced maintenance and troubleshooting of instrumentation; and assisting in the training of staff department analysts. Assists the department manager and/or other senior scientists in setting up more complex procedures. Serves as senior technical advisor for teams and projects

Columbia Analytical Services, Inc.
Kelso, WA
Lead Analyst DW Laboratory, , '02 – '08

Primary responsibilities include management of the petroleum hydrocarbon team, initiating new methods and process improvements, and staff development and training. Other duties include department wide compliance with CAS quality assurance guidelines, routine system checks, assist and encourage staff in troubleshooting equipment and procedural problems in a manner consistent with company, state and federal guidelines..

Columbia Analytical Services, Inc.
Kelso, WA
Petroleum Hydrocarbons Supervisor, , '98 – '02

Analysis, reporting, and archiving of water, soil, and product samples for semi-volatile petroleum hydrocarbons and miscellaneous FID tests. Methods include EPA methods 8100, 8310, 8315, 8330, 8040, 8015 and various state modifications of 8015 (OR, WA, CA, AK). Additional analyses include solvent scans, alcohols, glycols, and EPA methods 413.2 and 418.1. Other responsibilities include sample preparation and instrument maintenance

Columbia Analytical Services, Inc.
Kelso, WA
Petroleum Hydrocarbons, '93 – '98

SVOC sample preparations for water, soil, and oil to be analyzed in the GC, GC/MS, and PH Departments. These extraction methods included hazardous waste, wastewater, and drinking water procedures. Other responsibilities included extract cleanup via Florisil®, GPC, and Hg.

Treclen Laboratories
Spokane, WA
Bench Chemist, Extractions, '92 – '93

Inorganic water and soil testing and sample preparation by EPA methods.

Christina Kerksieck

1317 S. 13th Avenue • Kelso, WA 98626 • +1 360 577 7222

ALS Environmental

Education

San Francisco State University,
San Francisco, CA
BS, Microbiology, 2000

Microbiology Technical Manager

2012 - Present

Perform oversight of environmental microbiology analyses and serves as Technical Manager for the microbiology discipline. Ensure proper implementation of methods and techniques used in the department. Performs sample analysis for accredited tests and special projects. Provides final approval of SOPs and review/approval of analyst training records.

Previous Experience

ALS Environmental — **Scientist II Microbiology**, 2011-2012
Kelso, WA

Performed a variety of microbiology analyses for the pharmaceutical and environmental testing departments. Performed validation/qualification of all laboratory equipment (IQ/OQ/PQ). Developed methods and implementation of SOPs. Subject Matter Expert (SME) for CAS/ALS environmental and pharmaceutical microbiology laboratories..

Columbia Analytical Services, Inc. — **Scientist I**, 2008-2011
Kelso, WA

Microbiologist performing routine and non-routine microbiology testing of pharmaceutical raw materials, excipients and drug products in accordance with applicable methods (USP, BAM, AOAC). Method development and validation as required. Also responsible for analysis of environmental samples for BOD and CBOD, and a variety of microbiological tests (Total Coliform, Fecal Coliform, E. Coli, Plate Count, Colilert/Quantitray, Bacteria Swab, Enterococcus, Enterolert, etc.).

Roche Molecular Systems — **Scientist**, 2000-2007
Alameda, California

Produced master cell banks for new controls. Test and certify controls for manufacturing. Prepared DNA Panels for projects. Extensive mammalian cell culture experience with excellent sterile technique. Lyophlization, RNA transcription, and Bacteriophage Production, DNA extraction/purification from all cell types. Responsible for equipment calibration, validation, and preventative maintenance. cGMP experience. Experience in writing IR's (Investigation Reports), SOPs, and satisfying CAPA's (Corrective Action Preventative Action). Responsible for cryostorage inventory/management. Maintained documentation updated database and produced "Certificates of Analysis". Responsible for lab purchasing, lab and instrument maintenance. Point person for cell repository ordering. Prepared and participated in internal/external audits.

Center for Biomedical Laboratory Sci. — **Lab Assistant**, 1999-2000
San Francisco University,
San Francisco, CA

Performed research in Dr. Lily Chen's lab using the following techniques: transformation of bacteria and yeast, plasmid isolation from bacteria and yeast, agarose gel electrophoresis, restriction digestion and PCR.

Center for Biomedical Laboratory Sci. — **Internship Assistant**, 1998-1999
San Francisco University,
San Francisco, CA

Assisted with various laboratory preparations and organized Med-Tech Administrative Program.

Lester "Les"Kennedy

1317 S. 13th Avenue • Kelso, WA 98626 • +1 360 577 7222

ALS Environmental

Education

Lower Columbia College, Longview, WA
Coursework, general Studies, 1988 - 1990

Portland Bible College
Portland, OR
Batchelor ofTheology, 2009

Support Services Manager/Sample Management Manager

2010 - Present

Responsible for the operation of the Sample Management, Sample Control, Bottle preparation departments, including sample receiving, courier service, sample control, storage and disposal, bottle preparation and shipping, and general freight receiving. Responsible for employee supervision, personnel evaluations, workload coordination, and adherence to all standard operating procedures within said departments. Additional duties include oversight of quarantined soil importation for laboratory testing. Is the designated Sample Custodian for the laboratory.

Previous Experience

Columbia Analytical Services, Inc. — **Project Manager '99 -'11**
Kelso, WA — **SMO Supervisor, '06 -'11**

Responsible for technical project management, ensuring overall data quality and compliance with customer requirements, and serving as liaison to clients and regulatory agencies. Oversight of the daily activities in sample management department including receipt, login, storage, and proper disposal of all samples received in the laboratory.

Columbia Analytical Services, Inc. — **Supervisor Organic Extractions Laboratory, '97-'99**
Kelso, WA

Responsible for managing work load; directing efficiency; and ensuring that all critical holding times and QC are met each day. This involves GC/MS prep work, including extracting and GPC clean up; and subsequent sample screening of the GC/MS prep work. Additional responsibilities include data processing of GC/MS analytical runs including all steps of the data review and reporting process.

Columbia Analytical Services, Inc. — **Senior Analyst, GC/MS Laboratory, '96-'97**
Kelso, WA

Primary duties were performing analyses by EPA Method 8270, SIM TCL. SIM PAH, including all steps in the data review and reporting process.

Columbia Analytical Services, Inc. — **Senior Analyst, Organic Extractions Laboratory, '93-'96**
Kelso, WA

Primary responsibilities include managing workload; directing efficiency; and ensuring that all critical holding times and QC are met each day. This involves GC/MS prep work, including extracting and GPC clean up; and subsequent sample screening of the GC/MS prep work.

Columbia Analytical Services, Inc. — **Analyst, Organic Extractions Laboratory, '91-'93**
Kelso, WA

Duties primarily as listed above

Jeffery D. Christian

1317 S. 13th Avenue | Kelso, WA 98626 | +1 360 577 7222

ALS Environmental

Education

Evergreen State College – Olympia, WA
BS in Chemistry 1993

Coursework, *Pacific Lutheran University, Tacoma, WA.* 1988-1989.
Coursework, *Tacoma Community College, Tacoma, WA* 1970-1971, 1988-1989.
CERTIFICATION, Chemistry, *L.H. Bates Technical, Tacoma, WA,* 1976-1978.
Coursework, *Central Washington University, Ellensburg, WA.* 1969-1970.
Numerous Training/Educational Activities via Conferences, Professional Seminars, and Factory Training, 1989-2010

Publications

Mr. Christian has a number of publications and presentations. For a list of these publications and presentations, please contact ALS

Director of Operation, Western USA

2011 – Present

Responsible for oversight of operating units In the territory designated Western reporting to the COO. Primary responsibilities include establishment of consistent quality, technical, and client service enhancements across the group, as well as the financial performance of the individual operating units. In addition, a significant role is to represent operations as a member of the management team consisting of the Directors of Operations of other territories, Laboratory Directors for all locations, and senior management of the North America Environmental Division of ALS USA.

Previous Experience

Columbia Analytical Services, Inc. — **Chief Operating Officer/Vice President – '10 to '11**
Kelso, WA

Responsible for oversight of operating units of Columbia Analytical Services, Inc. with all Laboratory Directors reporting to the COO. Primary responsibilities include establishment of consistent quality, technical, and client service enhancements across the company, as well as the financial performance of the individual operating units. In addition, a significant role is to represent operations as a member of the Senior Management Team (SMT) consisting of the Chief Executive Officer, Chief Financial Officer, Chief Quality Officer, and the Director of Information Technology.

Columbia Analytical Services, Inc. — **Vice President/Kelso Laboratory Director '93–'10**
Kelso, WA

Responsible for all phases of laboratory operations, including project planning, budgeting, and quality assurance.

Columbia Analytical Services, Inc. — **Operations Manager, Kelso Laboratory '92–'93**
Kelso, WA

. Responsibilities included directing the daily operation of the Kelso laboratory. Other responsibilities and duties included functioning as a technical consultant to clients, providing assistance in developing and planning analytical schemes to match client objectives, and writing and developing analytical procedures/methods. Also, served as Project Manager for State of Alaska Department of Environmental Conservation contract and Coordinator for EPA Special Analytical Services (SAS) contracts.. Always leave an extra space after this paragraph to separate from the next job.

Columbia Analytical Services, Inc. — **Project Chemist & Manager, Metals Analysis Lab, '89–'92**
Kelso, WA

Responsible for directing the daily operation of the Metals Laboratory, including the sample preparation, AAS, ICP-OES, and ICP-MS Laboratories

Weyerhaeuser Technology Center, — **Scientist '86–'89**
Federal Way, WA

Responsibilities included supervising atomic spectroscopy laboratory which included flame and furnace AAS, ICP-OES, and sample preparation capabilities to handle a wide variety of sample types. Interfaced with internal and external clients to provide technical support. Wrote and developed analytical procedures/methods.

Weyerhaeuser Technology Center, — **Lead Technician, Metals Lab '81–'86**
Federal Way, WA

Responsibilities included primary ICP and AAS analyst for EPA-CLP contract work. Extensive experience in wide variety of environmental and product-related testing.

ITT Rayonier, Olympic Research Division, — **Research Assistant, '78–'81**
Shelton, WA

Responsibilities included performing water quality tests, product-related analytical tests, corrosion tests operated pilot equipment specific to the pulp and paper ind

APPROVED SIGNATORIES FOR FINAL ANALYTICAL REPORTS

ALS Environmental, Kelso, WA

CORONADO, JEFFREY
DEGNER, CARL
DOMENIGHINI, LISA
GRINDSTAFF, JEFF
HOLMES, HOWARD
JACKY, HARVEY
JAMES, JON
KANALY, MARY
KENNEDY, LES
LEAF, CHRIS
MALLOCH, JANET
MIHAI-LAZAR, CARMEN
MOORE, RACHEL
SALATA, GREGORY
SAMY, SHAR
SCHROEDER, COLLEEN

Update: April, 2014 Approved by: Gregory Salata, Client Services Manager

APPENDIX C

ALS Environmental Confidentiality Agreement

Confidentiality Agreement

The Confidentiality Agreement (the "Agreement") is entered into by and between ALS Group (hereinafter referred to as the "Company") and _____ (hereinafter referred to as "Employee").

WHEREAS, employee is presently employed by the Company in a position in which Employee will receive and have access to confidential business information and other secrets of the Company, and shall, to the best of Employee's ability, assist the Company in improving and developing the products and services of the Company; and

WHEREAS, employee is desirous of continuing such employment and receiving such disclosures of confidential business information, and assisting the Company in improving and developing its products and services.

NOW, this Agreement being a condition therefore and ancillary thereto, and in further consideration of the benefits to Employee pursuant to the employment by the Company, the receipt and sufficiency of all such consideration being hereby acknowledged by Employee, it is agreed between the Company and Employee as follows:

1. **Confidential Business Information.** Employee recognizes and agrees that the Company has certain confidential business information, including, but not limited to, compilations of information, customer lists, customer data, records, specifications, and trade secrets, and related business methods and techniques, which confidential business information are used by the Company to obtain a competitive advantage over the Company's competitors who do not know or use this information. Employee further recognizes and agrees that the protection of such confidential business information against unauthorized disclosure and use is of critical importance to the company to maintain its competitive position and Employee therefore agrees that use of, or disclose to any other person or entity, except as authorized by the Company in writing, any of the confidential business information of the Company. Employee also agrees not to disclose to the Company or utilize on the Company's behalf, any of the trade secrets or other confidential information of any of the Employee's former employers.

2. **Return of Confidential Business Information.** Upon termination of his employment for any reason, employee shall promptly deliver to the Company all drawings, manuals, letters, photographs, tapes or video recordings, records of any kind, and all copies thereof, that may be in the possession of, or under the control of, Employee pertaining to the Company's employers.

3. **Assignment of Rights to Company.** Employee agrees to assist the Company in all possible ways in the discovery, perfection, and development of new ideas, inventions, discoveries, devices, and methods in processes, all for the benefit of the Company and as its exclusive property. Employee agrees to and does hereby assign, transfer, and convey to the Company, or at the written direction of the Company and which are made, developed or conceived by Employee, either solely or jointly with others, during Employee's employment with the Company, whether prior or subsequent to the signing of this Agreement, whether made, developed or conceived by Employee during or outside of regular working hours or on or away from the

Company's premises or at Employee's expense, the expense of the Company or some other person or persons. At any time, the Employee shall execute such documents requested by the Company to confirm the rights of the Company in the ideas, inventions, discoveries, and devices, methods and processes referenced in this Section 3.

4. **Reasonableness of Covenants**. Employee specifically acknowledges and agrees as follow: (I) the covenants set forth in this Agreement are reasonable and necessary to protect the goodwill and the operations and business of the Company; (ii) the time duration of the covenants set forth in this Agreement and are reasonable and necessary to protect the goodwill and the operations and business of the Company; (iii) the geographical area limitations of the covenants set forth in this Agreement are reasonable and necessary to protect the goodwill and the operations and business of the Company; (iv) the covenants set forth in this Agreement are not oppressive to Employee and do not impose a greater restraint on Employee than is necessary to protect the goodwill and the operations and business of the Company.

5. **Remedies**. Employee recognizes that irreparable injury or damage will result to the business of the company in the event to the breach of any covenant contained in this Agreement and Employee therefore agrees that in the event of such breach on the part of the Employee, the Company shall be entitled, in addition to any legal or equitable remedies and damages available, to an injunction to restrain the violation thereof by Employee and all other persons action for or on behalf of Employee. Any claim of Employee against the Company shall not prevent the Company from enforcing any provision of this agreement. Further, in the event legal action is necessary to enforce any of Employee's obligations hereunder and the Company prevails in such legal action, the Company shall be entitled to a recovery of its attorney's fees expended in such action.

6. **Reformation**. Whenever possible, each provision of this agreement shall be interpreted in such manner as to be effective and valid under applicable law; provided, however, incase any on or more of the provisions contained in this Agreement shall, for any reason, be held to be invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall no affect any other provision of this agreement, and this Agreement shall be construed as if such invalid, illegal, or unenforceable provision had never been contained herein. Should a court of competent jurisdiction declare any of the provisions of this Agreement unenforceable due to any restriction of duration, territorial coverage, scene of activity, or otherwise, in lieu of declaring such provisions unenforceable, the parties hereto expressly authorize the court, to the extent permissible by law, to revise or reconstruct such provisions in a manner sufficient to cause them to be enforceable.

7. **Affiliates**. This agreement, and Employee's obligations hereunder, shall apply to any confidential business information, formulas, recipes, patterns, devices, secret inventions, processes, compilations of information, materials, ingredients, customer lists, records, specifications and trade secrets of any affiliate of the Company. For the purpose of this Agreement, the "affiliate" means any person that, directly or indirectly, controls, or controlled by, or is under common control with, another person'; "person" means any individual, corporation, partnership, joint venture, limited liability company, association, joint stock company, trust, unincorporated

organization or any other form of entity; and "control" means the power to direct or cause the direction of the management and policies of a person, directly or indirectly, whether through the ownership of voting securities by contract, or otherwise.

8. **Compelled Disclosure**. In the event that Employee is requested or required (by oral questions, interrogatories, requested for information or documents, subpoenas, civil investigative demand or similar process) to disclose any of the confidential business information of the Company, it is agreed that Employee will provide the Company with immediate notice of such request(s), so that the Company may seek an appropriate protective order or, if appropriate, waive Employee's compliance with this agreement. Employee agreed that, if in the absence of a protective order or the receipt of a waive hereunder, Employee is nonetheless, in the reasonable opinion of Employee's counsel, legally compelled to disclose the confidential business information of the Company or else stand liable for contempt or suffer other censure or penalty, Employee may, after prior notice to the Company, disclose such the confidential business information of the Company to the extent legally required.

9. **Indemnity**. Employee agrees to indemnify and hold harmless the Company, and its directors, officers, employees, agents, and attorneys, from and after the date hereof, against any and all actions, causes of action, claims, suites, proceedings, demands, assessments, demands, settlement, judgment, damages, loses, costs, and legal and other expenses arising out of or resulting from the breach or failure of Employee to Company with any covenant or agreement made herein.

10. **Choice of Law: Waiver of Trial by Jury**. This Agreement shall be construed in accordance with, and governed for all purposes by the laws of the State of Texas and obligations and undertakings of each of the parties to this contract shall be performable at Houston, Harris County. TO THE EXTENT NOT PROHIBITED BY APPLICABLE LAW, THE PARTIES HEREBY KNOWLINGLY, VOLUNTARILY, AND INTENTIONALLY WAIVE ANY RIGHT TO TRIAL BY JURY THAT THE COMPANY OR EMPLOYEE MAY HAVE IN ACTION OR PROCEEDING, IN LAW OR IN EQUITY, IN CONNECTION WITH THIS AGREEMENT, EACH PARTY REPRESENTS AND WARRANTS THAT NEITHER PARTY HAS REPRESENTED, EXPRESSLY, OR OTHERWISE THAT IT WILL NOT, IN THE EVENT OF LITIGATION, SEEK TO ENFORCE THIS RIGHT TO JURY TRIAL WAIVER. EACH PARTY ACKNOWLEDGES THAT THE OTHER PARTY HAS BEEN INCLUDED TO ENTER INTO THIS AGREEMENT BY, AMONG OTHER THINGS, THE PROVISIONS OF THE WAIVER.

11. **Waiver**. No waiver of any provision of this Agreement shall constitute a waiver of any other provision of this agreement, nor such waiver constitute a waiver of any subsequent breach of such provision.

12. **Acknowledgement of Receipt.** Employee acknowledges a receipt of a copy of this Agreement, which has been executed in multiple copies, all executed copies of that shall be deemed originals.

13. **No Promise of Employment.** It is expressly agreed that this Agreement is not a promise of future employment.

14. **Assignment**: **Survival**. This agreement shall not be assignable by Employee. This agreement and the obligations of Employee hereunder, shall survive the termination of Employee's employment with the Company.

15. **Entire Agreement**. This Agreement entered into by the Company and Employee, embodies the entire agreement and understanding between the Company and the Employee relating to the subject matter hereof, and supersedes all prior agreements and understandings relating to the employment and compensation of the Employee and may only be amended by a written agreement signed by all parties hereto.

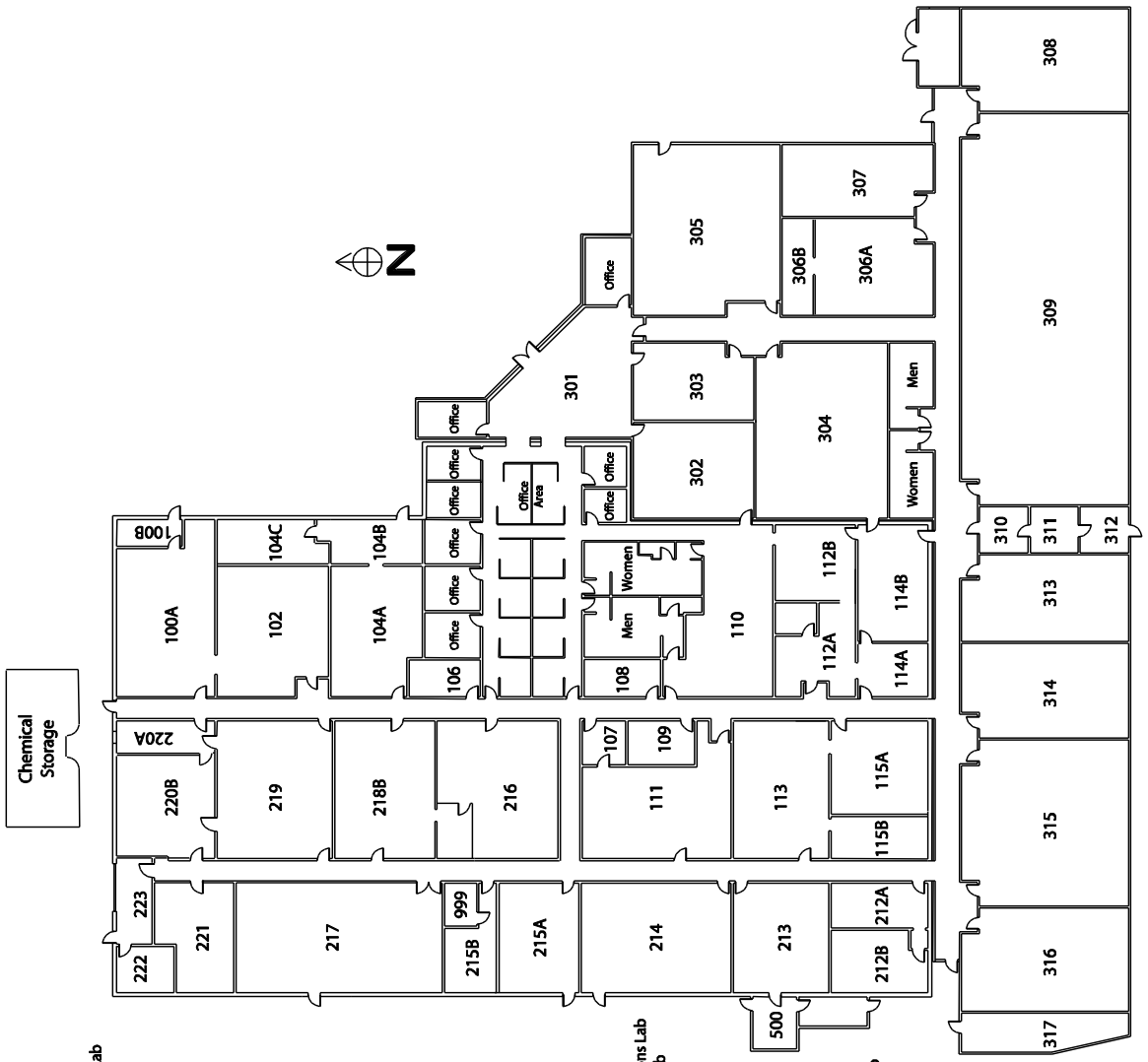
Employee Signature: _____ Date: _____

Employee Printed Name: _____

Witness: _____ Date: _____

Witness Printed Name: _____

APPENDIX D – Laboratory Floor Plan



APPENDIX E – Analytical Equipment

GENERAL CHEMISTRY/WATER CHEMISTRY LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balances (16):			
Precisa,Mettler,OHOUS, Adams models	1990-2011	LM	13
Autoclave - Market Forge Sterilmatic	1988	LM	5
Autoclave – Heidolph Brinkman 3870EP	2010	LM	3
Autotitrator – Thermo Orion 500	2007	LM	3
Calorimeters (2):			
Parr 1241 EA Adiabatic	1987	LM	4
Parr 6300 Isoparabolic	2005	LM	4
Centrifuge - Damon/IEC Model K	1992	LM	13
Colony Counter - Quebec Darkfield	1988	LM	2
Conductivity Meters (2):			
YSI Model 3200	2004	LM	4
VWR	2001	LM	4
Digestion Systems (5):			
COD (4)	1987, 1989	LM	4
Kjeldahl, Lachat 46-place (1)	1999	LM	3
Dissolved Oxygen Meter - YSI Model 58 (3)	1987, 1988, 1991	LM	4
Distillation apparatus (Midi) - Easy Still (2)	1996, 2000	LM	5
Drying Ovens (12):			
Shel-Lab and VWR models	1990-2010	LM	13
Air Drying Cabinets	2011	LM	-
Flash Point Testers (2):			
ERDCO Setaflash Tester	1991	LM	3
Petroleum Systems Services	2005	LM	3
Flow-Injection Analyzers (2):			
Bran-Leubbe	2002	LM	2
Lachat 8500	2007	LM	2
Ion Chromatographs (4)			
Dionex DX-120 with Peaknet Data System	1998	LM	3
Dionex ICS-2500 with Chromchem Data System	2002	LM	3
	2006	LM	3
Dionex ICS-2000 with Chromchem Data System	2009	LM	3
Dionex ICS-1600 with Chromchem Data System			
Meters (ISE and pH) (4)			
Fisher Scientific Accument Model 50	1997	LM	4

Fisher Scientific Accument Model 25 Fisher Scientific Accument Model 20 Fisher Scientific Accument Model AR25	1993 2000 1992	LM LM LM	4 4 4
Microscope - Olympus	1988	LM	1
Muffle Furnace- Sybron Thermolyne Model F-A1730	1991	LM	13
Shatter Box (2): GP 1000 SPEX 8530	 1989 2011	LM	5
Sieve Shakers (2): CE Tyler - Portable RX 24 WS Tyler - RX 86	 1990 1991	 LM LM	 5 5
Thomas-Wiley Laboratory Mill, Model 4	1989	LM	5
Total Organic Carbon (TOC) Analyzers (2) Coulemetrics Model 5012 Teledyne Tekmar Fusion 1	 1997 2009	 LM LM	 3 3
Total Organic Halogen (TOX) Analyzers (2): Mitsubishi TOX-100	2001	LM	2
Turbidimeter - Hach Model 2100N	1996	LM	5
UV-Visible Spectrophotometers (4): SpectraMax 384 Plus Beckman-Coulter DU520 Perkin Elmer Lambda 25 Abrazix	 2009 2005 2008 2011	 LM LM LM LM	 4 4 4 2
Discrete Autoanlayzer –Westco SmartChem AD20-1	2011	LM	2
Vacuum Pumps (3): Welch Duo-Seal Model 1376 Busch R-5 Series Single Stage Chem Star 1402N-01	 1990 1991 2011	LM	13
Water Baths/Incubators (5): Various Fisher Scientific and VWR Models	1986 - 2009	LM	13
Drill Press – Craftsman	2012	-	4
METALS LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance (8) Mettler AE 200 analytical balance Various Mettler, Sartorius, and Ohaus models	1988-2010	MM	12
Atomic Absorption Spectrophotometers (4): Varian SpectrAA Zeeman/220 AA Perkin Elmer AAnalyst 200 Flame AA CETAC Mercury Analyzer M-6100	 2000 2005 2010	 LM MM MM	 2 2 2

Buck AA Spectrophotometer Model 205	2008	LM	2
Atomic Fluorescence Spectrophotometer Brooks-Rand Model III (1)	2005	LM	3
Centrifuge - IEC Model Clinical Centrifuge	1990	LM	12
Drying Oven - VWR Model 1370F	1990	LM	12
Freeze Dryers (1) - Labconco	2006	LM	5
Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) (2)			
Thermo Scientific Model iCAP 6500	2007	MM	3
Thermo Scientific Model iCAP 6500	2012	MM	3
Inductively Coupled Plasma Mass Spectrometers (ICP-MS) (3):			
Agilent 7700	2014	MM	2
Thermo X-Series	2006	MM	2
Nexion Model 300D	2011	MM	2
Muffle Furnace (2) - Thermolyne Furnatrol - 53600	1991, 2005	LM	5
Shaker - Burrell Wrist Action Model 75	1990	LM	12
TCLP Extractors (3)	1989, 2002	LM	5
Turbidimeter – Hach			
SEMIVOLATILE ORGANICS SAMPLE PREPARATION LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance (4) Mettler PM480, AG204, AE240 OHaus EP613	1999 - 2011	MM	12
Centrifuge – Beckman J-6B (2)	1988	LM	12
Drying Ovens (2)			
Fisher Model 655G	1991	LM	12
VWR Model 1305U	1999	LM	12
Evaporators/concentrators			
Organomation N-Evap (8)	1990-2010	LM	12
Organomation S-Evap (8)	1990-2010	LM	12
Biotage Turbovap (2)	2013	LM	12
Extractor Heaters: Lab-Line Multi-Unit for Soxhlet and Continuous Liquid-Liquid Extractions (102)	1987-2007	LM	8
Solids Extractors:			
Sonic Bath VWR	1994	LM	6
Sonic Horn (5)	1994	LM	6
Soxhtherm		LM	
Gerhardt (2)	2000	LM	6
OI Analytical (6)	2008	LM	6

Extractors, TCLP (8):			
Millipore TCLP Zero Headspace Extractors (8)	1992-2011	LM	2
TCLP 12 position Extractor/Tumbler	1989	LM	2
Gel Permeation Chromatography (GPC) (4)			
ABC single column (1)	2007	LM	4
J2 Scientific AccuPrep (2)	2005, 2010	LM	4
Gilson (1)	2013	LM	4
Muffle Furnace (2)	2006, 2009	LM	4
Solid Phase Extractors (18) - Horizon SPE-Dex 4790	2003, 2006,2008	LM	4
GC SEMIVOLATILE ORGANICS INSTRUMENT LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Gas Chromatographs (17):			
Hewlett-Packard 5890 GC with HP 7673 Autosampler and Dual ECD Detectors	1990 – 1995	LM	6
Hewlett-Packard 5890 GC with HP 7673 Autosampler and Dual FPD Detectors	1991	LM	3
Agilent 6890 GC with Agilent 7683 Autosampler and Dual ECD Detectors (6)	2001, 2005, 2007,2011	LM	6
Agilent 6890 GC with Agilent 7683 Autosampler and Dual FPD Detectors	2003	LM	3
Agilent 7890A Dual ECD Detectors Agilent 7683B autosampler (2)	2010, 2012	LM	6
Hewlett-Packard 5890 GC with HP 7673 Autosampler and FID Detector	1995	LM	3
Agilent 6890 with Dual FID Detectors and Agilent 7873 Autosampler (4)	2001, 2005	LM	6
Agilent 7890A Dual NPD Detectors and Agilent 7683B autosampler	2012	LM	3
Varian Ion trap GC/MS:	2003	LM	2
Varian 3800 GC w/CP8400 autosampler	2006	LM	2
Varian Saturn 2100T mass spectrometer	2003	LM	2
Thremo Ion Trap ITQ-90C GC/MS w/TriPlus autosampler	2008	LM	2
GC/MS SEMIVOLATILE ORGANICS INSTRUMENT LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler AB 104-S	2000	MM	6
Gas Chromatograph: Hewlett-Packard 5890 with HP 7673 autosampler and FID Detector	1994	LM	6

Semivolatile GC/MS Systems (12):			
Agilent 6890/5973 with ATAS Optic2 LVI and HP 7673 Autosampler (2)	1997, 2001	LM	6
Agilent 5890/5970 and HP 7673 Autosampler	1990	LM	6
Agilent 5890/5970 with ATAS Optic2 LVI and HP 7673 Autosampler	1994	LM	6
Agilent 5890/5972 with ATAS Optic2 LVI and HP 7673 Autosampler (2)	1993, 1994	LM	6
Agilent 6890/5973 with ATAS Optic3 LVI and HP 7683 Autosampler	2005	LM	6
Agilent 6890/5973 with Agilent PTV Injector and 7683 Autosampler	2007	LM	6
Agilent7890A/5975C with Agilent 7693 Autosampler (4)	2010 - 2011	LM	6
Semivolatile GC/MS/MS – Waters Quattro Micro GC Micromass with Agilent 6890, Agilent PTV Injector, 7683B Autosampler	2008	MM	2
HPLC LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler BB240	1994	MM	5
Drying Oven - Fisher Model 630F	1991	LM	5
Evaporator – Turbo Vap	2009	LM	5
Centrifuge (2)			
Beckman Coulter	2002	LM	5
Eppendorf	2012	LM	5
High-Performance Liquid Chromatographs (3): Agilent 1260 Infinity with Diode Array UV Detector	2011	LM	4
High-Performance LC/MS (3)			
Spectrometer - Thermo Electron TSQ Quantum LC/MS/MS and autosampler	2005	MM	2
API 5000 LC/MS/MS and SIL-20AC autosampler	2008	MM	4
AB Sciex 5500 and Schimadzu DGU 20A5	2011	MM	3
Agilent 1100 HPLC -UV/Fluorescence detector	2003	LM	3
VOLATILE ORGANICS LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler PE 160	1989	MM	4
Fisher Vortex Mixer	1989	LM	4

Drying Ovens (2): Boekel 107801 VWR 1305 U	 1989 1991	 LM LM	 4 4
Sonic Water Bath - Branson Model 2200	1989	LM	4
Volatile GC/MS Systems (8): Agilent 5890/5970 Tekmar 3000 Purge and Trap Concentrator Dynatech ARCHON 5100 Autosampler Agilent 5890/5971 Tekmar 3000 Purge and Trap Concentrator Dynatech ARCHON 5100 Autosampler Agilent 6890/5973 Tekmar 3100 Purge and Trap Concentrator Encon Centurion Autosampler Agilent 6890/5973 Tekmar Velocity Purge and Trap Concentrator Tekmar Aquatech Autosampler Agilent 6890/5973 Tekmar 3000 Purge and Trap Concentrator Varian Archon 5100 Autosampler Agilent 7980A/5975C (2) Teledyne Tekmar-Atomx Agilent 6890/5973 Encon Evolution Purge and Trap Concentrator Encon Centurion Autosampler	 1989 1995 1996 1991 2001 1995 2001 2001 2001 2005 2005 2005 2007 2007 2007 2010, 2011 2010, 2011 2013 2013 2013	 LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM LM	 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4
Hewlett-Packard 5890 Series II GC with PID/PID/FID Encon Purge and Trap Concentrator Dynatech Archon 5100 Autosampler	1991 1992 1992	LM	3
Agilent 7890 GC with FID Encon Evolution Purge and Trap Concentrator Encon Centurion Autosampler	2013	LM	4

AUTOMATED DATA PROCESSING EQUIPMENT			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
1-WAN: LIMS Sample Manager using Oracle 11g Enterprise DBMS running on Red Hat Enterprise Linux Advanced Server v.6.5 platform connected/linked via both fiber and DMVPN circuits.	2013	LM	NA
1 - Network Server, 1 for Reporting and Data Acquisition running Windows Server 2008 R2, 1 for Applications running Windows Server 2008 R2. Data acquisition capacity at 1.4 TB with redundant tape and disk arrays.	2012	LM	NA

Approximately 90+ HP, Dell, Kyocera Laserjet printers (various types including models III, 4, 5, 8150, 4000, 4041, 4050, 4200 4250, 8150, 1720dn, W5300, 1300D, M4000)	2010 - 2014	LM	NA
Approximately 200+ Dell/HP PC/Workstations running Windows XP/Windows 7 on LAN connected via 100BT/1GigE	2010 - 2014	LM	NA
Microsoft Office 2010 Professional as the base application for all PC/Workstations. Some systems using Office 2000/97, Office 2007.	1996 - 2014	LM	NA
E-Mail via Exchange 2010 with webmail via Outlook Web Access interface. Microsoft Outlook 2010.	2011 - 2014	LM	NA
Facsimile Machines - Brother 4750e; Brother 2920; Brother 1860	2005 - 2008	LM	NA
Copiers/Scanners: BizHub 600 (5), BizHub 920 (2), BizHub Pro 950 (3), BizHub Pro 1050 (3). All are accessible via LAN for network scanning.	2005 - 2014	LM	NA
Thruput, MARRS, Stealth, Harold, Blackbird, EDDGE, CASLIMS, & LabCoat reporting software systems.	1998 - 2014	LM	NA
Data processing terminals (74) Enviroquant (63) Target (10) Saturn (1)	1996 - 2014	LM	NA

APPENDIX F – Containers, Preservation and Holding Times

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Bacterial Tests				
Coliform, Colilert (SM 9223)	W, DW	P, Bottle or Bag	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	6-24 hours[e]
Coliform, Fecal and Total (SM 9221, 9222D)	W, S, DW	P,G	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	6-24 hours[e]
Fecal Streptococci (SM 9230B)	W	P,G	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	6-24 hours[e]
Inorganic Tests				
Acidity (SM 2310B)	W	P,G	Cool, 4˚C	14 days[EPA]
Alkalinity (SM 2320B)	W, DW	P,G	Cool, 4˚C	14 days[EPA]
Ammonia (SM 4500NH3)	W, DW	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Biochemical Oxygen Demand(SM 5210B)	W	P,G	Cool, 4˚C	48 hours
Bromate (EPA 300.1)	W, DW	P,G	50mg/L EDA, cool to 4˚C	28 days
Bromide (EPA 300.1)	W, DW	P,G	None Required	28 days
Chemical Oxygen Demand (SM 5220C)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Chloride (EPA 300.0)	W, DW	P,G	None Required	28 days
Chloride (EPA 9056)	W, S	P,G	Cool, 4˚C	28 days
Chlorine, Total Residual (SM 4500 Cl F)	W,S	P,G	None Required	24 hours
Chlorite (EPA 300.1)	W, DW	P,G	50mg/L EDA, cool to 4˚C	14 days
Chlorophyll-A (SM 11200H)	W	G Amber	Cool, 4˚C	Analyze immediately
Chromium VI (EPA 7196A)	W	P,G	Cool, 4˚C	24 hours
Color (SM 2120B)	W, DW	P,G	Cool, 4˚C	48 hours
Cyanide, Total and Amenable to Chlorination (EPA 335.4, 9010, 9012) (SM 4500CN E,G)	W, S,DW	P,G	Cool, 4˚C, NaOH to pH>12, plus 0.6 g Ascorbic Acid	14 days
Cyanide, Weak Acid Dissociable (SM 4500CN I)	W,S	P,G	Cool, 4˚C, NaOH to pH >12	14 days

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Ferrous Iron (CAS SOP)	W, D	G Amber	Cool, 4˚C	24 hours
Fluoride (EPA 300.0, SM 4500 F-C)	W,S	P,G	Cool, 4˚C	28 days
Fluoride (EPA 9056)	W,S	P,G	Cool, 4˚C	Analyze immediately
Formaldehyde (ASTM D6303)	W	G Amber	Cool, 4˚C	48 hours
Hardness (SM 2340C)	W, DW	P,G	HNO_3 to pH<2	6 months
Hydrogen Ion (pH) (SM 4500H B)	W, DW	P,G	None Required	Analyze immediately
Kjeldahl and Organic Nitrogen (ASTM D3590-89)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Nitrocellulose	S	G	Cool, 4˚C	28 days
Nitrate (EPA 300.0)	W, DW	P,G	Cool, 4˚C	48 hours
Nitrate (EPA 353.2)	W, S	P,G	Cool, 4˚C, H_2SO_4 to pH<2	48 hours
Nitrate (EPA 9056)	W,S	P,G	Cool, 4˚C	Analyze immediately
Nitrate-Nitrite (EPA 353.2)	W, DW	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Nitrite (EPA 300.0)	W, DW	P,G	Cool, 4˚C	48 hours
Nitrite (EPA 353.2)	W, S	P,G	Cool, 4˚C, H_2SO_4 to pH<2	48 hours
Nitrite (EPA 9056)	W,S	P,G	Cool, 4˚C	Analyze immediately
Orthophosphate (SM 4500 P-E)	W, DW	P,G	Cool, 4˚C	Analyze immediately
Oxygen, Dissolved (Probe) (SM 4500O G)	W, DW	G, Bottle and Top	None Required	Analyze immediately
Oxygen, Dissolved (Winkler)	W, DW	G, Bottle and Top	Fix on Site and Store in Dark	8 hours
Phenolics, Total (EPA 420.1,9056)	W, S	G Amber	Cool, 4˚C, H_2SO_4 to pH<4	28 days
Perchlorate (EPA 314.0)	W, DW,S	P,G	Protect from temp. extremes	28 days
Phosphorus, Total (EPA 365.3)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Residue, Total (SM 2540B)	W	P,G	Cool, 4˚C	7 days
Residue, Filterable (TDS) (SM2540C)	W	P,G	Cool, 4˚C	7 days

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Residue, Nonfilterable (TSS) (SM 2540D)	W	P,G	Cool, 4˚C	7 days
Residue, Settleable (SM 2540F)	W	P,G	Cool, 4˚C	48 hours
Residue, Volatile (EPA 160.4)	W	P,G	Cool, 4˚C	7 days
Silica (SM 4500SiO2 C)	W	P Only	Cool, 4˚C	28 days
Specific Conductance (SM 2510 B)	W, DW	P,G	Cool, 4˚C	28 days
Sulfate (EPA 300.0)	W, DW	P,G	Cool, 4˚C	28 days
Sulfate (EPA 9056)	W, S	P,G	Cool, 4˚C	28 days
Sulfide (SM 4500S2 D)	W	P,G	Cool, 4˚C, Add Zinc Acetate,plus Sodium Hydroxide to pH>9	7 days
Sulfide (SM 4500S2 F)	W	P,G	Cool, 4˚C, Add Zinc Acetate,plus Sodium Hydroxide to pH>9	7 days
Sulfide (9030/934)	W, S	P,G	Cool, 4˚C, Add Zinc Acetate,plus Sodium Hydroxide to pH>9	7 days
Sullfides, Acid Voaltile	S	G	Cool, 4˚C	14 days
Sulfite (SM 4500SO3 B)	W	P,G	None Required	24 hours
Surfactants (MBAS) (SM 5540 C)	W	P,G	Cool, 4˚C	48 hours
Tannin and Lignin (SM 5550B)	W	P,G	Cool, 4˚C	28 days
Turbidity (EPA 180.1)	W, DW	P,G	Cool, 4˚C	48 hours
Oil and Grease, Hexane Extractable Material (EPA 1664)	W	G, Teflon-Lined Cap	Cool, 4˚C, H_2SO_4 or HCL to pH<2	28 days
Organic Carbon, Total (9060 & SM 5310 C)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Organic Carbon, Total (ASTM-D4129)	S	P,G	Cool, 4˚C	28 days
Organic Halogens, Total (EPA 9020)	W	G, Teflon-Lined Cap	Cool, 4˚C, H_2SO_4 to pH<2, No headspace	28 days
Organic Halogens, Adsorbable (EPA 1650B)	W	G, Teflon-Lined Cap	Cool, 4˚C, HNO_3 to pH<2	6 months

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Metals				
Chromium VI (EPA 7195/7191)	W	P,G	Cool, 4˚C	24 hours
Metals (200.7, 200.8, 200.9, 6010, 6020)	W,DW	P,G	HNO_3 to pH<2	6 months
Metals (200.7, 200.8, 200.9, 6010, 6020)	S	G, Teflon-Lined cap	Cool, 4˚C	6 months
Mercury (EPA 245.1, 7470, 7471)	W, DW	P,G	HNO_3 to pH<2	28 days
Mercury (7471)	S	P,G	Cool, 4˚C	28 days
1631E	W	F	Cool, 4˚C, HCl or H_2SO_4 to pH<2	90 days
1631E	S	F	Freeze < -15ºC	1 Yr
Methyl Mercury 1630	W,S,T	F	HCL to pH<2	6 months
Arsenic Species 1632	W	G	HCL to pH<2, Cool < 4ºC	28 days
Volatile Organics				
Gasoline Range Organics (8015, NWTPH-Gx)	W	G, Teflon-Lined, Septum Cap	Cool, 4˚C, HCl to pH<2, No headspace	14 days
Gasoline Range Organics (8015, NWTPH-Gx)	S	G, Teflon-Lined Cap	Cool, 4ºC, Minimize Headspace	14 days
Purgeable Halocarbons (624, 8021, 8260)	W	G, Teflon-Lined, Septum Cap	**No Residual Chlorine Present**: HCl to pH<2, Cool, 4˚C, No Headspace	14 days
Purgeable Halocarbons (624, 8021, 8260)	W	G, Teflon-Lined, Septum Cap	**Residual Chlorine Present**: 10% $Na_2S_2O_3$, HCl to pH<2, Cool, 4˚C	14 days
Purgeable Halocarbons (8021, 8260)	S	G, Teflon-Lined Cap	Cool, 4˚C, Minimize Headspace	14 days
Purgeable Halocarbons (8021, 8260)	S	Method 5035	Encore, Freeze at -20˚C Methanol, Cool, 4C	48 hrs to prepare from Encore, 14 days after preparation.

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Purgeable Halocarbons (8021, 8260)	S	Method 5035	Sodium Bisulfate Cool, 4˚C	48 hrs to prepare from Encore, 14 days after preparation.
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8021, 8260)	W	G, Teflon-Lined,Septum Cap, No Headspace	**No Residual Chlorine Present**: HCl to pH<2, Cool, 4˚C, No Headspace	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8021, 8260)	W	G, Teflon-Lined,Septum Cap, No Headspace	**Residual Chlorine Present**: 10% $Na_2S_2O_3$, HCl to pH<2, Cool 4˚C	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8021, 8260)	S	G, Teflon-Lined Cap	Cool, 4˚C, Minimize Headspace	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8021, 8260)	S	Method 5035	Encore, Freeze at -20˚C Methanol, Cool, 4C	48 hr to prepare from Encore, 14 days after preparation.
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8021, 8260)	S	Method 5035	Sodium Bisulfate Cool, 4˚C	48 hr to prepare from Encore, 14 days after preparation
Acrolein, Acrylonitrile, Acetonitrile (624, 8260)	W	G, Teflon - Lined Septum Cap	Adjust pH to 4-5, Cool, 4˚C, No headspace	7 days
EDB and DBCP (EPA 8260)	W,S	G, Teflon - Lined Cap	Cool, 4˚C, 3 mg $Na_2S_2O_3$, No Headspace	28 days
Vinyl chloride,styrene, 2-chloroethyl vinyl ether (8260)	W	G, Teflon - Lined Septum Cap	Cool, 4˚C, Minimize Headspace	7 days
Vinyl chloride,styrene, 2-chloroethyl vinyl ether (8260)	W	G, Teflon - Lined Septum Cap	Cool, 4˚C, Minimize Headspace	7 days
Semivolatile Organics				
Nonyl Phenols	W	G, Teflon-Lined Cap	H2SO4 to pH<2, Cool, 4˚C	28 days
Organotins (CAS SOP)	W,S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction
Otto Fuel	W	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Resin and Fatty Acids (NCASI 85.02)	W	G, Teflon-Lined Cap	NaOH to pH >10, Cool, 4˚C[g]	30 days until extraction; 30 days after extraction
Methanol in Process Liquid NCASI 94.03	L	G, Teflon-Lined Cap	Cool, 4˚C	30 days
HAPS – Condensates NCASI 99.01		G, Teflon-Lined Cap	Cool, 4˚C	14/30 days
HAPS – Impinger/Canisters NCASI 99.02			Cool, 4˚C	21 days
Perfluorinated Compounds HPLC/MS/MS	W	P	Cool, 4˚C	14 days until extraction; 40 days after extraction
PBDE/PBB – ROHS GC/MS	W,S,T	G	Cool, 4˚C	40 days after extraction
Pharma Personal Care Products 1694	W	Amber G, Teflon-Lined Cap	Cool, < 6˚C	7[f] days until extraction;30 days after extraction
Nitroaromatics and Nitramines 8330B	W,S	G, Teflon-Lined Cap	Cool, 4˚C	S 14, W 7 days until extraction; 40 days after extraction
Nitroaromatics/Nitoramines HPLC/MS/MS	W,S,T	G	Cool, 4˚C Tissues < -10 C	S 14, W 7 days until extraction; 40 days after extraction
Organic acids HPLC/MS/MS	W	G, Teflon-Lined, Septum Cap	H2SO4 to pH<2, Cool, 4˚C	14 days
Petroleum Hydrocarbons, Extractable (Diesel-Range Organics) (EPA 8015)	W,S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction
Alcohols and Glycols (EPA 8015)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction;40 days after extraction
Acid Extractable Semivolatile Organics (EPA 625, 8270)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction;40 days after extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Base/Neutral Extractable Semivolatile Organics (EPA 625, 8270)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction;40 days after extraction
Chlorinated Herbicides (EPA 8151)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction;40 days after extraction
Chlorinated Phenolics (EPA 1653)	W	G, Teflon-Lined Cap	H2SO4 to pH<2, Cool, 4˚C[g]	30 days until extraction; 30 days after extraction
Polynuclear Aromatic Hydrocarbons (EPA 625, 8270)	W,S	G, Teflon-Lined Cap	Cool, 4˚C, Store in Dark[g]	7[f] days until extraction;40 days after extraction
Organochlorine Pesticides and PCBs (EPA 608, 8081, 8082, GC/MS/MS)	W,S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction
Organophosphorus Pesticides (EPA 8141, GC/MS/MS)	W,S	G, Teflon-Lined Cap	Cool, 4˚C, Store in Darkg	7[f] days until extraction;40 days after extraction
Nitrogen- and Phosphorus-Containing Pesticides (EPA 8141)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction;40 days after extraction
Drinking Water Organics				
Purgeable Organics (EPA 524.2)	DW	G, Teflon-Lined, Septum cap	Ascorbic Acid, HCl to pH≤2, Cool, 4˚C, No Headspace	14 days
EDB, DBCP, and TCP (EPA 504.1)	DW	G, Teflon-Lined, Septum cap	Cool, 4˚C, 3 mg $Na_2S_2O_3$, No Headspace	14 days
Carbamates, Carbamoyloximes (EPA 531.1)	DW	G, Amber, Teflon-Lined Cap	1.8 mL monochloroacetic acid to pH<3; 80 mg/L $Na_2S_2O_3$ if Res.Cl.; Cool, 4°C	28 days
Chlorinated Herbicides (EPA 515.4)	DW	G, Amber, Teflon-Lined Cap	If Res.Cl, 2mg/4omL NaS; Cool , <6ºC	14 days until extraction; 21 days after extraction
Chlorinated Pesticides (EPA 508.1, 525.2)	DW	G, Amber, Teflon-Lined Cap	50 mg/L NaS, HCl to pH≤ 2;Cool 4ºC	14 days until extraction; 30 days after extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Diquat and Paraquat (EPA 549.2)	DW	G, Amber, Teflon-Lined Cap	100 mg/L $Na_2S_2O_3$ if Res.Cl.Cool 4°C	7days until extraction; 21 days after extraction
Endothall (EPA 548.1)	DW	G, Amber, Teflon-Lined Cap	Cool, 4˚C	7 days until extraction; 14 days after extraction
Haloacetic Acids (EPA 552.2)	DW	G, Amber, Teflon-Lined Cap	100 mg/L NH_4Cl,Cool, 4˚C	14 days until extraction; 7 days after extraction
Semivolatile Organics (EPA 525.2)	DW	G, Amber, Teflon-Lined Cap	50 mg/L NaS, HCl to pH≤ 2;Cool, 4˚C	14 days until extraction; 30 days after extraction
Nitrosoamines (EPA 521)	DW	G, Amber, Teflon-Lined Cap	Dechlorinate at collection[g]	14 days until extraction; 28 days after extraction
Selected Pesticides and Flame Retardants (EPA 527)	DW	G, Amber, Teflon-Lined Cap	See Method, Cool, 4˚C	14 days until extraction; 28 days after extraction
Toxicity Characteristic Leaching Procedure (TCLP)				
Semivolatile Organics (EPA 1311/8270)	HW	G, Teflon - Lined Cap	Sample: Cool, 4˚C, Store in dark[g]	14 days until TCLP extraction
			TCLP extract: Cool, 4˚C, Store in dark[g]	7 days until extraction; 40 days after extraction
Organochlorine Pesticides (EPA 1311/8081)	HW	G, Teflon - Lined Cap	Sample: Cool, 4˚C	14 days until TCLP extraction
			TCLP extract: Cool, 4˚C	7 days until extraction; 40 days after extraction
Chlorinated Herbicides (EPA 1311/8151)	HW	G, Teflon - Lined Cap	Sample: Cool, 4˚C	14 days until TCLP extraction
			TCLP extract: Cool, 4˚C	7 days until extraction; 40 days after extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Mercury(EPA 1311/7470)	HW	P,G	Sample: Cool, 4°C	28 days until extraction
			TCLP extract: HNO_3 to pH<2	28 days after extraction
Metals, except Mercury (EPA 1311/6010)	HW	P,G	Sample: Cool, 4°C	180 days until extraction;
			TCLP extract: HNO_3 to pH<2	14 days until TCLP extraction
Volatile Organics (EPA 1311/8260)	HW	G, Teflon-Lined Cap	Sample: Cool, 4°C , Minimize Headspace	14 days until TCLP extraction
			Extract: Cool 4°C, HCL to pH,2, No Headspace	14 days after extraction

a For EPA SW-846 methods the method listed generically, without specific revision suffixes.

b DW = Drinking Water, W = Water; S = Soil or Sediment; HW = Hazardous Waste

c P = Polyethylene; G = Glass, F- Fluoropolymer

d For chlorinated water samples

e The maximum holding time is dependent upon the geographical proximity of sample source to the laboratory.

f Fourteen days until extraction for soil, sediment, and sludge samples.

g If the water sample contains residual chlorine, 10% sodium thiosulfate is used to dechlorinate.

APPENDIX G – Standard Operating Procedures

Corporate General and Quality Assurance SOPs

SOP TITLE	SOP ID	Revision
Laboratory Ethics and Data Integrity	CE-GEN001	2.00
(proprietary– client specific)	CE-GEN002	1.00
Records Management Policy	CE-GEN003	1.00
Preventive Action	CE-GEN004	1.00
Document Control	CE-GEN005	1.00
Data Recall	CE-GEN006	0.00
Procurement and Control of Laboratory Services and Supplies	CE-GEN007	0.00
Method Development	CE-GEN008	0.00
Establishing Standard Operating Procedures	CE-GEN009	0.00
Handling Customer Feedback	CE-GEN010	0.00
Assigning and TSR to a Project	CE-GEN011	0.00
Policy for the Use of Accreditation Organization Names, Symbols, and Logos	CE-GEN012	0.00
(proprietary – client specific)	CE-GEN013	0.00
(proprietary– client specific)	CE-GEN014	0.00
Internal Audits	CE-QA001	1.00
Manual Integration Policy	CE-QA002	1.00
Training Policy	CE-QA003	1.00
Qualification of Subcontract Laboratories	CE-QA004	1.00
Laboratory Management Review	CE-QA005	1.00
Proficiency Testing Sample Analysis	CE-QA006	0.00
Making Entries onto Analytical Records	CE-QA007	0.00
Nonconformance and Corrective Action	CE-QA008	0.00

Control Limits	CE-QA009	0.00
Estimation of Uncertainty of Analytical Measurements	CE-QA010	0.00
Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation	CE-QA011	0.00
Quality of Reagents and Standards	CE-QA012	0.00

LABORATORY SOPs

SOP NAME	**SOP ID**	**Revision**
DATA ARCHIVING	ADM-ARCH	6
DOCUMENTING LABORATORY BALANCE AND TEMPERATURE CHECKS	ADM-BAL	5
SAMPLE BATCHES	ADM-BATCH	10
CONTROL CHARTING QUALITY CONTROL DATA	ADM-CHRT	3
DEPARTMENT OF DEFENSE PROJECTS LABORATORY PRACTICES AND PROJECT MANAGEMENT	ADM-DOD	6
LABORATORY DATA REVIEW PROCESS	ADM-DREV	8
CONTINGENCY PLAN FOR LABORATORY EQUIPMENT FAILURE	ADM-ECP	3
METHOD VALIDATION DOCUMENTATION	ADM-MDLC	4
MANUAL INTEGRATION OF CHROMATOGRAPHIC PEAKS	ADM-MI	0
PROJECT MANAGEMENT	ADM-PCM	11
DATA REPORTING AND REPORT GENERATION	ADM-RG	9
REAGENT AND STANDARDS LOGIN AND TRACKING	ADM-RLT	4
SUPPORT EQUIPMENT MONITORING AND CALIBRATION	ADM-SEMC	12
ALS KELSO TRAINING PROCEDURE	ADM-TRAIN	1
CHECKING VOLUMETRIC LABWARE	ADM-VOLWARE	3
COLIFORM, FECAL	BIO-9221FC	9

COLIFORM, TOTAL	BIO-9221TC	5
COLIFORM, FECAL (MEMBRANE FILTER PROCEDURE)	BIO-9222D	4
COLILERT® , COLILERT-18®, & COLISURE®	BIO-9223	9
ENTEROLERT	BIO-ENT	2
HEPTEROTROPHIC PLATE COUNT	BIO-HPC	6
MICROBIOLOGY QUALITY ASSURANCE AND QUALITY CONTROL	BIO-QAQC	16
SHEEN SCREEN/OIL DEGRADING MICROORGANISMS	BIO-SHEEN	3
SEPARATORY FUNNEL LIQUID-LIQUID EXTRACTION	EXT-3510	10
CONTINUOUS LIQUID - LIQUID EXTRACTION	EXT-3520	14
SOLID PHASE EXTRACTION	EXT-3535	6
SOXHLET EXTRACTION	EXT-3540	11
AUTOMATED SOXHLET EXTRACTION	EXT-3541	8
ULTRASONIC EXTRACTION	EXT-3550	10
WASTE DILUTION EXTRACTION	EXT-3580	5
SILICA GEL CLEANUP	EXT-3630	5
GEL PERMEATION CHROMATOGRAPHY	EXT-3640A	8
REMOVAL OF SULFUR USING COPPER	EXT-3660	6
REMOVAL OF SULFUR USING MERCURY	EXT-3660M	3
SULFURIC ACID CLEANUP	EXT-3665	5
CARBON CLEANUP	EXT-CARCU	4
DIAZOMETHANE PREPARATION	EXT-DIAZ	6

DMD SYNTHESIS	EXT-DMD	3
FLORISIL CLEANUP	EXT-FLOR	6
ORGANIC EXTRACTIONS GLASSWARE CLEANING	EXT-GC	6
PERCENT LIPIDS IN TISSUE	EXT-LIPID	3
EXTRACTION METHOD FOR ORGANOTINS IN SEDIMENTS, WATER, AND TISSUE	EXT-OSWT	7
PREPARATION OF REAGENTS AND BLANK MATRICES USED IN SEMIVOLATILE ORGANICS ANALYSIS	EXT-REAG	2
ADDITION OF SPIKES AND SURROGATES	EXT-SAS	9
MEASURING SAMPLE WEIGHTS AND VOLUMES FOR ORGANIC ANALYSIS	EXT-WVOL	3
FACILITY AND LABORATORY CLEANING	FAC-CLEAN	2
OPERATION AND MAINTENANCE OF LABORATORY REAGENT WATER SYSTEMS	FAC-WATER	2
FLASHPOINT DETERMINATION - SETAFLASH	GEN-1020	7
COLOR	GEN-110.2	6
TOTAL SOLIDS	GEN-160.3	13
SOLIDS, TOTAL VOLATILE AND PERCENT ASH IN SOIL AND SOLID SAMPLES	GEN-160.4	7
SETTEABLE SOLIDS	GEN-160.5	4
HALIDES, ADSORBABLE ORGANIC (AOX)	GEN-1650	4
GRAVIMETRIC DETERMINATION OF HEXANE EXTRACTABLE MATERIAL (1664)	GEN-1664	9
ALKALINITY TOTAL	GEN-2320	9
HARDNESS, TOTAL	GEN-2340	8
DETERMINATION OF INORGANIC ANIONS IN DRINKING WATER BY ION CHROMATOGRAPHY	GEN-300.1	7
ACIDITY	GEN-305.2	4

PERCHLORATE BY ION CHROMATOGRAPHY	GEN-314.0	13
CHLORIDE (TITRIMETRIC, MERCURIC NITRATE)	GEN-325.3	4
CHLORINE, TOTAL/FREE RESIDUAL	GEN-330.4	2
TOTAL RESIDUAL CHLORINE - METHOD 330.5	GEN-330.5	1
AMMONIA BY FLOW INJECTION ANALYSIS	GEN-350.1	10
NITRATE/NITRITE, NITRITE BY FLOW INJECTION ANALYSIS	GEN-353.2	9
PHOSPHORUS DETERMINATION USING COLORMETRIC PROCEDURE	GEN-365.3	12
PHENOLICS, TOTAL	GEN-420.1	14
AMMONIA AS NITROGEN BY ION SPECIFIC ELECTRODE	GEN-4500 NH3 E	7
DISSOLVED SILICA	GEN-4500 SIO_2C	3
SILICA DETERMINATION USING SMARTCHEM METHOD	GEN-4500 SiO2E	0
NITRITE BY COLORIMETRIC PROCEDURE	GEN-4500NO2 B	3
ORTHOPHOSPHATE DETERMINATION USING COLORIMETRIC PROCEDURE	GEN-4500-PE	1
SULFIDE, METHYLENE BLUE	GEN-4500S2D	3
SULFIDE, TITRIMETRIC (IODINE)	GEN-4500S2F	2
HALOGENS TOTAL AS CHLORIDE BY BOMB COMBUSTION	GEN-5050	2
BIOCHEMICAL OXYGEN DEMAND	GEN-5210B	5
HALIDES, ADSORBABLE ORGANIC (AOX) - SM 5320B	GEN-5320B	2
AQUATIC HUMIC SUBSTANCES	GEN-5510B	1
DETERMINATION OF METHYLENE BLUE ACTIVE SUBSTANCES (MBAS)	GEN-5540C	7
TANNIN AND LIGNIN	GEN-5550	6

HALIDES, TOTAL ORGANIC (TOX)	GEN-9020	8
HALIDES, EXTRACTABLE ORGANIC (EOX)	GEN-9020M	2
TOTAL SULFIDES BY METHYLENE BLUE DETERMINATION	GEN-9030	10
TOTAL HALIDES BY OXIDATIVE COMBUSTION AND MICROCOULOMETRY	GEN-9076	2
CARBON, TOTAL ORGANIC IN SOIL	GEN-ASTM	9
AUTOFLUFF	GEN-AUTOFLU	2
SULFIDES, ACIDS VOLATILE	GEN-AVS	7
HEAT OF COMBUSTION	GEN-BTU	4
CHLOROPHYLL-a BY COLORIMETRY	GEN-CHLOR	1
TOTAL CYANIDES AND CYANIDES AMENABLE TO CHLORINATION	GEN-CN	18
CYANIDE, WEAK ACID DISSOCIABLE	GEN-CNWAD	1
CHEMICAL OXYGEN DEMAND	GEN-COD	8
CONDUCTIVITY IN WATER AND WASTES	GEN-COND	10
CORROSIVITY TOWARDS STEEL	GEN-CORR	1
HEXAVALENT CHROMIUM - COLORIMETRIC	GEN-CR6	12
STANDARD TEST METHODS FOR DETERMINING SEDIMENT CONCENTRATION IN WATER SAMPLES	GEN-D3977	0
CARBONATE (CO3) BY EVOLUTION AND COLUMETRIC TITRATION	GEN-D513-82M	0
SULFIDE, SOLUBLE DETERMINATION OF SOLUBLE SULFIDE IN SEDIMENT	GEN-DIS.S2	2
BULK DENSITY OF SOLID WASTE FRACTIONS	GEN-E1109	0
FDA EXTRACTABLES	GEN-FDAEX	2
FERROUS IRON IN WATER	GEN-FeII	4

FLUORIDE BY ION SELECTIVE ELECTRODE	GEN-FISE	8
FORMALDEHYDE COLORIMETRIC DETERMINATION	GEN-FORM	2
HYDROGEN PEROXIDE BY PERMANGANATE TITRATION	GEN-H2O2	2
HYDROGEN HALIDES BY ION CHROMATOGTRAPHY (METHOD 26)	GEN-HA26	3
HYDAZINE IN WATER USING COLORIMETRIC PROCEDURE	GEN-HYD	1
TOTAL SULFUR FOR ION CHROMATOGRAPHY	GEN-ICS	2
ION CHROMATOGRAPHY	GEN-IONC	17
COLOR, NCASI	GEN-NCAS	3
NITROCELLULOSE IN SOIL	GEN-NCEL	1
OXYGEN CONSUMPTION RATE	GEN-O2RATE	0
CARBON, TOTAL ORGANIC DETERMINATION (WALKELY BLACK METHOD)	GEN-OSU	3
Ph IN SOIL AND SOLIDS	GEN-Phs	13
Ph IN WATER	GEN-Phw	13
PARTICLE SIZE DETERMINATION - ASTM PROCEDURE	GEN-PSASTM	2
PARTICLE SIZE DETERMINATION	GEN-PSP	7
SULFIDES, REACTIVE	GEN-RS	4
TOTAL SULFIDE BY PSEP	GEN-S2PS	1
SULFITE	GEN-SO3	2
SPECIFIC GRAVITY	GEN-SPGRAV	1
SUBSAMPLING AND COMPOSITING OF SAMPLES	GEN-SUBS	5
SOLIDS, TOTAL DISSOLVED (TDS)	GEN-TDS	11

THIOCYANATE	GEN-THIOCN	1
NITROGEN, TOTAL AND SOLUBLE KJELDAHL	GEN-TKN	13
TOTAL NITROGEN AND TOTAL PHOSPHORUS BY ALKALINE PERSULFATE DIGESTION NCASI METHOD TNTP-W10900	GEN-TNTP	0
TOTAL ORGANIC CARBON IN WATER	GEN-TOC	12
SOLIDS, TOTAL SUSPENDED (TSS)	GEN-TSS	10
TURBIDITY MEASUREMENT	GEN-TURB	6
GLASSWASHING FOR INORGANIC ANALYSES	GEN-WASH	4
PHARMACEUTICALS, PERSONAL CARE PRODUCTS AND ENDOCRINE DISRUPTING COMPOUNDS HPLC/TANDEM MASS SPECTROMETRY (HPLC/MS/MS)	LCP-1694	3
DETERMINATION OF SELECTED PERFLUORINATED ALKYL ACIDS IN DRINKING WATER BY SOLID PHASE EXTRACTION AND TANDEM (LC/MS/MS)	LCP-537	0
DETERMINATION OF HORMONES IN DRINKING WATER BY SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY ELECTROSPRAY IONIZATION TANDEM (LC/ESI-MS/MS)	LCP-539	1
ALDEHYDES BY HPLC	LCP-8315	6
Quantitative Determination of Carbamate Pesticides by High Performance Liquid Chromatography/Tandam Mass Spectrometry (HPLC/MS/MS)	LCP-8321	0
Determination of Carbamates in Water by EPA 8321 Using LC Tandem Mass Spectrometry	LCP-8321W	2
NITROAROMATICS AND NITRAMINES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY(HPLC)	LCP-8330B	4
Acrylamide by High Performance Liquid Chromatography/tandem mass spectrometry (HPLC/ms/ms)..	LCP-ACRYL	1
QUANTITATIVE DETERMINATION OF AFLATOXINS By High Performance Liquid Chromatography/tandem mass spectrometry (HPLC/ms/ms)	LCP-AFLA	0
Dioctyl sulfosuccinate by High Performance Liquid Chromatography/tandem mass spectrometry (HPLC/ms/ms)..	LCP-DOS	5
QUANTITATION OF NITROAROMATICS AND NITRAMINES IN WATER, SOIL, AND TISSUE BY LIQUID CHROMATOGRAPHY AND TANDEM MASS SPECTROMETRY (LC-MS/MS)	LCP-LCMS4	2
NITROGUANIDINE BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY	LCP-NITG	6
QUANTITATION OF NITROPHENOLS IN SOILS BY LIQUID CHROMATOGRAPHYAND TANDEM MASS SPECTROMETRY (LC-MS/MS)	LCP-NITRO	3

ORGANIC ACIDS IN AQUEOUS MATRICES BY HPLC	LCP-OALC	5
QUANTITATIVE DETERMINATION OF OPTICAL BRIGHTENER 220 By High Performance Liquid Chromatography (HPLC)	LCP-OPBr	1
OXYANIONS IN WATER USING LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY (LC/MS/MS)	LCP-OXY	0
PERFLUORINATED COMPOUNDS BY HPLC/MS/MS	LCP-PFC	3
DETERMINATION FO PHTHALATES IN FOOD BY LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY (LC/MSMS)	LCP-PHT	1
DETERMINATION OF MANNOSE AND GALACTOSE IN WATER BY HPLC/MS/MS	LCP-SUGAR	1
METHYL MERCURY IN SOIL AND SEDIMENT BY ATOMIC FLUORESCENCE SPECTROMETRY	MET-1630S	3
METHYL MERCURY IN TISSUE BY ALCOHOLIC POTASSIUM HYDROXIDE DIGESTION, ETHYLATION, PURGE AND TRAP, AND COLD VAPOR ATOMIC FLUORESCENCE SPECTROMETRY	MET-1630T	2
METHYL MERCURY IN WATER BY ATOMIC FLUORESCENCE SPECTROMETRY	MET-1630W	3
MERCURY IN WATER BY OXIDATION, PURGE&TRAP, AND COLD VAPOR ATOMIC FLUORES. SPECTROMETRY	MET-1631	12
DETERMINATION OF ARSENIC SPECIES BY HYDRIDE GENERATION CRYOGENIC TRAPPING GAS CHROMATOGRAPHY ATOMIC ABSORPTION SPECTROPHOTOMETRY	MET-1632	3
MERCURY IN WATER	MET-245.1	14
METALS DIGESTION	MET-3010A	12
METALS DIGESTION	MET-3020A	15
METALS DIGESTION	MET-3050B	13
CLOSED VESSEL OIL DIGESTION	MET-3051M	3
CLOSED VESSEL DIGESTION OF SILICEOUS AND ORGANICALLY BASED MATRICIES	MET-3052M	1
DETERMINATION OF METALS & TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA-MS (METHOD 6020)	MET-6020	15
ARSENIC BY BOROHYDRIDE REDUCTION ATOMIC ABSORPTION	MET-7062	4
METALS DIGESTION FOR HEXAVALENT CHROMIUM	MET-7195	9

MERCURY IN LIQUID WASTE	MET-7470A	16
MERCURY IN SOLID OR SEMISOLID WASTE	MET-7471	17
SELENIUM BY BOROHYDRIDE REDUCTION ATOMIC ABSORPTION	MET-7742	4
BIOACCESSIBILITY OF METALS IN SOIL AND SOLID WASTE	MET-BIOACC	1
METALS DIGESTION OF AQUEOUS SAMPLES	MET-DIG	14
SAMPLE FILTRATION FOR METALS ANALYSIS	MET-FILT	3
METALS LABORATORY GLASSWARE CLEANING	MET-GC	4
DETERMINATION OF TRACE METALS BY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY (GFAA)	MET-GFAA	21
DETERMINATION OF METALS AND TRACE ELEMENTS BY ICP/AES	MET-ICP	24
DETERMINATION OF METALS & TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA-MS (METHOD 200.8)	MET-ICP.MS	15
TRACE METALS IN WATER BY PRECONCENTRATION USING REDUCTIVE PRECIPITATION FOLLOWED BY ICP-MS	MET-RPMS	7
METALS AND SEMIVOLATILES SPLP EXTRACTION (EPA METHOD 1312)	MET-SPLP	1
WASTE EXTRACTION TEST (WET) PROCEDURE (STLC) for NONVOLATILE and SEMIVOLATILE PARAMETERS	MET-STLC	2
METALS AND SEMIVOLATILES TCLP EXTRACTION (EPA METHOD 1311)	MET-TCLP	8
SAMPLE PREPARATION OF BIOLOGICAL TISSUES FOR METALS ANALYSIS BY GFAA, ICP-OES, AND ICP-MS	MET-TDIG	4
TISSUE SAMPLE PREPARATION	MET-TISP	8
ANALYSIS OF WATER AND SOLID SAMPLES FOR ALIPHATIC HYDROCARBONS	PET-ALIPHAT	2
GASOLINE RANGE ORGANICS BY GAS CHROMATOGRAPHY	PET-GRO	9
ANALYSIS OF WATER, SOLIDS AND SOLUBLE WASTE SAMPLES FOR SEMI-VOLATILE FUEL HYDROCARBONS	PET-SVF	12
ANALYSIS OF WATER AND SOLIDS SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS	PET-TPH	2
METHOD FOR DETERMINING GASOLINE RANGE ORGANICS, WISCONSIN DNR	PET-WIGRO	0

ANALYSIS OF SOLID AND AQUEOUS SAMPLES FOR STATE OF WISCONSIN DIESEL RANGE ORGANICS	PHC-WIDRO	4
BOTTLE ORDER PREPARATION AND SHIPPING	SMO-BORD	15
FOREIGN SOILS HANDLING TREATMENT	SMO-FSHT	10
SAMPLE RECEIVING	SMO-GEN	30
SAMPLE TRACKING AND INTERNAL CHAIN OF CUSTODY	SMO-SCOC	13
SAMPLE DISPOSAL	SMO-SDIS	10
ORGANOCHLORINE PESTICIDES AND PCBs (METHOD 608)	SOC-608	8
GLYCOLS	SOC-8015M	10
ORGANOCHLORINE PESTICIDES BY GAS CHROMATOGRAPHY: CAPILLARY COLUMN TECHNIQUE	SOC-8081	17
PCBS AS AROCLORS	SOC-8082Ar	16
CONGENER-SPECIFIC DETERMINATION OF PCBS BY GC/ECD	SOC-8082Co	13
DETERMINATION OF NITROGEN OR PHOSPHORUS CONTAINING PESTICIDES	SOC-8141	12
CHLORINATED HERBICIDES	SOC-8151	15
CHLORINATED PHENOLS METHOD 8151 MODIFIED	SOC-8151M	10
METHANOL IN PROCESS LIQUIDS AND STATIONARY SOURCE EMISSIONS	SOC-9403	7
HAZARDOUS AIR POLLUTANTS (HAPS) IN PULP AND PAPER INDUSTRY CONDENSATES	SOC-9901	5
HAPS AND OTHER COMPOUNDS IN IMPINGER/CANISTER SAMPLES FROM WOOD PRODUCTS FACILITIES	SOC-9902	4
ALCOHOLS	SOC-ALC	1
BUTYLTINS	SOC-BUTYL	12
CALIBRATION OF INSTRUMENTS FOR ORGANICS CHROMATOGRAPHIC ANALYSES	SOC-CAL	9
CONFIRMATION PROCEDURE FOR GC AND HPLC ANALYSES	SOC-CONF	6

DIMP	SOC-DIMP	8
DETERMINATION OF OTTO FUEL II IN WATER	SOC-OTTO	1
PICRIC ACID AND PICRAMIC ACID BY HPLC	SOC-PICRIC	2
POLYBROMINATED DIPHENYL ETHERS (PBDEs) AND POLYBROMINATED BIPHENYLS (PBBs) BY GC/MS	SOC-ROHS	1
SEMI-VOLATILE ORGANICS SCREENING	SOC-SCR	5
1,2-DIBROMOETHANE, 1,2-DIBROMO-3-CHLOROPROPANE, AND 1,2,3-TCP BY GC	SVD-504	10
ORGANOCHLORINE PESTICIDES AND PCBS IN DRINKING WATER	SVD-508_1	8
CHLORINATED HEBICIDES IN DRINKING WATER	SVD-515.4	9
N-NITROSAMINES BY GC/MS/MS	SVD-521	5
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS (METHOD 525.2)	SVD-525	9
ENDOTHALL IN DRINKING WATER BY GC/MS	SVD-548	9
DIQUAT AND PARAQUAT BY HPLC	SVD-549	7
HALOACETIC ACIDS IN DRINKING WATER	SVD-552	7
CHLORINATED PHENOLICS BY IN-SITU ACETYLATION AND GC/MS	SVM-1653A	8
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS	SVM-625	7
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS - METHOD 8270D	SVM-8270D	2
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS - LOW LEVEL PROCEDURE	SVM-8270L	8
POLYNUCLEAR AROMATIC HYDROCARBONS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY SIM	SVM-8270P	8
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS SELECTED ION MONITORING	SVM-8270S	6
QUANTITATIVE GEOCHEMICAL BIOMARKERS BY GC/MS SELECTIVE ION MONITORING	SVM-BIO	0
NONYLPHENOLS ISOMERS AND NONYLPHENOL ETHOXYLATES	SVM-NONYL	4

ORGANOPHOSPHOROUS PESTICIDES BY GC/MS/MS	SVM-OPPMS2	1
CHLORINATED PESTICIDES BY GC/MS/MS, EPA METHOD 1699 MODIFIED	SVM-PESTMS2	3
1,2,3-TRICHLOROPROPANE BY ISOTOPE DILUTION-GC/MS SIM	SVM-TCP	0
PURGE AND TRAP FOR AQUEOUS SAMPLES	VOC-5030	8
PURGE AND TRAP/EXTRACTION FOR VOC IN SOIL AND WASTE SAMPLES , CLOSED SYSTEM	VOC-5035	10
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-524.2	16
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-624	13
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-8260	18
VOLATILE ORGANIC COMPOUNDS BY GC/MS SELECTIVE ION MONITORING	VOC-8260S	2
VOA STORAGE BLANKS	VOC-BLAN	9
SAMPLE SCREENING FOR VOLATILE ORGANIC COMPOUNDS IN SOIL, WATER AND MISC. MATRICES	VOC-BVOC	7
ZERO HEADSPACE EXTRACTION (EPA METHOD 1311)	VOC-ZHE	7

APPENDIX H – Data Qualifiers

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

APPENDIX I – Controlled and Normative Documents

Internal QA Documents	Location
Quality Assurance Manual	Q:\QA Manual\QAM.rXX.DOC
Software Quality Assurance Plan	Corporate IT
ALS-Kelso Certifications/Accreditations	Cert_kel.xls (QA Dept.)
MDL/LOD/LOQ Tracking Spreadsheet	MDL_LIST.(*date*).xls
Technical Training Summary Database	TrainDat.mdb
Approved Signatories List	QAM App A
Personnel resumes/qualifications	HR Department
Personnel Job Descriptions	HR Department
ALS – Kelso Data Quality Objectives	Kelso DQO 20XX.rX.xls
Master Logbook of Laboratory Logbooks	QA Masterlog-001
Standard Operating Procedures and Spreadsheet	1_ Kelso SOP.xls
Proficiency Testing Schedule and Tracking Spreadsheet	PT_Schedule.xls
External Normative Documents	**Location**
USEPA Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition, EPA 815-B-97-001 (January 2005	QA Department
USEPA 40 CFR Part 136, Guidelines for Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and EPA Method Update Rule 2007 and 2012.	QA Department and online access
USEPA 40 CFR Part 141, National Primary Drinking Water Regulations and EPA Method Update Rule 2007.	QA Department and online access
National Environmental Laboratory Accreditation Program (NELAP), 2003 Quality Standards.	QA Department
TNI: TNI Standard – Environmental Laboratory Sector, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, EL-V1-2009.	QA Department
Quality Standards. American National Standard General requirements for the competence of testing and calibration laboratories, ANSI/ISO/IEC 17025:2005(E)	QA Department
DoD Quality Systems Manual for Environmental Laboratories, Versions 4.2 and 5.0	QA Department and online access
Analytical Methods (see References section)	Laboratory Departments and Online access

APPENDIX J – Laboratory Accreditations

The list of accreditations, certifications, licenses, and permits existing at the time of this QA Manual revision is given below, followed by the entire primary NELAP and DOD ELAP accreditations (un-numbered attachments). Current accreditation information is available at any time by contacting the laboratory or viewing the ALS Global website www.alsglobal.com.

Program	Number
National Programs	
DoD ELAP	L14-51
ISO 17025	L14-50
State Programs	
Alaska DEC UST	UST-040
Arizona DHS	AZ0339
Arkansas - DEQ	88-0637
California DHS	2795
Florida DOH	E87412
Georgia DNR	881
Hawaii DOH	-
Idaho DHW	-
Indiana DOH	C-WA-01
Louisiana DEQ	3016
Maine DHS	WA01276
Michigan DEQ	9949
Minnesota DOH	053-999-457
Montana DPHHS	CERT0047
Nebraska DHHS	NE-OS-23-13
Nevada DEP	WA35
New Jersey DEP	WA005
North Carolina DWQ	605
Oklahoma DEQ	9801
Oregon - DOH (primary NELAP)	WA100010
South Carolina DHEC	61002
Texas CEQ	T104704427-13-5
Utah	WA012762014-3
Washington DOE	C544
Wisconsin DNR	998386840
Wyoming (EPA Region8)	-
Miscellaneous	
Foreign Soil Permit	USDA
Plant Import Permit	USDA
Controlled Substances Permit	US DEA
Controlled Substances Permit	WA DOH

Oregon

Environmental Laboratory Accreditation Program

Department of Agriculture, Laboratory Division
Department of Environmental Quality, Laboratory Division
Oregon Health Authority, Public Health Division

NELAP Recognized

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

ALS Environmental, Kelso

1317 South 13th Ave.
Kelso WA 98626

Issue Date: 04/22/2014 ***Expiration Date:*** 02/10/2015

As of 04/22/2014 ***this list supercedes all previous lists for this certificate number.***
Customers. Please verify the current accreditation standing with ORELAP.

MATRIX : Biological Tissue

Reference	Code	Description
CAS SOC-Butyl	**60035009**	**Butyltin by GC/Flame Photometric Detector**

Analyte Code	*Analyte*
1201	Butyltin trichloride
1202	Dibutyltin dichloride
1209	Tetrabutyltin
1203	Tributyltin chloride

EPA 1631E	**10237204**	**Mercury in Water by Oxidation, Purge & Trap, and Cold Vapor Atomic Fluorescence**

Analyte Code	*Analyte*
1095	Mercury

EPA 1632A	**10123407**	**Arsenic in Water by Gaseous Hydride Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic
1012	Arsenite (As+3)
6138	Dimethylarsinic acid (DMA)
1207	Monomethylarsonic acid (MMA)

EPA 1694 1.0	**10132908**	**Pharmaceuticals and Personal Care Products by HPLC/MS/MS**

Analyte Code	*Analyte*
6911	Perfluorobutane Sulfonate (PFBS)
9562	Perfluorodecane Sulfonate (PFDS)
6905	Perfluorodecanoic acid (PFDA)
6903	Perfluorododecanoic (PFDDA)
6908	Perfluoroheptanoic acid (PFHA)
6910	Perfluorohexane Sulfonate (PFHS)
6913	Perfluorohexanoic acid (PFHXA)
6906	Perfluorononanoic acid (PFNA)
6912	Perfluorooctanoic acid
6909	Perfluorooctanoic Sulfonate (PFOS)
6914	Perfluoropentanoic acid (PFPEA)
6904	Perfluoroundecanoic acid (PFUDA)

EPA 3540C	**10140202**	**Soxhlet Extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

ALS Environmental, Kelso

1317 South 13th Ave.
Kelso WA 98626

Issue Date: 04/22/2014 ***Expiration Date:*** 02/10/2015

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Customers. Please verify the current accreditation standing with ORELAP.

EPA 3541 **10140406** **Automated Soxhlet Extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3630C **10146802** **Silica gel cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3640A **10147203** **Gel Preparation Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 365.3 **10070607** **Phosphorous - Colorimetric, two reagent.**

Analyte Code	*Analyte*
1908	Total Phosphate

EPA 3660B **10148400** **Sulfur cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3665A **10148808** **Sulfuric Acid / permanganate Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 5035A **10284807** **Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 6010C **10155803** **ICP - AES**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1175	Tin
1185	Vanadium
1190	Zinc

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

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EPA 6020A **10156408** **Inductively Coupled Plasma-Mass Spectrometry**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1075	Lead
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1165	Thallium
1185	Vanadium
1190	Zinc

EPA 7010 **10157809** **Metals by Graphite Furnace Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic
1040	Chromium
1075	Lead
1140	Selenium
1165	Thallium

EPA 7196A **10162400** **Chromium Hexavalent colorimetric**

Analyte Code	*Analyte*
1045	Chromium VI

EPA 7471B **10166402** **Mercury by Cold Vapor Atomic Absorption**

Analyte Code	*Analyte*
1095	Mercury

EPA 7742 **10169207** **Selenium by Borohydride Reduction and Atomic Absorption**

Analyte Code	*Analyte*
1140	Selenium

EPA 8081B **10178800** **Organochlorine Pesticides by GC/ECD**

Analyte Code	*Analyte*
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7005	Alachlor
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)

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Analyte Code	*Analyte*
7300	Chlorpyrifos
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
7725	Isodrin
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)

EPA 8082A **10179201** **Polychlorinated Biphenyls (PCBs) by GC/ECD**

Analyte Code	*Analyte*
9095	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ-206)
9090	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ-194)
9103	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ-195)
9065	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ-170)
9020	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ-128)
9112	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ-201)
9116	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ-174)
9114	2,2',3,3',4,5',6-Heptachlorobiphenyl (BZ-177)
9120	2,2',3,3',4,6'-Hexachlorobiphenyl (BZ-132)
9133	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ-203)
9134	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ-180)
9075	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ-183)
9025	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ-138)
9139	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ-184)
9080	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ-187)
9030	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ-141)
9151	2,2',3,4',5',6-Hexachlorobiphenyl (BZ-149)
8975	2,2',3,4,5'-Pentachlorobiphenyl (BZ-87)
9155	2,2',3,4',5-Pentachlorobiphenyl (BZ-90)
9154	2,2',3,4',5'-Pentachlorobiphenyl (BZ-97)
9035	2,2',3,5,5',6-Hexachlorobiphenyl (BZ-151)
9166	2,2',3,5',6-Pentachlorobiphenyl (BZ-95)
8945	2,2',3,5'-Tetrachlorobiphenyl (BZ-44)
9040	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ-153)
9174	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ-154)
9175	2,2',4,4',5-Pentachlorobiphenyl (BZ-99)
8980	2,2',4,5,5'-Pentachlorobiphenyl (BZ-101)
8950	2,2',4,5'-Tetrachlorobiphenyl (BZ-49)
8955	2,2',5,5'-Tetrachlorobiphenyl (BZ-52)
8930	2,2',5-Trichlorobiphenyl (BZ-18)
9085	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ-189)
9050	2,3,3',4,4',5-Hexachlorobiphenyl (BZ-156)
9045	2,3,3',4,4',5'-Hexachlorobiphenyl (BZ-157)
9193	2,3,3',4,4',6-Hexachlorobiphenyl (BZ-158)
8985	2,3,3',4,4'-Pentachlorobiphenyl (BZ-105)
8990	2,3,3',4',6-Pentachlorobiphenyl (BZ-110)

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Analyte Code	*Analyte*
9207	2,3,3',4'-Tetrachlorobiphenyl (BZ-56)
9055	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ-167)
9218	2,3',4,4',5',6-Hexachlorobiphenyl (BZ-168)
9005	2,3,4,4',5-Pentachlorobiphenyl (BZ-114)
8995	2,3',4,4',5-Pentachlorobiphenyl (BZ-118)
9000	2,3',4,4',5'-Pentachlorobiphenyl (BZ-123)
9220	2,3',4,4',6-Pentachlorobiphenyl (BZ-119)
9221	2,3,4,4'-Tetrachlorobiphenyl (BZ-60)
8960	2,3',4,4'-Tetrachlorobiphenyl (BZ-66)
9230	2,3',4',5-Tetrachlorobiphenyl (BZ-70)
9239	2,3',4'-Trichlorobiphenyl (BZ-33)
8920	2,3-Dichlorobiphenyl (BZ-5)
9250	2,4,4',5-Tetrachlorobiphenyl (BZ-74)
9252	2,4,4'-Trichlorobiphenyl (BZ-28)
8940	2,4',5-Trichlorobiphenyl (BZ-31)
8915	2-Chlorobiphenyl (BZ-1)
9060	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ-169)
9015	3,3',4,4',5-Pentachlorobiphenyl (BZ-126)
8965	3,3',4,4'-Tetrachlorobiphenyl (BZ-77)
8970	3,4,4',5-Tetrachlorobiphenyl (BZ-81)
9266	3,4,4'-Trichlorobiphenyl (BZ-37)
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
8912	Aroclor-1262 (PCB-1262)
8913	Aroclor-1268 (PCB-1268)
9105	Decachlorobiphenyl (BZ-209)

EPA 8270D **10186002** **Semivolatile Organic compounds by GC/MS**

Analyte Code	*Analyte*
5660	4-Bromophenyl phenyl ether (BDE-3)
5562	Azobenzene
5570	Benzaldehyde
5640	Biphenyl
6545	n-Nitrosodi-n-propylamine

EPA 8270D SIM **10242509** **Semivolatile Organic compounds by GC/MS Selective Ion Monitoring**

Analyte Code	*Analyte*
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
6221	1,2-Diphenylhydrazine
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6380	1-Methylnaphthalene
9501	1-Methylphenanthrene
6852	2,3,5-Trimethylnaphthalene
6835	2,4,5-Trichlorophenol
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
6175	2,4-Dinitrophenol
6185	2,4-Dinitrotoluene (2,4-DNT)
6188	2,6-Dimethylnaphthalene
6190	2,6-Dinitrotoluene (2,6-DNT)
5795	2-Chloronaphthalene

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Analyte Code	*Analyte*
5800	2-Chlorophenol
6360	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6460	2-Nitroaniline
6490	2-Nitrophenol
6412	3 & 4 Methylphenol
5660	4-Bromophenyl phenyl ether (BDE-3)
5700	4-Chloro-3-methylphenol
5825	4-Chlorophenyl phenylether
6410	4-Methylphenol (p-Cresol)
6470	4-Nitroaniline
6500	4-Nitrophenol
5500	Acenaphthene
5505	Acenaphthylene
5555	Anthracene
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5605	Benzo(e)pyrene
5590	Benzo(g,h,i)perylene
9309	Benzo(j)fluoranthene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5630	Benzyl alcohol
5640	Biphenyl
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl) ether
5780	bis(2-Chloroisopropyl) ether
5670	Butyl benzyl phthalate
5680	Carbazole
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
5895	Dibenz(a,h) anthracene
5905	Dibenzofuran
6070	Diethyl phthalate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
4840	Hexachloroethane
6315	Indeno(1,2,3-cd) pyrene
6320	Isophorone
5005	Naphthalene
5015	Nitrobenzene
6525	n-Nitrosodiethylamine
6545	n-Nitrosodi-n-propylamine
6535	n-Nitrosodiphenylamine
6605	Pentachlorophenol
6608	Perylene
6615	Phenanthrene
6625	Phenol
6665	Pyrene

EPA 8330B **10308006** **Nitroaromatics, Nitramines and Nitrate Esters by High Performance Liquid Chromatography (HPLC)**

Analyte Code	*Analyte*
6885	1,3,5-Trinitrobenzene (1,3,5-TNB)
6160	1,3-Dinitrobenzene (1,3-DNB)

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Analyte Code	*Analyte*
9651	2,4,6-Trinitrotoluene (2,4,6-TNT)
6185	2,4-Dinitrotoluene (2,4-DNT)
6190	2,6-Dinitrotoluene (2,6-DNT)
9303	2-Amino-4,6-dinitrotoluene (2-am-dnt)
9507	2-Nitrotoluene
6150	3,5-Dinitroaniline
9510	3-Nitrotoluene
9306	4-Amino-2,6-dinitrotoluene (4-am-dnt)
9513	4-Nitrotoluene
6415	Methyl-2,4,6-trinitrophenylnitramine (tetryl)
5015	Nitrobenzene
6485	Nitroglycerin
9522	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
9558	Pentaerythritoltetranitrate
9432	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)

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MATRIX : Drinking Water

Reference	Code	Description
EPA 180.1	**10011402**	**Turbidity - Nephelometric**

Analyte Code	*Analyte*
2055	Turbidity

EPA 200.7 4.4	**10013806**	**ICP - metals**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1055	Copper
1760	Hardness (calc.)
1070	Iron
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1990	Silica as SiO2
1150	Silver
1155	Sodium
1185	Vanadium
1190	Zinc

EPA 200.8 5.4	**10014605**	**Metals by ICP-MS**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1055	Copper
1075	Lead
1090	Manganese
1105	Nickel
1140	Selenium
1150	Silver
1165	Thallium

EPA 200.9 2.2	**10015404**	**Metals by Graphite Atomic Absorption**

Analyte Code	*Analyte*
1005	Antimony
1010	Arsenic
1055	Copper
1075	Lead
1140	Selenium
1165	Thallium

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EPA 245.1 3 **10036609** **Mercury by Cold Vapor Atomic Absorption**

Analyte Code	*Analyte*
1095	Mercury

EPA 300.0 2.1 **10053200** **Methods for the Determination of Inorganic Substances in Environmental Samples**

Analyte Code	*Analyte*
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1820	Nitrate-nitrite
1840	Nitrite as N
2000	Sulfate

EPA 300.1 **10053608** **Ion chromatography - anions.**

Analyte Code	*Analyte*
1535	Bromate
1540	Bromide
1570	Chlorate
1595	Chlorite

EPA 314.0 **10055400** **Perchlorate in Drinking Water by Ion Chromatography**

Analyte Code	*Analyte*
1895	Perchlorate

EPA 335.4 **10061208** **Methods for the Determination of Inorganic Substances in Environmental Samples**

Analyte Code	*Analyte*
1645	Total cyanide

EPA 353.2 2 **10067604** **Nitrate/Nitrite Nitrogen - Automated, Cadmium**

Analyte Code	*Analyte*
1810	Nitrate as N
1840	Nitrite as N
1825	Total nitrate+nitrite

EPA 504.1 **10082607** **EDB/DBCP/TCP micro-extraction, GC/ECD**

Analyte Code	*Analyte*
5180	1,2,3-Trichloropropane
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)

EPA 508.1 2 **10086405** **Chlorinated Pesticides, Herbicides, and Organohalides, liquid/solid extraction by GC/ECD**

Analyte Code	*Analyte*
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I

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Analyte Code	*Analyte*
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
7810	Methoxychlor
8870	PCBs
8250	Toxaphene (Chlorinated camphene)

EPA 515.4 1 **10088503** **Chlorinated acids Liquid/Solid and GC/ECD**

Analyte Code	*Analyte*
8655	2,4,5-T
8545	2,4-D
8560	2,4-DB
8600	3,5-Dichlorobenzoic acid
6500	4-Nitrophenol
8505	Acifluorfen
8530	Bentazon
8540	Chloramben
8555	Dalapon
8570	DCPA di acid degradate
8595	Dicamba
8605	Dichloroprop (Dichlorprop)
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
6605	Pentachlorophenol
8645	Picloram
8650	Silvex (2,4,5-TP)

EPA 524.2 4.1 **10088809** **Volatile Organic Compounds GC/MS Capillary Column**

Analyte Code	*Analyte*
5105	1,1,1,2-Tetrachloroethane
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5150	1,2,3-Trichlorobenzene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane (Ethylene dichloride)
4655	1,2-Dichloropropane
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4665	2,2-Dichloropropane
4535	2-Chlorotoluene
4540	4-Chlorotoluene
4910	4-Isopropyltoluene (p-Cymene)
4375	Benzene
4385	Bromobenzene

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Analyte Code	*Analyte*
4390	Bromochloromethane
4395	Bromodichloromethane
4397	Bromoethane (Ethyl Bromide)
4400	Bromoform
4455	Carbon tetrachloride
4475	Chlorobenzene
4575	Chlorodibromomethane
4485	Chloroethane (Ethyl chloride)
4505	Chloroform
4645	cis-1,2-Dichloroethylene
4680	cis-1,3-Dichloropropene
4595	Dibromomethane (Methylene bromide)
4625	Dichlorodifluoromethane (Freon-12)
4765	Ethylbenzene
4835	Hexachlorobutadiene
4900	Isopropylbenzene
5240	m+p-xylene
4950	Methyl bromide (Bromomethane)
4960	Methyl chloride (Chloromethane)
5000	Methyl tert-butyl ether (MTBE)
4975	Methylene chloride (Dichloromethane)
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4440	sec-Butylbenzene
5100	Styrene
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
5140	Toluene
5205	Total trihalomethanes
4700	trans-1,2-Dichloroethylene
4685	trans-1,3-Dichloropropylene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)
5235	Vinyl chloride
5260	Xylene (total)

EPA 525.2 2 **10090003** **Semi-Volatile by SPE extraction and GC/MS**

Analyte Code	*Analyte*
6185	2,4-Dinitrotoluene (2,4-DNT)
6190	2,6-Dinitrotoluene (2,6-DNT)
4310	Acetochlor
7005	Alachlor
7065	Atrazine
5580	Benzo(a)pyrene
6062	bis(2-Ethylhexyl)adipate
7160	Butachlor
5670	Butyl benzyl phthalate
8550	Dacthal (DCPA)
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
6070	Diethyl phthalate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
7555	EPTC (Eptam, s-ethyl-dipropyl thio carbamate)
6275	Hexachlorobenzene
6285	Hexachlorocyclopentadiene
6320	Isophorone
7835	Metolachlor

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Analyte Code	*Analyte*
7845	Metribuzin
7875	Molinate
8045	Propachlor (Ramrod)
8125	Simazine
8180	Terbacil

EPA 548.1 1 **10092805** **Endothall by Ion Exchange, Methylation and GC/MS**

Analyte Code	*Analyte*
7525	Endothall

EPA 549.2 **10093206** **Diquat/Paraquat, Liquid/Solid Extraction and HPLC/UV**

Analyte Code	*Analyte*
9390	Diquat
9528	Paraquat

EPA 552.2 1 **10095804** **Haloacetic Acid/Dalapon, Liquid/Liquid Extraction, Derivitization and GC/ECD**

Analyte Code	*Analyte*
9312	Bromoacetic acid
9315	Bromochloroacetic acid
9336	Chloroacetic acid
9357	Dibromoacetic acid
9360	Dichloroacetic acid
9414	Total haloacetic acids
9642	Trichloroacetic acid

SM 2120 B 20th ED **20224004** **Color by Visual Comparison**

Analyte Code	*Analyte*
1605	Color

SM 2320 B 20th ED **20045209** **Alkalinity by Titration**

Analyte Code	*Analyte*
1505	Alkalinity as CaCO3

SM 2340 B 20th ED **20046202** **Hardness by calculation**

Analyte Code	*Analyte*
1750	Hardness

SM 2510 B 20th ED **20048208** **Conductivity by Probe**

Analyte Code	*Analyte*
1610	Conductivity

SM 2540 C 20th ED **20050004** **Total Dissolved Solids**

Analyte Code	*Analyte*
1955	Residue-filterable (TDS)

SM 4500-Cl F 20th ED **20080506** **Residual Chlorine by DPD Ferrous Titration**

Analyte Code	*Analyte*
1945	Residual free chlorine

ORELAP Fields of Accreditation

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EPA CODE: WS01276
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SM 4500-F⁻ C 20th ED	**20102005**	**Fluoride by Ion Selective Electrode**

Analyte Code	*Analyte*
1730	Fluoride

SM 4500-H+ B 20th ED	**20104807**	**pH by Probe**

Analyte Code	*Analyte*
1900	pH

SM 4500-P E 20th ED	**20123802**	**Phosphorus by Ascorbic Acid Reduction**

Analyte Code	*Analyte*
1870	Orthophosphate as P

SM 5310 C 20th ED	**20138403**	**Total Organic Carbon by Persulfate-Ultraviolet Oxidation Method**

Analyte Code	*Analyte*
2040	Total organic carbon

SM 9215 B (PCA) 20th ED	**20181208**	**Heterotrophic Plate Count Pour Plate (plate count agar): Heterotrophic Bacteria**

Analyte Code	*Analyte*
2555	Heterotrophic plate count

SM 9223 B (Colilert-18® Multiple-tube) 20th ED	**20229407**	**Chromogenic/Fluorogenic Quantitative: Total Coliform and E. coli**

Analyte Code	*Analyte*
2530	Fecal coliforms

SM 9223 B (Colilert®) 20th ED	**20212208**	**Chromogenic/Fluorogenic Qualitative (Colilert®): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9223 B (Colilert®-18 Quanti-Tray®) 20th ED	**20213201**	**Chromogenic/Fluorogenic Quantitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9223 B (Colilert®-18) 20th ED	**20214204**	**Chromogenic/Fluorogenic Qualitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9223 B (Colilert®-18) 21st ED	**20214408**	**Chromogenic/Fluorogenic Qualitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

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MATRIX : Non-Potable Water

Reference	Code	Description
ASTM D1426-98B	**30023406**	**Ammonia by Titration**

Analyte Code	*Analyte*
1515	Ammonia as N

ASTM D3590-89B	**30016809**	**Total Kjeldahl Nitrogen in Water**

Analyte Code	*Analyte*
1795	Kjeldahl nitrogen - total

ASTM D4129 05	**30018907**	**Total and Organic Carbon in Water by High Temperature Oxidation and by Coulometric Detection**

Analyte Code	*Analyte*
2040	Total organic carbon

CAS PestMS2 (1699 modified) 2	**60035101**	**Chlorinated Pesticides by GC/MS/MS**

Analyte Code	*Analyte*
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7300	Chlorpyrifos
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
7725	Isodrin
7810	Methoxychlor
7870	Mirex
5553	Octachlorostyrene
3890	Oxychlordane
7910	trans-Nanochlor

CAS SOC-Butyl	**60035009**	**Butyltin by GC/Flame Photometric Detector**

Analyte Code	*Analyte*
1201	Butyltin trichloride
1202	Dibutyltin dichloride
1209	Tetrabutyltin
1203	Tributyltin chloride

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Enterolert® **60030208** **Chromogenic/Fluorogenic Quantitative (Enterolert®): Enterococci**

Analyte Code	*Analyte*
2520	Enterococci

EPA 1020A **10117007** **Ignitability Setaflash Closed-cup Method**

Analyte Code	*Analyte*
1780	Ignitability

EPA 160.4 **10256801** **Total Volatile Solids, ignition @ 550 C.**

Analyte Code	*Analyte*
4075	Vol. residue, density, water & solids content of coatings

EPA 1630 **10122608** **Methyl Mercury by Purge & Trap Cold Vapor Atomic Fluorescence Spectrometry**

Analyte Code	*Analyte*
1205	Methyl Mercury

EPA 1631E **10237204** **Mercury in Water by Oxidation, Purge & Trap, and Cold Vapor Atomic Fluorescence**

Analyte Code	*Analyte*
1095	Mercury

EPA 1632A **10123407** **Arsenic in Water by Gaseous Hydride Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic
1012	Arsenite (As+3)
6138	Dimethylarsinic acid (DMA)
1207	Monomethylarsonic acid (MMA)

EPA 1650 **10124808** **Adsorbable Organic Halides by Adsorption and Coulometric Titration**

Analyte Code	*Analyte*
4345	Adsorbable organic halogens (AOX)

EPA 1653A **10125403** **Chlorinated Phenolics by "In Situ" Acetylation and GC/MS**

Analyte Code	*Analyte*
6735	2,3,4,6-Tetrachlorophenol
6835	2,4,5-Trichlorophenol
6840	2,4,6-Trichlorophenol
6805	3,4,5-Trichlorocatechol
6815	3,4,5-Trichloroguaiacol
6810	3,4,6-Trichlorocatechol
6820	3,4,6-Trichloroguaiacol
6825	4,5,6-Trichloroguaiacol
6605	Pentachlorophenol
6720	Tetrachlorocatechol
6725	Tetrachloroguaiacol
6875	Trichlorosyringol

EPA 1664A (HEM) **10127807** **N-Hexane Extractable Material (Oil and Grease) by Extraction and Gravimetry**

Analyte Code	*Analyte*
1803	n-Hexane Extractable Material (O&G)
1860	Oil & Grease

ORELAP Fields of Accreditation

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EPA 1694 1.0 **10132908** **Pharmaceuticals and Personal Care Products by HPLC/MS/MS**

Analyte Code	*Analyte*
6769	17a-estradiol
6771	17a-ethynylestradiol
6773	17ß-estradiol
4307	Acetominophen
7052	Androstenedione
7065	Atrazine
9301	Bisphenol A
5675	Caffeine
7194	Carbamazepine
7375	DEET
7086	Diazepam
7087	Diclofenac
6075	Diethylstilbestrol
7253	Estriol
7254	Estrone
7257	Fluoxetine
7258	Gemfibrozil
7219	Hydrocodone
7259	Ibuprofen
7719	Iopromide
7313	Meprobamate
7316	Methadone
7269	Naproxen
7317	Oxybenzone
7318	Pentoxifylline
6911	Perfluorobutane Sulfonate (PFBS)
9562	Perfluorodecane Sulfonate (PFDS)
6905	Perfluorodecanoic acid (PFDA)
6903	Perfluorododecanoic (PFDDA)
6908	Perfluoroheptanoic acid (PFHA)
6910	Perfluorohexane Sulfonate (PFHS)
6913	Perfluorohexanoic acid (PFHXA)
6906	Perfluorononanoic acid (PFNA)
6912	Perfluorooctanoic acid
6909	Perfluorooctanoic Sulfonate (PFOS)
6914	Perfluoropentanoic acid (PFPEA)
6904	Perfluoroundecanoic acid (PFUDA)
7284	Progesterone
9585	Salicylic acid
7297	Sulfamethoxazole
7301	Testosterone
7304	Triclosan
7307	Trimethoprim

EPA 180.1 **10011402** **Turbidity - Nephelometric**

Analyte Code	*Analyte*
2055	Turbidity

EPA 200.7 4.4 **10013806** **ICP - metals**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
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Analyte Code	*Analyte*
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1760	Hardness (calc.)
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1990	Silica as SiO2
1150	Silver
1155	Sodium
1160	Strontium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

EPA 200.8 5.4 **10014605** **Metals by ICP-MS**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1075	Lead
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1165	Thallium
3035	Uranium
1185	Vanadium
1190	Zinc

EPA 200.9 2.2 **10015404** **Metals by Graphite Atomic Absorption**

Analyte Code	*Analyte*
1005	Antimony
1010	Arsenic
1055	Copper
1075	Lead
1140	Selenium
1165	Thallium

EPA 245.1 3 **10036609** **Mercury by Cold Vapor Atomic Absorption**

Analyte Code	*Analyte*
1095	Mercury

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EPA 300.0 2.1 **10053200** **Methods for the Determination of Inorganic Substances in Environmental Samples**

Analyte Code	*Analyte*
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1820	Nitrate-nitrite
1840	Nitrite as N
2000	Sulfate

EPA 3005A **10133207** **Acid Digestion of waters for Total Recoverable or Dissolved Metals**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3010A **10133605** **Acid Digestion of Aqueous samples and Extracts for Total Metals**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3020A **10134404** **Acid Digestion of Aqueous samples and Extracts for Total Metals for Analysis by GFAA**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 314.0 **10055400** **Perchlorate in Drinking Water by Ion Chromatography**

Analyte Code	*Analyte*
1895	Perchlorate

EPA 330.4 **10059004** **Residual Chlorine - DPD-FAS Titration**

Analyte Code	*Analyte*
1940	Total residual chlorine

EPA 335.4 **10061208** **Methods for the Determination of Inorganic Substances in Environmental Samples**

Analyte Code	*Analyte*
1645	Total cyanide

EPA 3510C **10138202** **Separatory Funnel Liquid-liquid extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3520C **10139001** **Continuous Liquid-liquid extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 353.2 2 **10067604** **Nitrate/Nitrite Nitrogen - Automated, Cadmium**

Analyte Code	*Analyte*
1810	Nitrate as N
1820	Nitrate-nitrite
1840	Nitrite as N
1825	Total nitrate+nitrite

ORELAP Fields of Accreditation

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EPA 3535A	**10139409**	**Solid-Phase Extraction (SPE)**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3610B	**10144602**	**Alumina Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3620C	**10146006**	**Florisil Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3630C	**10146802**	**Silica gel cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3640A	**10147203**	**Gel Preparation Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 365.3	**10070607**	**Phosphorous - Colorimetric, two reagent.**

Analyte Code	*Analyte*
1870	Orthophosphate as P
1908	Total Phosphate

EPA 3660B	**10148400**	**Sulfur cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3665A	**10148808**	**Sulfuric Acid / permanganate Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 420.1	**10079206**	**Phenolics - Spectrophotometric, manual.**

Analyte Code	*Analyte*
1905	Total phenolics

EPA 5030B	**10153409**	**Purge and trap for aqueous samples**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 524.2 4.1	**10088809**	**Volatile Organic Compounds GC/MS Capillary Column**

Analyte Code	*Analyte*
4840	Hexachloroethane

EPA 6010C	**10155803**	**ICP - AES**

Analyte Code	*Analyte*
1000	Aluminum

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Analyte Code	*Analyte*
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

EPA 6020A **10156408** **Inductively Coupled Plasma-Mass Spectrometry**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1075	Lead
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1160	Strontium
1165	Thallium
3035	Uranium
1185	Vanadium
1190	Zinc

EPA 608 **10103603** **Organochlorine Pesticides & PCBs by GC/ECD**

Analyte Code	*Analyte*
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)

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Analyte Code	*Analyte*
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7685	Heptachlor
7690	Heptachlor epoxide
7810	Methoxychlor
8250	Toxaphene (Chlorinated camphene)

EPA 624 **10107207** **Volatile Organic Compounds by purge and trap GC/MS**

Analyte Code	*Analyte*
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane (Ethylene dichloride)
4655	1,2-Dichloropropane
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
4500	2-Chloroethyl vinyl ether
4995	4-Methyl-2-pentanone (MIBK)
4325	Acrolein (Propenal)
4340	Acrylonitrile
4375	Benzene
4395	Bromodichloromethane
4400	Bromoform
4455	Carbon tetrachloride
4475	Chlorobenzene
4575	Chlorodibromomethane
4485	Chloroethane (Ethyl chloride)
4505	Chloroform
4680	cis-1,3-Dichloropropene
4625	Dichlorodifluoromethane (Freon-12)
4765	Ethylbenzene
4950	Methyl bromide (Bromomethane)
4960	Methyl chloride (Chloromethane)
4975	Methylene chloride (Dichloromethane)
5100	Styrene
5115	Tetrachloroethylene (Perchloroethylene)
5140	Toluene
4700	trans-1,2-Dichloroethylene
4685	trans-1,3-Dichloropropylene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)
5235	Vinyl chloride
5260	Xylene (total)

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EPA 625 **10300002** **Base/Neutrals and Acids by GC/MS**

Analyte Code	*Analyte*
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
6221	1,2-Diphenylhydrazine
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
6175	2,4-Dinitrophenol
6185	2,4-Dinitrotoluene (2,4-DNT)
6190	2,6-Dinitrotoluene (2,6-DNT)
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6360	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
6490	2-Nitrophenol
5945	3,3'-Dichlorobenzidine
5660	4-Bromophenyl phenyl ether
5700	4-Chloro-3-methylphenol
5825	4-Chlorophenyl phenylether
6500	4-Nitrophenol
5500	Acenaphthene
5505	Acenaphthylene
5555	Anthracene
5595	Benzidine
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5590	Benzo(g,h,i)perylene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl) ether
5780	bis(2-Chloroisopropyl) ether
5670	Butyl benzyl phthalate
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
5895	Dibenz(a,h) anthracene
6070	Diethyl phthalate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene
4840	Hexachloroethane
6315	Indeno(1,2,3-cd) pyrene
6320	Isophorone
5005	Naphthalene
5015	Nitrobenzene
6530	n-Nitrosodimethylamine
6545	n-Nitrosodi-n-propylamine
6535	n-Nitrosodiphenylamine
6605	Pentachlorophenol
6615	Phenanthrene
6625	Phenol
6665	Pyrene

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EPA 7010 **10157809** **Metals by Graphite Furnace Atomic Absorption**

Analyte Code	*Analyte*
1005	Antimony
1010	Arsenic
1040	Chromium
1075	Lead
1140	Selenium
1165	Thallium

EPA 7062 **10159407** **Antimony and Arsenic by Borohydride Reduction and Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic

EPA 7195 **10162002** **Chromium, Hexavalent (Coprecipitation) by Graphite Furnace Atomic Absorption**

Analyte Code	*Analyte*
1045	Chromium VI

EPA 7196A **10162400** **Chromium Hexavalent colorimetric**

Analyte Code	*Analyte*
1045	Chromium VI

EPA 7470A **10165807** **Mercury in Liquid Waste by Cold Vapor Atomic Absorption**

Analyte Code	*Analyte*
1095	Mercury

EPA 7742 **10169207** **Selenium by Borohydride Reduction and Atomic Absorption**

Analyte Code	*Analyte*
1140	Selenium

EPA 8015C **10173805** **Non-halogenated organics using GC/FID**

Analyte Code	*Analyte*
9369	Diesel range organics (DRO)
4785	Ethylene glycol
9408	Gasoline range organics (GRO)

EPA 8021B **10174808** **Aromatic and Halogenated Volatiles by GC with PID and/or ECD Purge & Trap**

Analyte Code	*Analyte*
4375	Benzene
4765	Ethylbenzene
5140	Toluene
5260	Xylene (total)

EPA 8081B **10178800** **Organochlorine Pesticides by GC/ECD**

Analyte Code	*Analyte*
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7005	Alachlor
7025	Aldrin

ALS Environmental, Kelso

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Analyte Code	*Analyte*
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7300	Chlorpyrifos
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
4840	Hexachloroethane
7725	Isodrin
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans-Nanochlor

EPA 8082A **10179201** **Polychlorinated Biphenyls (PCBs) by GC/ECD**

Analyte Code	*Analyte*
9095	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ-206)
9090	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ-194)
9103	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ-195)
9065	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ-170)
9020	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ-128)
9112	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ-201)
9116	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ-174)
9114	2,2',3,3',4,5',6'-Heptachlorobiphenyl (BZ-177)
9120	2,2',3,3',4,6'-Hexachlorobiphenyl (BZ-132)
9133	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ-203)
9134	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ-180)
9075	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ-183)
9025	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ-138)
9139	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ-184)
9080	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ-187)
9030	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ-141)
9151	2,2',3,4',5',6-Hexachlorobiphenyl (BZ-149)
8975	2,2',3,4,5'-Pentachlorobiphenyl (BZ-87)
9155	2,2',3,4',5-Pentachlorobiphenyl (BZ-90)
9154	2,2',3,4',5'-Pentachlorobiphenyl (BZ-97)
9035	2,2',3,5,5',6-Hexachlorobiphenyl (BZ-151)
9166	2,2',3,5',6-Pentachlorobiphenyl (BZ-95)
8945	2,2',3,5'-Tetrachlorobiphenyl (BZ-44)
9040	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ-153)
9174	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ-154)
9175	2,2',4,4',5-Pentachlorobiphenyl (BZ-99)
8980	2,2',4,5,5'-Pentachlorobiphenyl (BZ-101)
8950	2,2',4,5'-Tetrachlorobiphenyl (BZ-49)
8955	2,2',5,5'-Tetrachlorobiphenyl (BZ-52)
8930	2,2',5-Trichlorobiphenyl (BZ-18)

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Analyte Code	*Analyte*
9085	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ-189)
9050	2,3,3',4,4',5-Hexachlorobiphenyl (BZ-156)
9045	2,3,3',4,4',5'-Hexachlorobiphenyl (BZ-157)
9193	2,3,3',4,4',6-Hexachlorobiphenyl (BZ-158)
8985	2,3,3',4,4'-Pentachlorobiphenyl (BZ-105)
8990	2,3,3',4',6-Pentachlorobiphenyl (BZ-110)
9207	2,3,3',4'-Tetrachlorobiphenyl (BZ-56)
9055	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ-167)
9217	2,3,4,4',5,6-Hexachlorobiphenyl (BZ-166)
9218	2,3',4,4',5',6-Hexachlorobiphenyl (BZ-168)
9005	2,3,4,4',5-Pentachlorobiphenyl (BZ-114)
8995	2,3',4,4',5-Pentachlorobiphenyl (BZ-118)
9000	2,3',4,4',5'-Pentachlorobiphenyl (BZ-123)
9220	2,3',4,4',6-Pentachlorobiphenyl (BZ-119)
9221	2,3,4,4'-Tetrachlorobiphenyl (BZ-60)
8960	2,3',4,4'-Tetrachlorobiphenyl (BZ-66)
9230	2,3',4',5-Tetrachlorobiphenyl (BZ-70)
9239	2,3',4'-Trichlorobiphenyl (BZ-33)
8920	2,3-Dichlorobiphenyl (BZ-5)
9250	2,4,4',5-Tetrachlorobiphenyl (BZ-74)
9252	2,4,4'-Trichlorobiphenyl (BZ-28)
8940	2,4',5-Trichlorobiphenyl (BZ-31)
9256	2,4'-Dichlorobiphenyl (BZ-8)
8915	2-Chlorobiphenyl (BZ-1)
9060	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ-169)
9015	3,3',4,4',5-Pentachlorobiphenyl (BZ-126)
8965	3,3',4,4'-Tetrachlorobiphenyl (BZ-77)
8970	3,4,4',5-Tetrachlorobiphenyl (BZ-81)
9266	3,4,4'-Trichlorobiphenyl (BZ-37)
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
8912	Aroclor-1262 (PCB-1262)
8913	Aroclor-1268 (PCB-1268)
9105	Decachlorobiphenyl (BZ-209)

EPA 8141B **10182204** **Organophosphorous Pesticides by GC/NPD**

Analyte Code	*Analyte*
7075	Azinphos-methyl (Guthion)
7125	Bolstar (Sulprofos)
7300	Chlorpyrifos
7315	Coumaphos
7395	Demeton-o
7385	Demeton-s
7410	Diazinon
8610	Dichlorovos (DDVP, Dichlorvos)
7475	Dimethoate
8625	Disulfoton
7550	EPN
7570	Ethoprop
7600	Fensulfothion
7605	Fenthion
7770	Malathion
7785	Merphos
7825	Methyl parathion (Parathion, methyl)
7850	Mevinphos

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Analyte Code	*Analyte*
7955	Parathion, ethyl
7985	Phorate
8110	Ronnel
8155	Sulfotepp
8200	Tetrachlorvinphos (Stirophos, Gardona) Z-isomer
8245	Tokuthion (Prothiophos)
8275	Trichloronate

EPA 8151A **10183207** **Chlorinated Herbicides by GC/ECD**

Analyte Code	*Analyte*
8655	2,4,5-T
8545	2,4-D
8560	2,4-DB
8555	Dalapon
8595	Dicamba
8605	Dichloroprop (Dichlorprop)
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
7775	MCPA
7780	MCPP
8650	Silvex (2,4,5-TP)

EPA 8260C **10307003** **Volatile Organics: GC/MS (capillary column)**

Analyte Code	*Analyte*
5105	1,1,1,2-Tetrachloroethane
5185	1,1,1-Trichloro-2,2,2-trifluoroethane
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5195	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
5165	1,1,2-Trichloroethane
5167	1,1,2-Trichlorofluoroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5150	1,2,3-Trichlorobenzene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane (Ethylene dichloride)
4655	1,2-Dichloropropane
6800	1,3,5-Trichlorobenzene
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4735	1,4-Dioxane (1,4- Diethyleneoxide)
4510	1-Chlorohexane
4665	2,2-Dichloropropane
4410	2-Butanone (Methyl ethyl ketone, MEK)
4500	2-Chloroethyl vinyl ether
4535	2-Chlorotoluene
4860	2-Hexanone
5020	2-Nitropropane
4536	4-Bromofluorobenzene
4540	4-Chlorotoluene
4910	4-Isopropyltoluene (p-Cymene)
4995	4-Methyl-2-pentanone (MIBK)

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
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Analyte Code	*Analyte*
4305	Acetamide
4315	Acetone
4320	Acetonitrile
4325	Acrolein (Propenal)
4330	Acrylamide
4340	Acrylonitrile
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
4400	Bromoform
4450	Carbon disulfide
4455	Carbon tetrachloride
4475	Chlorobenzene
4575	Chlorodibromomethane
4485	Chloroethane (Ethyl chloride)
4505	Chloroform
4525	Chloroprene (2-Chloro-1,3-butadiene)
4705	cis & trans-1,2-Dichloroethene
4645	cis-1,2-Dichloroethylene
4680	cis-1,3-Dichloropropene
4595	Dibromomethane (Methylene bromide)
4625	Dichlorodifluoromethane (Freon-12)
4725	Diethyl ether
4755	Ethyl acetate
4810	Ethyl methacrylate
4765	Ethylbenzene
4835	Hexachlorobutadiene
4870	Iodomethane (Methyl iodide)
4875	Isobutyl alcohol (2-Methyl-1-propanol)
4900	Isopropylbenzene
5240	m+p-xylene
4925	Methacrylonitrile
4950	Methyl bromide (Bromomethane)
4960	Methyl chloride (Chloromethane)
5000	Methyl tert-butyl ether (MTBE)
4975	Methylene chloride (Dichloromethane)
5245	m-Xylene
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4440	sec-Butylbenzene
5100	Styrene
4370	T-amylmethylether (TAME)
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
5140	Toluene
4700	trans-1,2-Dichloroethylene
4685	trans-1,3-Dichloropropylene
4605	trans-1,4-Dichloro-2-butene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)
5225	Vinyl acetate
5235	Vinyl chloride
5260	Xylene (total)

EPA 8270D **10186002** **Semivolatile Organic compounds by GC/MS**

Analyte Code	*Analyte*
6715	1,2,4,5-Tetrachlorobenzene

ORELAP Fields of Accreditation

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Analyte Code	*Analyte*
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
6221	1,2-Diphenylhydrazine
6885	1,3,5-Trinitrobenzene (1,3,5-TNB)
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6420	1,4-Naphthoquinone
6630	1,4-Phenylenediamine
5790	1-Chloronaphthalene
6380	1-Methylnaphthalene
6425	1-Naphthylamine
6735	2,3,4,6-Tetrachlorophenol
6835	2,4,5-Trichlorophenol
6795	2,4,6-Trichloroaniline
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
6175	2,4-Dinitrophenol
6185	2,4-Dinitrotoluene (2,4-DNT)
5992	2,5-Dichlorophenol
6005	2,6-Dichlorophenol
6190	2,6-Dinitrotoluene (2,6-DNT)
5735	2-Chloroaniline
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6360	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
5145	2-Methylaniline (o-Toluidine)
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6430	2-Naphthylamine
6460	2-Nitroaniline
6490	2-Nitrophenol
5050	2-Picoline (2-Methylpyridine)
6412	3 & 4 Methylphenol
5945	3,3'-Dichlorobenzidine
6120	3,3'-Dimethylbenzidine
6355	3-Methylcholanthrene
6405	3-Methylphenol (m-Cresol)
6465	3-Nitroaniline
5540	4-Aminobiphenyl
5660	4-Bromophenyl phenyl ether (BDE-3)
5700	4-Chloro-3-methylphenol
5745	4-Chloroaniline
5825	4-Chlorophenyl phenylether
6410	4-Methylphenol (p-Cresol)
6470	4-Nitroaniline
6500	4-Nitrophenol
6125	a-a-Dimethylphenethylamine
5500	Acenaphthene
5505	Acenaphthylene
5510	Acetophenone
5545	Aniline
5555	Anthracene
5560	Aramite
7065	Atrazine
5562	Azobenzene
5570	Benzaldehyde
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5605	Benzo(e)pyrene
5590	Benzo(g,h,i)perylene

ORELAP Fields of Accreditation

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Analyte Code	*Analyte*
9309	Benzo(j)fluoranthene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5610	Benzoic acid
5630	Benzyl alcohol
5640	Biphenyl
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl) ether
5780	bis(2-Chloroisopropyl) ether
5670	Butyl benzyl phthalate
7180	Caprolactam
5680	Carbazole
7260	Chlorobenzilate
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
7405	Diallate
7410	Diazinon
5895	Dibenz(a,h) anthracene
5905	Dibenzofuran
6070	Diethyl phthalate
7475	Dimethoate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
7580	Famphur
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene
4840	Hexachloroethane
6290	Hexachlorophene
6315	Indeno(1,2,3-cd) pyrene
7725	Isodrin
6320	Isophorone
7740	Kepone
6345	Methapyrilene
7825	Methyl parathion (Parathion, methyl)
5005	Naphthalene
5015	Nitrobenzene
6525	n-Nitrosodiethylamine
6530	n-Nitrosodimethylamine
6545	n-Nitrosodi-n-propylamine
6535	n-Nitrosodiphenylamine
6555	n-Nitrosomorpholine
6560	n-Nitrosopiperidine
6565	n-Nitrosopyrrolidine
7955	Parathion, ethyl
6590	Pentachlorobenzene
6600	Pentachloronitrobenzene
6605	Pentachlorophenol
6608	Perylene
6615	Phenanthrene
6625	Phenol
6650	Pronamide (Kerb)
6665	Pyrene
5095	Pyridine
6685	Safrole
8235	Thionazin (Zinophos)

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EPA 8270D SIM **10242509** **Semivolatile Organic compounds by GC/MS Selective Ion Monitoring**

Analyte Code	*Analyte*
4735	1,4-Dioxane (1,4- Diethyleneoxide)
6380	1-Methylnaphthalene
9501	1-Methylphenanthrene
6852	2,3,5-Trimethylnaphthalene
6188	2,6-Dimethylnaphthalene
6385	2-Methylnaphthalene
5500	Acenaphthene
5505	Acenaphthylene
5555	Anthracene
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5590	Benzo(g,h,i)perylene
9309	Benzo(j)fluoranthene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5640	Biphenyl
5670	Butyl benzyl phthalate
5680	Carbazole
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
5895	Dibenz(a,h) anthracene
5905	Dibenzofuran
5910	Dibenzothiophene
6070	Diethyl phthalate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
6265	Fluoranthene
6270	Fluorene
6315	Indeno(1,2,3-cd) pyrene
5005	Naphthalene
6605	Pentachlorophenol
6608	Perylene
6615	Phenanthrene
6665	Pyrene

EPA 8315A **10188008** **Determination of Carbonyl Compounds by HPLC/UV-VIS**

Analyte Code	*Analyte*
4815	Formaldehyde

EPA 8330B **10308006** **Nitroaromatics, Nitramines and Nitrate Esters by High Performance Liquid Chromatography (HPLC)**

Analyte Code	*Analyte*
6885	1,3,5-Trinitrobenzene (1,3,5-TNB)
6160	1,3-Dinitrobenzene (1,3-DNB)
9651	2,4,6-Trinitrotoluene (2,4,6-TNT)
6185	2,4-Dinitrotoluene (2,4-DNT)
6190	2,6-Dinitrotoluene (2,6-DNT)
9303	2-Amino-4,6-dinitrotoluene (2-am-dnt)
9507	2-Nitrotoluene
6150	3,5-Dinitroaniline
9510	3-Nitrotoluene
9306	4-Amino-2,6-dinitrotoluene (4-am-dnt)
9513	4-Nitrotoluene
6415	Methyl-2,4,6-trinitrophenylnitramine (tetryl)
5015	Nitrobenzene
6485	Nitroglycerin

ORELAP Fields of Accreditation

ORELAP ID: WA100010
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Certificate: WA100010 - 008

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Analyte Code	*Analyte*
9522	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
9558	Pentaerythritoltetranitrate
9432	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)

EPA 9012B **10243206** **Total and Amenable Cyanide (automated colorimetric with off-line distillation)**

Analyte Code	*Analyte*
1510	Amenable cyanide
1645	Total cyanide

EPA 9020B **10194408** **Total Organic Halides**

Analyte Code	*Analyte*
2045	Total organic halides (TOX)

EPA 9040C **10244403** **pH Electrometric Measurement**

Analyte Code	*Analyte*
1900	pH

EPA 9060A **10244801** **Total Organic Carbon**

Analyte Code	*Analyte*
2040	Total organic carbon

NCASI 94.03 0 **60031507** **Methanol in Process Liquids and Wastewaters**

Analyte Code	*Analyte*
4930	Methanol

NCASI 99.01 **60002804** **Selected HAPS in Condensates by GC/FID**

Analyte Code	*Analyte*
4930	Methanol

NWTPH-Dx **90018409** **Oregon DEQ TPH Diesel Range**

Analyte Code	*Analyte*
9369	Diesel range organics (DRO)
9506	Residual Range Organics (RRO)

NWTPH-Gx **90018603** **Oregon DEQ TPH Gasoline Range Organics by GC/FID-PID Purge & Trap**

Analyte Code	*Analyte*
9408	Gasoline range organics (GRO)

NWTPH-HCID **90013200** **Oregon DEQ Total Petroleum Hydrocarbon ID**

Analyte Code	*Analyte*
2050	Total Petroleum Hydrocarbons (TPH)

SM 2120 B 20th ED **20224004** **Color by Visual Comparison**

Analyte Code	*Analyte*
1605	Color

SM 2310 B 20th ED **20044206** **Acidity by Titration**

Analyte Code	*Analyte*
1500	Acidity, as CaCO3

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

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SM 2320 B 20th ED	**20045209**	**Alkalinity by Titration**

Analyte Code	*Analyte*
1505	Alkalinity as CaCO3

SM 2340 B 20th ED	**20046202**	**Hardness by calculation**

Analyte Code	*Analyte*
1750	Hardness

SM 2510 B-97 online	**20048606**	**Conductivity by Probe**

Analyte Code	*Analyte*
1610	Conductivity

SM 2540 B 20th ED	**20049007**	**Total Solids**

Analyte Code	*Analyte*
1950	Residue-total

SM 2540 C 20th ED	**20050004**	**Total Dissolved Solids**

Analyte Code	*Analyte*
1955	Residue-filterable (TDS)

SM 2540 D 20th ED	**20050800**	**Total Suspended Solids**

Analyte Code	*Analyte*
1960	Residue-nonfilterable (TSS)

SM 2540 D-2011	**20051212**	**Total Suspended Solids Dried at 103 - 105 C**

Analyte Code	*Analyte*
1960	Residue-nonfilterable (TSS)

SM 2540 D-97 online	**20051201**	**Total Suspended Solids Dried at 103 - 105C**

Analyte Code	*Analyte*
1960	Residue-nonfilterable (TSS)

SM 2540 F 20th ED	**20051803**	**Settleable Solids**

Analyte Code	*Analyte*
1965	Residue-settleable

SM 4500-Cl C 20th ED	**20078802**	**Chlorine by Iodometric Method II**

Analyte Code	*Analyte*
1575	Chloride

SM 4500-Cl F 20th ED	**20080506**	**Residual Chlorine by DPD Ferrous Titration**

Analyte Code	*Analyte*
1945	Residual free chlorine
1940	Total residual chlorine

SM 4500-CN E 20th ED	**20092404**	**Cyanide by Colorimetric Determination**

Analyte Code	*Analyte*
1635	Cyanide

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Analyte Code	*Analyte*
1645	Total cyanide

SM 4500-CN G 20th ED **20093203** **Cyanide Amenable to Chlorination after Distillation**

Analyte Code	*Analyte*
1510	Amenable cyanide

SM 4500-CN⁻ E-97 online **20096406** **Cyanide by Colorimetric Method**

Analyte Code	*Analyte*
1635	Cyanide

SM 4500-F⁻ C 20th ED **20102005** **Fluoride by Ion Selective Electrode**

Analyte Code	*Analyte*
1730	Fluoride

SM 4500-H+ B 20th ED **20104807** **pH by Probe**

Analyte Code	*Analyte*
1900	pH

SM 4500-NH3 E 20th ED **20109802** **Ammonia by Selective Ion Probe**

Analyte Code	*Analyte*
1515	Ammonia as N

SM 4500-NH3 G 20th ED **20111006** **Ammonia by Automated Phenate**

Analyte Code	*Analyte*
1515	Ammonia as N

SM 4500-O G 20th ED **20121204** **Dissolved Oxygen by Membrane Electrode Method**

Analyte Code	*Analyte*
1880	Oxygen, dissolved

SM 4500-S2 F-2011 **20126663** **Sulfide by Iodometric Method**

Analyte Code	*Analyte*
2005	Sulfide

SM 4500-S2⁻ D 20th ED **20125400** **Sulfide by Methylene Blue Method**

Analyte Code	*Analyte*
2005	Sulfide

SM 4500-S2⁻ D-97 online **20125808** **Sulfide by Methylene Blue Method**

Analyte Code	*Analyte*
2005	Sulfide

SM 4500-S2⁻ F 20th ED **20126209** **Sulfide by Iodometric Titration**

Analyte Code	*Analyte*
2005	Sulfide

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SM 4500-SO_3^{-} B 20th ED	**20130205**	**Sulfite by Iodometric Method**

Analyte Code	*Analyte*
2015	Sulfite-SO3

SM 5210 B 20th ED	**20134809**	**Biochemical Oxygen Demand, 5-Day (BOD5)**

Analyte Code	*Analyte*
1530	Biochemical oxygen demand

SM 5220 C 20th ED	**20135608**	**Chemical Oxygen Demand by Closed Reflux and Titration**

Analyte Code	*Analyte*
1565	Chemical oxygen demand

SM 5310 C 20th ED	**20138403**	**Total Organic Carbon by Persulfate-Ultraviolet Oxidation Method**

Analyte Code	*Analyte*
2040	Total organic carbon

SM 5540 C 20th ED	**20144609**	**Surfactants as MBAS**

Analyte Code	*Analyte*
2025	Surfactants - MBAS

SM 5550 B 20th ED	**20145306**	**Tannin and Lignin**

Analyte Code	*Analyte*
9597	Tannin & Lignin

SM 9215 B (PCA) 20th ED	**20181208**	**Heterotrophic Plate Count Pour Plate (plate count agar): Heterotrophic Bacteria**

Analyte Code	*Analyte*
2555	Heterotrophic plate count

SM 9221 B (LTB) + C MPN 20th ED	**20186805**	**Multiple Tube Fermentation Quantitative (LTB): Total Coliform**

Analyte Code	*Analyte*
2500	Total coliforms

SM 9221 E (EC) 20th ED	**20226806**	**Multiple Tube Fermentation Quantitative (EC): Fecal Coliform**

Analyte Code	*Analyte*
2530	Fecal coliforms

SM 9222 D (m-FC) 20th ED	**20209603**	**Membrane Filtration Quantitative (m-FC): Fecal Coliform**

Analyte Code	*Analyte*
2530	Fecal coliforms

SM 9223 B (Colilert-18® Multiple-tube) 20th ED	**20229407**	**Chromogenic/Fluorogenic Quantitative: Total Coliform and E. coli**

Analyte Code	*Analyte*
2530	Fecal coliforms

SM 9223 B (Colilert®) 20th ED	**20212208**	**Chromogenic/Fluorogenic Qualitative (Colilert®): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

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SM 9223 B (Colilert®-18 Quanti-Tray®) 20th ED	**20213201**	**Chromogenic/Fluorogenic Quantitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9223 B (Colilert®-18) 20th ED	**20214204**	**Chromogenic/Fluorogenic Qualitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9223 B (Colilert®-18) 21st ED	**20214408**	**Chromogenic/Fluorogenic Qualitative (Colilert®-18): Total Coliform and E. coli**

Analyte Code	*Analyte*
2525	Escherichia coli
2500	Total coliforms

SM 9230 B (PSE) 20th ED	**20217203**	**Multiple Tube Fermentation Quantitative: Fecal Streptococci**

Analyte Code	*Analyte*
2540	Fecal streptococci

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MATRIX : Solids

Reference	Code	Description
ASTM D4129 05	**30018907**	**Total and Organic Carbon in Water by High Temperature Oxidation and by Coulometric Detection**

Analyte Code	*Analyte*
2040	Total organic carbon

ASTM D422-63	**30030854**	**Partical Size Distribution (Grain sizing)**

Analyte Code	*Analyte*
6118	Distribution of particle sizes

CAS PestMS2 (1699 modified) 2	**60035101**	**Chlorinated Pesticides by GC/MS/MS**

Analyte Code	*Analyte*
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7300	Chlorpyrifos
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
7725	Isodrin
7810	Methoxychlor
7870	Mirex
5553	Octachlorostyrene
3890	Oxychlordane
7910	trans-Nanochlor

CAS SOC-Butyl	**60035009**	**Butyltin by GC/Flame Photometric Detector**

Analyte Code	*Analyte*
1201	Butyltin trichloride
1202	Dibutyltin dichloride
1209	Tetrabutyltin
1203	Tributyltin chloride

EPA 1020A	**10117007**	**Ignitability Setaflash Closed-cup Method**

Analyte Code	*Analyte*
1780	Ignitability

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EPA 1110A **10235208** **Corrosivity Toward Steel**

Analyte Code	*Analyte*
1615	Corrosivity

EPA 1311 **10118806** **Toxicity Characteristic Leaching Procedure**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 1312 **10119003** **Synthetic Precipitation Leaching Procedure**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 160.3 **10009800** **Total Solids, dried @ 103-105 C.**

Analyte Code	*Analyte*
1950	Residue-total

EPA 1630 **10122608** **Methyl Mercury by Purge & Trap Cold Vapor Atomic Fluorescence Spectrometry**

Analyte Code	*Analyte*
1205	Methyl Mercury

EPA 1631E **10237204** **Mercury in Water by Oxidation, Purge & Trap, and Cold Vapor Atomic Fluorescence**

Analyte Code	*Analyte*
1095	Mercury

EPA 1664A (HEM) **10127807** **N-Hexane Extractable Material (Oil and Grease) by Extraction and Gravimetry**

Analyte Code	*Analyte*
1803	n-Hexane Extractable Material (O&G)
1860	Oil & Grease

EPA 1694 1.0 **10132908** **Pharmaceuticals and Personal Care Products by HPLC/MS/MS**

Analyte Code	*Analyte*
6911	Perfluorobutane Sulfonate (PFBS)
9562	Perfluorodecane Sulfonate (PFDS)
6905	Perfluorodecanoic acid (PFDA)
6903	Perfluorododecanoic (PFDDA)
6908	Perfluoroheptanoic acid (PFHA)
6910	Perfluorohexane Sulfonate (PFHS)
6913	Perfluorohexanoic acid (PFHXA)
6906	Perfluorononanoic acid (PFNA)
6912	Perfluorooctanoic acid
6909	Perfluorooctanoic Sulfonate (PFOS)
6914	Perfluoropentanoic acid (PFPEA)
6904	Perfluoroundecanoic acid (PFUDA)

EPA 300.0 2.1 **10053200** **Methods for the Determination of Inorganic Substances in Environmental Samples**

Analyte Code	*Analyte*
1575	Chloride
1730	Fluoride
2000	Sulfate

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EPA 3050B	**10135601**	**Acid Digestion of Sediments, Sludges, and soils**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 314.0	**10055400**	**Perchlorate in Drinking Water by Ion Chromatography**

Analyte Code	*Analyte*
1895	Perchlorate

EPA 350.1 2	**10063602**	**Ammonia Nitrogen - Colorimetric, Auto Phenate**

Analyte Code	*Analyte*
1515	Ammonia as N

EPA 353.2 2	**10067604**	**Nitrate/Nitrite Nitrogen - Automated, Cadmium**

Analyte Code	*Analyte*
1810	Nitrate as N
1840	Nitrite as N
1825	Total nitrate+nitrite

EPA 3540C	**10140202**	**Soxhlet Extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3541	**10140406**	**Automated Soxhlet Extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3550C	**10142004**	**Ultrasonic Extraction**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3580A	**10143007**	**Waste Dilution**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3620C	**10146006**	**Florisil Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3630C	**10146802**	**Silica gel cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3640A	**10147203**	**Gel Preparation Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 365.3	**10070607**	**Phosphorous - Colorimetric, two reagent.**

Analyte Code	*Analyte*

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Analyte Code	*Analyte*
1870	Orthophosphate as P
1908	Total Phosphate

EPA 3660B **10148400** **Sulfur cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 3665A **10148808** **Sulfuric Acid / permanganate Cleanup**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 5030B **10153409** **Purge and trap for aqueous samples**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 5035A **10284807** **Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples**

Analyte Code	*Analyte*
8031	Extraction/Preparation

EPA 524.2 4.1 **10088809** **Volatile Organic Compounds GC/MS Capillary Column**

Analyte Code	*Analyte*
4840	Hexachloroethane

EPA 6010C **10155803** **ICP - AES**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

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EPA 6020A **10156408** **Inductively Coupled Plasma-Mass Spectrometry**

Analyte Code	*Analyte*
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1075	Lead
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1160	Strontium
1165	Thallium
1185	Vanadium
1190	Zinc

EPA 7010 **10157809** **Metals by Graphite Furnace Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic
1040	Chromium
1075	Lead
1140	Selenium
1165	Thallium

EPA 7062 **10159407** **Antimony and Arsenic by Borohydride Reduction and Atomic Absorption**

Analyte Code	*Analyte*
1010	Arsenic

EPA 7196A **10162400** **Chromium Hexavalent colorimetric**

Analyte Code	*Analyte*
1045	Chromium VI

EPA 7471B **10166402** **Mercury by Cold Vapor Atomic Absorption**

Analyte Code	*Analyte*
1095	Mercury

EPA 7742 **10169207** **Selenium by Borohydride Reduction and Atomic Absorption**

Analyte Code	*Analyte*
1140	Selenium

EPA 8015C **10173805** **Non-halogenated organics using GC/FID**

Analyte Code	*Analyte*
9369	Diesel range organics (DRO)
4785	Ethylene glycol
9408	Gasoline range organics (GRO)

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EPA 8021B **10174808** **Aromatic and Halogenated Volatiles by GC with PID and/or ECD Purge & Trap**

Analyte Code	*Analyte*
4375	Benzene
4765	Ethylbenzene
5140	Toluene
5260	Xylene (total)

EPA 8081B **10178800** **Organochlorine Pesticides by GC/ECD**

Analyte Code	*Analyte*
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7005	Alachlor
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7300	Chlorpyrifos
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
4840	Hexachloroethane
7725	Isodrin
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans-Nanochlor

EPA 8082A **10179201** **Polychlorinated Biphenyls (PCBs) by GC/ECD**

Analyte Code	*Analyte*
9095	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ-206)
9090	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ-194)
9103	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ-195)
9065	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ-170)
9020	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ-128)
9112	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ-201)
9116	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ-174)
9114	2,2',3,3',4,5',6'-Heptachlorobiphenyl (BZ-177)
9120	2,2',3,3',4,6'-Hexachlorobiphenyl (BZ-132)
9133	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ-203)
9134	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ-180)

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Analyte Code	*Analyte*
9075	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ-183)
9025	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ-138)
9139	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ-184)
9080	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ-187)
9030	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ-141)
9151	2,2',3,4',5',6-Hexachlorobiphenyl (BZ-149)
8975	2,2',3,4,5'-Pentachlorobiphenyl (BZ-87)
9155	2,2',3,4',5-Pentachlorobiphenyl (BZ-90)
9154	2,2',3,4',5'-Pentachlorobiphenyl (BZ-97)
9035	2,2',3,5,5',6-Hexachlorobiphenyl (BZ-151)
9166	2,2',3,5',6-Pentachlorobiphenyl (BZ-95)
8945	2,2',3,5'-Tetrachlorobiphenyl (BZ-44)
9040	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ-153)
9174	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ-154)
9175	2,2',4,4',5-Pentachlorobiphenyl (BZ-99)
8980	2,2',4,5,5'-Pentachlorobiphenyl (BZ-101)
8950	2,2',4,5'-Tetrachlorobiphenyl (BZ-49)
8955	2,2',5,5'-Tetrachlorobiphenyl (BZ-52)
8930	2,2',5-Trichlorobiphenyl (BZ-18)
9085	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ-189)
9050	2,3,3',4,4',5-Hexachlorobiphenyl (BZ-156)
9193	2,3,3',4,4',6-Hexachlorobiphenyl (BZ-158)
8985	2,3,3',4,4'-Pentachlorobiphenyl (BZ-105)
8990	2,3,3',4',6-Pentachlorobiphenyl (BZ-110)
9207	2,3,3',4'-Tetrachlorobiphenyl (BZ-56)
9055	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ-167)
9218	2,3',4,4',5',6-Hexachlorobiphenyl (BZ-168)
9005	2,3,4,4',5-Pentachlorobiphenyl (BZ-114)
8995	2,3',4,4',5-Pentachlorobiphenyl (BZ-118)
9000	2,3',4,4',5'-Pentachlorobiphenyl (BZ-123)
9220	2,3',4,4',6-Pentachlorobiphenyl (BZ-119)
9221	2,3,4,4'-Tetrachlorobiphenyl (BZ-60)
8960	2,3',4,4'-Tetrachlorobiphenyl (BZ-66)
9230	2,3',4',5-Tetrachlorobiphenyl (BZ-70)
9239	2,3',4'-Trichlorobiphenyl (BZ-33)
8920	2,3-Dichlorobiphenyl (BZ-5)
9250	2,4,4',5-Tetrachlorobiphenyl (BZ-74)
9252	2,4,4'-Trichlorobiphenyl (BZ-28)
8940	2,4',5-Trichlorobiphenyl (BZ-31)
9256	2,4'-Dichlorobiphenyl (BZ-8)
8915	2-Chlorobiphenyl (BZ-1)
9060	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ-169)
9015	3,3',4,4',5-Pentachlorobiphenyl (BZ-126)
8965	3,3',4,4'-Tetrachlorobiphenyl (BZ-77)
8970	3,4,4',5-Tetrachlorobiphenyl (BZ-81)
9266	3,4,4'-Trichlorobiphenyl (BZ-37)
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
8912	Aroclor-1262 (PCB-1262)
8913	Aroclor-1268 (PCB-1268)
9105	Decachlorobiphenyl (BZ-209)

EPA 8141B **10182204** **Organophosphorous Pesticides by GC/NPD**

Analyte Code	*Analyte*
7075	Azinphos-methyl (Guthion)

ALS Environmental, Kelso

1317 South 13th Ave.
Kelso WA 98626

Issue Date: 04/22/2014 ***Expiration Date:*** 02/10/2015

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Analyte Code	*Analyte*
7125	Bolstar (Sulprofos)
7300	Chlorpyrifos
7315	Coumaphos
7395	Demeton-o
7385	Demeton-s
7410	Diazinon
8610	Dichlorovos (DDVP, Dichlorvos)
7475	Dimethoate
8625	Disulfoton
7550	EPN
7570	Ethoprop
7600	Fensulfothion
7605	Fenthion
7770	Malathion
7785	Merphos
7825	Methyl parathion (Parathion, methyl)
7850	Mevinphos
7955	Parathion, ethyl
7985	Phorate
8110	Ronnel
8155	Sulfotepp
8200	Tetrachlorvinphos (Stirophos, Gardona) Z-isomer
8245	Tokuthion (Prothiophos)
8275	Trichloronate

EPA 8151A **10183207** **Chlorinated Herbicides by GC/ECD**

Analyte Code	*Analyte*
8655	2,4,5-T
8545	2,4-D
8560	2,4-DB
8555	Dalapon
8595	Dicamba
8605	Dichloroprop (Dichlorprop)
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
7775	MCPA
7780	MCPP
8650	Silvex (2,4,5-TP)

EPA 8260C **10307003** **Volatile Organics: GC/MS (capillary column)**

Analyte Code	*Analyte*
5105	1,1,1,2-Tetrachloroethane
5185	1,1,1-Trichloro-2,2,2-trifluoroethane
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5195	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
5165	1,1,2-Trichloroethane
5167	1,1,2-Trichlorofluoroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5150	1,2,3-Trichlorobenzene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane (Ethylene dichloride)
4655	1,2-Dichloropropane

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

ALS Environmental, Kelso

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Analyte Code	*Analyte*
6800	1,3,5-Trichlorobenzene
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4735	1,4-Dioxane (1,4- Diethyleneoxide)
4510	1-Chlorohexane
4665	2,2-Dichloropropane
4410	2-Butanone (Methyl ethyl ketone, MEK)
4500	2-Chloroethyl vinyl ether
4535	2-Chlorotoluene
4860	2-Hexanone
5020	2-Nitropropane
4536	4-Bromofluorobenzene
4540	4-Chlorotoluene
4910	4-Isopropyltoluene (p-Cymene)
4995	4-Methyl-2-pentanone (MIBK)
4305	Acetamide
4315	Acetone
4320	Acetonitrile
4325	Acrolein (Propenal)
4330	Acrylamide
4340	Acrylonitrile
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
4400	Bromoform
4450	Carbon disulfide
4455	Carbon tetrachloride
4475	Chlorobenzene
4575	Chlorodibromomethane
4485	Chloroethane (Ethyl chloride)
4505	Chloroform
4525	Chloroprene (2-Chloro-1,3-butadiene)
4705	cis & trans-1,2-Dichloroethene
4645	cis-1,2-Dichloroethylene
4680	cis-1,3-Dichloropropene
4595	Dibromomethane (Methylene bromide)
4625	Dichlorodifluoromethane (Freon-12)
4725	Diethyl ether
4755	Ethyl acetate
4810	Ethyl methacrylate
4765	Ethylbenzene
4835	Hexachlorobutadiene
4870	Iodomethane (Methyl iodide)
4875	Isobutyl alcohol (2-Methyl-1-propanol)
4900	Isopropylbenzene
5240	m+p-xylene
4925	Methacrylonitrile
4950	Methyl bromide (Bromomethane)
4960	Methyl chloride (Chloromethane)
5000	Methyl tert-butyl ether (MTBE)
4975	Methylene chloride (Dichloromethane)
5245	m-Xylene
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4440	sec-Butylbenzene
5100	Styrene

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Analyte Code	*Analyte*
4370	T-amylmethylether (TAME)
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
5140	Toluene
4700	trans-1,2-Dichloroethylene
4685	trans-1,3-Dichloropropylene
4605	trans-1,4-Dichloro-2-butene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)
5225	Vinyl acetate
5235	Vinyl chloride
5260	Xylene (total)

EPA 8270D **10186002** **Semivolatile Organic compounds by GC/MS**

Analyte Code	*Analyte*
6715	1,2,4,5-Tetrachlorobenzene
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
6221	1,2-Diphenylhydrazine
6885	1,3,5-Trinitrobenzene (1,3,5-TNB)
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6420	1,4-Naphthoquinone
6630	1,4-Phenylenediamine
5790	1-Chloronaphthalene
6380	1-Methylnaphthalene
6425	1-Naphthylamine
6735	2,3,4,6-Tetrachlorophenol
6835	2,4,5-Trichlorophenol
6795	2,4,6-Trichloroaniline
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
6175	2,4-Dinitrophenol
6185	2,4-Dinitrotoluene (2,4-DNT)
5992	2,5-Dichlorophenol
6005	2,6-Dichlorophenol
6190	2,6-Dinitrotoluene (2,6-DNT)
5735	2-Chloroaniline
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6360	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
5145	2-Methylaniline (o-Toluidine)
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6430	2-Naphthylamine
6460	2-Nitroaniline
6490	2-Nitrophenol
5050	2-Picoline (2-Methylpyridine)
6412	3 & 4 Methylphenol
5945	3,3'-Dichlorobenzidine
6120	3,3'-Dimethylbenzidine
6355	3-Methylcholanthrene
6405	3-Methylphenol (m-Cresol)
6465	3-Nitroaniline
5540	4-Aminobiphenyl
5660	4-Bromophenyl phenyl ether (BDE-3)
5700	4-Chloro-3-methylphenol
5745	4-Chloroaniline
6410	4-Methylphenol (p-Cresol)

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

ALS Environmental, Kelso

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Kelso WA 98626

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Analyte Code	*Analyte*
6470	4-Nitroaniline
6500	4-Nitrophenol
6125	a-a-Dimethylphenethylamine
5500	Acenaphthene
5505	Acenaphthylene
5510	Acetophenone
5545	Aniline
5555	Anthracene
5560	Aramite
7065	Atrazine
5562	Azobenzene
5570	Benzaldehyde
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5605	Benzo(e)pyrene
5590	Benzo(g,h,i)perylene
9309	Benzo(j)fluoranthene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5610	Benzoic acid
5630	Benzyl alcohol
5640	Biphenyl
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl) ether
5780	bis(2-Chloroisopropyl) ether
5670	Butyl benzyl phthalate
7180	Caprolactam
5680	Carbazole
7260	Chlorobenzilate
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
7405	Diallate
7410	Diazinon
5895	Dibenz(a,h) anthracene
5905	Dibenzofuran
6070	Diethyl phthalate
7475	Dimethoate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
7580	Famphur
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene
4840	Hexachloroethane
6290	Hexachlorophene
6315	Indeno(1,2,3-cd) pyrene
7725	Isodrin
6320	Isophorone
7740	Kepone
6345	Methapyrilene
7825	Methyl parathion (Parathion, methyl)
5005	Naphthalene
5015	Nitrobenzene
6525	n-Nitrosodiethylamine
6530	n-Nitrosodimethylamine
6545	n-Nitrosodi-n-propylamine
6535	n-Nitrosodiphenylamine
6555	n-Nitrosomorpholine

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Analyte Code	*Analyte*
6560	n-Nitrosopiperidine
6565	n-Nitrosopyrrolidine
7955	Parathion, ethyl
6590	Pentachlorobenzene
6600	Pentachloronitrobenzene
6605	Pentachlorophenol
6608	Perylene
6615	Phenanthrene
6625	Phenol
6650	Pronamide (Kerb)
6665	Pyrene
5095	Pyridine
6685	Safrole
8235	Thionazin (Zinophos)

EPA 8270D SIM **10242509** **Semivolatile Organic compounds by GC/MS Selective Ion Monitoring**

Analyte Code	*Analyte*
4735	1,4-Dioxane (1,4- Diethyleneoxide)
6380	1-Methylnaphthalene
6852	2,3,5-Trimethylnaphthalene
6188	2,6-Dimethylnaphthalene
6385	2-Methylnaphthalene
5500	Acenaphthene
5505	Acenaphthylene
5555	Anthracene
5575	Benzo(a)anthracene
5580	Benzo(a)pyrene
5605	Benzo(e)pyrene
5590	Benzo(g,h,i)perylene
9309	Benzo(j)fluoranthene
5600	Benzo(k)fluoranthene
5585	Benzo[b]fluoranthene
5640	Biphenyl
5670	Butyl benzyl phthalate
5680	Carbazole
5855	Chrysene
6065	Di(2-ethylhexyl) phthalate (bis(2-Ethylhexyl)phthalate, DEHP)
5895	Dibenz(a,h) anthracene
5905	Dibenzofuran
5910	Dibenzothiophene
6070	Diethyl phthalate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
6265	Fluoranthene
6270	Fluorene
6315	Indeno(1,2,3-cd) pyrene
5005	Naphthalene
6545	n-Nitrosodi-n-propylamine
6605	Pentachlorophenol
6608	Perylene
6615	Phenanthrene
6665	Pyrene

EPA 8330B **10308006** **Nitroaromatics, Nitramines and Nitrate Esters by High Performance Liquid Chromatography (HPLC)**

Analyte Code	*Analyte*
6885	1,3,5-Trinitrobenzene (1,3,5-TNB)
6160	1,3-Dinitrobenzene (1,3-DNB)
9651	2,4,6-Trinitrotoluene (2,4,6-TNT)

ORELAP Fields of Accreditation

ORELAP ID: WA100010
EPA CODE: WS01276
Certificate: WA100010 - 008

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Analyte Code	Analyte
6185	2,4-Dinitrotoluene (2,4-DNT)
6190	2,6-Dinitrotoluene (2,6-DNT)
9303	2-Amino-4,6-dinitrotoluene (2-am-dnt)
9507	2-Nitrotoluene
6150	3,5-Dinitroaniline
9510	3-Nitrotoluene
9306	4-Amino-2,6-dinitrotoluene (4-am-dnt)
9513	4-Nitrotoluene
6415	Methyl-2,4,6-trinitrophenylnitramine (tetryl)
5015	Nitrobenzene
6485	Nitroglycerin
9522	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
9558	Pentaerythritoltetranitrate
9432	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)

EPA 9012B **10243206** **Total and Amenable Cyanide (automated colorimetric with off-line distillation)**

Analyte Code	Analyte
1510	Amenable cyanide
1645	Total cyanide

EPA 9013A **10308802** **Cyanide Extraction Procedure for Solids and Oils**

Analyte Code	Analyte
8031	Extraction/Preparation

EPA 9020B **10194408** **Total Organic Halides**

Analyte Code	Analyte
2045	Total organic halides (TOX)

EPA 9030B **10195605** **Acid-Soluble and Acid-Insoluble sulfides: Distillation**

Analyte Code	Analyte
2005	Sulfide

EPA 9034 **10196006** **Titrimetric Procedure for Acid-Soluble and Acid-Insoluble Sulfides**

Analyte Code	Analyte
2005	Sulfide

EPA 9056A **10199607** **Determination of Inorganic Anions by Ion Chromatography**

Analyte Code	Analyte
1575	Chloride
1730	Fluoride
1805	Nitrate
1835	Nitrite
2000	Sulfate

EPA 9071A **10201408** **Oil and Grease Extraction Method for sludge and sediment samples**

Analyte Code	Analyte
1860	Oil & Grease

NWTPH-Dx **90018409** **Oregon DEQ TPH Diesel Range**

Analyte Code	Analyte
9369	Diesel range organics (DRO)
9506	Residual Range Organics (RRO)

ORELAP Fields of Accreditation

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EPA CODE: WS01276
Certificate: WA100010 - 008

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NWTPH-Gx **90018603** **Oregon DEQ TPH Gasoline Range Organics by GC/FID-PID Purge & Trap**

Analyte Code	*Analyte*
9408	Gasoline range organics (GRO)

NWTPH-HCID **90013200** **Oregon DEQ Total Petroleum Hydrocarbon ID**

Analyte Code	*Analyte*
2050	Total Petroleum Hydrocarbons (TPH)

PLUMB 1981 **60006259** **Extraction/Preparation**

Analyte Code	*Analyte*
6118	Distribution of particle sizes
8031	Extraction/Preparation

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 4.2 10/26/2010 and is accredited is accordance with the:

United States Department of Defense
Environmental Laboratory Accreditation Program
(DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
July 19, 2011	March 13, 2014	March 13, 2016

Accreditation No.:	*Certificate No.:*
65188	L14-51

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626
Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous	EPA 1631E	CVAFS	Mercury (Low level)
Aqueous	EPA 1664A	Gravimetry	Hexane Extractable Material (HEM)
Aqueous	EPA 1664A	Gravimetry	Total Petroleum Hydrocarbons (TPH)
Aqueous	EPA 180.1	Nephelometer	Turbidity
Aqueous	EPA 2340B	Calculation by 6010	Hardness as $CaCO_3$)
Aqueous	EPA 245.1	CVAA	Mercury
Aqueous	EPA 300.0	IC	Bromide
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate + Nitrite as N
Aqueous	EPA 300.0	IC	Nitrate as N
Aqueous	EPA 300.0	IC	Nitrite as N
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 353.2	Automated Colorimetry	Nitrate + Nitrite as N
Aqueous	EPA 7196A	Colorimetry	Chromium VI
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8260C SIM	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,1,2-Trichloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,1-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	1,2-Dibromoethane (EDB)
Aqueous	EPA 8260C SIM	GC-MS	1,2-Dichloroethane
Aqueous	EPA 8260C SIM	GC-MS	1,3 Butadine
Aqueous	EPA 8260C SIM	GC-MS	1,4-Dichlorobenzene
Aqueous	EPA 8260C SIM	GC-MS	Bromodichloromethane
Aqueous	EPA 8260C SIM	GC-MS	Carbon Tetrachloride
Aqueous	EPA 8260C SIM	GC-MS	Chlorodibromomethane
Aqueous	EPA 8260C SIM	GC-MS	Chloroform
Aqueous	EPA 8260C SIM	GC-MS	Chloromethane
Aqueous	EPA 8260C SIM	GC-MS	cis-1,2-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	Dichloromethane (Methylene Chloride)
Aqueous	EPA 8260C SIM	GC-MS	Tetrachloroethene
Aqueous	EPA 8260C SIM	GC-MS	trans-1,2-Dichloroethene
Aqueous	EPA 8260C SIM	GC-MS	Trichloroethene
Aqueous	EPA 8260C SIM	GC-MS	Vinyl chloride
Aqueous	EPA 9020B	Microcoulometric-titration detector	Total Organic Halides (TOX)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626
Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous	EPA 9040C	pH Meter	pH
Aqueous	EPA 9060A	TOC Meter	Total Organic Carbons (TOC)
Aqueous	SM 2130B	Nephelometer	Turbidity
Aqueous	SM 4500 CN- G	Colorimetry	Cyanide, Amenable
Aqueous	SM 4500 P-E	Colorimetry	ortho-phosphorous
Aqueous	SM 4500 S2 D	Distillation Unit	Sulfide
Aqueous	SM2320B	Titrimetry	Total Alkalinity (as $CaCO_3$)
Aqueous	SM2510B	Conductivity Meter	Specific Conductance
Aqueous	SM2540B	Balance	Solids, Total
Aqueous	SM2540C	Balance	Solids, Total Dissolved
Aqueous	SM2540D	Balance	Solids, Total Suspended
Aqueous	SM4500CN E	Colorimetry	Total Cyanide
Aqueous	SM4500CN-G	Colorimetry	Cyanide, Amenable
Aqueous	SM4500NH3 G	Colorimetry	Ammonia
Aqueous	SM5220C	Titrimetry	Chemical Oxygen Demand (COD)
Aqueous	SM5310C	TOC Meter	Total Organic Carbons (TOC)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n butanoic acid (PFBA)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n octanesulfonate (PFOS)
Aqueous	SOP-LCP-PFC	HPLC/MS/MS	Perfluor-n octanoic acid (PFOA)
Aqueous/Drinking Water	EPA 200.9	GFAA	Antimony
Aqueous/Drinking Water	EPA 200.9	GFAA	Selenium
Aqueous/Drinking Water	EPA 200.9	GFAA	Thallium
Aqueous/Drinking Water	EPA 200.9	GFAA	Arsenic
Aqueous/Drinking Water	EPA 200.9	GFAA	Lead
Aqueous/Solid	ASTM D 1426-93B	ISE	Nitrogen, Total Kjeldahl (TKN)
Aqueous/Solid	EPA 1630	CVAFS	Methyl Mercury
Aqueous/Solid	EPA 1020A	Closed Cup Flashpoint	Ignitability
Aqueous/Solid	EPA 314.0	IC	Perchlorate
Aqueous/Solid	EPA 350.1	Colorimetry	Ammonia
Aqueous/Solid	EPA 365.3	Colorimetry	Total Phosphorus
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Aluminum

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626
Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Antimony
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Arsenic
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Barium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Beryllium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Boron
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Cadmium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Calcium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Chromium, total
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Cobalt
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Copper
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Iron
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Lead
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Magnesium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Manganese
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Molybdenum
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Nickel
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Potassium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Selenium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Silver
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Sodium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Strontium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Thallium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Tin
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Titanium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Vanadium
Aqueous/Solid	EPA 6010B, C/200.7	ICP	Zinc
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Aluminum
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Antimony
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Arsenic
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Barium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Beryllium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Boron
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Cadmium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Chromium, total

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626
Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Cobalt
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Copper
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Iron
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Lead
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Manganese
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Molybdenum
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Nickel
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Selenium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Silver
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Strontium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Thallium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Tin
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Titanium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Vanadium
Aqueous/Solid	EPA 6020, A/200.8	ICP-MS	Zinc
Aqueous/Solid	EPA 7010	GFAA	Antimony
Aqueous/Solid	EPA 7010	GFAA	Arsenic
Aqueous/Solid	EPA 7010	GFAA	Chromium, total
Aqueous/Solid	EPA 7010	GFAA	Lead
Aqueous/Solid	EPA 7010	GFAA	Selenium
Aqueous/Solid	EPA 7010	GFAA	Thallium
Aqueous/Solid	EPA 7742	AA, Borohydride Reduction; GFAA	Selenium
Aqueous/Solid	EPA 8015C/AK103-RRO	GC-FID	Residual Range Organics (RRO)
Aqueous/Solid	EPA 8015C; AK101-GRO; NWTPH-Gx	GC-FID	Gasoline Range Organics (GRO)
Aqueous/Solid	EPA 8015C; AK102-DRO; NWTPH-Dx	GC-FID	Diesel Range Organics (DRO)
Aqueous/Solid	EPA 8021B	GC-FID	Benzene
Aqueous/Solid	EPA 8021B	GC-FID	Ethyl Benzene
Aqueous/Solid	EPA 8021B	GC-FID	Toluene
Aqueous/Solid	EPA 8021B	GC-FID	Xylene, total
Aqueous/Solid	EPA 8081A, B	GC-ECD	Aldrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Alpha-BHC

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDD (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDE (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	DDT (4,4)
Aqueous/Solid	EPA 8081A, B	GC-ECD	delta-BHC
Aqueous/Solid	EPA 8081A, B	GC-ECD	Dieldrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan I
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan II
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endosulfan sulfate
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin aldehyde
Aqueous/Solid	EPA 8081A, B	GC-ECD	Endrin ketone
Aqueous/Solid	EPA 8081A, B	GC-ECD	gamma-BHC
Aqueous/Solid	EPA 8081A, B	GC-ECD	gamma-Chlordane
Aqueous/Solid	EPA 8081A, B	GC-ECD	Heptachlor
Aqueous/Solid	EPA 8081A, B	GC-ECD	Heptachlor Epoxide (beta)
Aqueous/Solid	EPA 8081A, B	GC-ECD	Methoxychlor
Aqueous/Solid	EPA 8081A, B	GC-ECD	Toxaphene (total)
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDD
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDE
Aqueous/Solid	EPA 8081B	GC-ECD	2,4-DDT
Aqueous/Solid	EPA 8081B	GC-ECD	Chlorpyrifos
Aqueous/Solid	EPA 8081B	GC-ECD	cis-Nonachlor
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachlorobenzene
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachlorobutadiene
Aqueous/Solid	EPA 8081B	GC-ECD	Hexachloroethane
Aqueous/Solid	EPA 8081B	GC-ECD	Isodrin
Aqueous/Solid	EPA 8081B	GC-ECD	Mirex
Aqueous/Solid	EPA 8081B	GC-ECD	Oxychlordane
Aqueous/Solid	EPA 8081B	GC-ECD	trans-Nonachlor
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5,5,6-Nonachlorobiphenyl (PCB 206)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5,6-Octachlorobiphenyl (PCB 195)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4,5-Heptachlorobiphenyl (PCB 170)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,3,4,4-Hexachlorobiphenyl (PCB 128)

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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5,5-Heptachlorobiphenyl (PCB180)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5,6-Heptachlorobiphenyl (PCB 183)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,5-Hexachlorobiphenyl (PCB 138)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,4,6,6-Heptachlorobiphenyl (PCB 184)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,5,5,6-Heptachlorobiphenyl (PCB 187)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,5-Pentachlorobiphenyl (PCB87)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,4,5-Pentachlorobiphenyl (PCB90)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,3,5-Tetrachlorobiphenyl (PCB44)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,4,4,5,5-Hexachlorobiphenyl (PCB153)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,4,5,5-Pentachlorobiphenyl (PCB 101)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,5,5-Tetrachlorbiphenyl (PCB 53)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,2,5-Trichlorobiphenyl (PCB18)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5,5-Heptachlorobiphenyl (PCB 189)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5-Hexachlorobiphenyl (PCB 156)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,5-Hexachlorobiphenyl (PCB 157)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4,6-Hexachlorobiphenyl (PCB 158)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,3,4,4-Pentachlorobiphenyl (PCB 105)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5,5 Hexachlorobiphenyl (PCB 167)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5,6-Hexachlorobiphenyl (PCB 168)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 114)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 118)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4,5-Pentachlorobiphenyl (PCB 123)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4-Tetrachlorobiphenyl (PCB60)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,3,4,4-Tetrachlorobiphenyl (PCB66)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,4,4-Trichlorobiphenyl (PCB 28)
Aqueous/Solid	EPA 8082, A	GC-ECD	2,4-Dichlorobiphenyl (PCB8)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4,5,5-Hexachlorobiphenyl (PCB 169)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4,5-Pentachlorobiphenyl (PCB 126)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,3,4,4-Tetrachlorobiphenyl (PCB 77)
Aqueous/Solid	EPA 8082, A	GC-ECD	3,4,4,5-Tetrachlorobiphenyl (PCB 81)
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1016
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1221
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1232

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ALS Environmental-Kelso

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Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1242
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1248
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1254
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1260
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1262
Aqueous/Solid	EPA 8082, A	GC-ECD	Aroclor 1268
Aqueous/Solid	EPA 8082, A	GC-ECD	Decachlorobiphenyl (PC B209)
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-TP (Silvex)
Aqueous/Solid	EPA 8151A	GC-ECD	2,4-D
Aqueous/Solid	EPA 8151A	GC-ECD	2,4-DB
Aqueous/Solid	EPA 8151A	GC-ECD	Dalapon
Aqueous/Solid	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solid	EPA 8151A	GC-ECD	Dichloroprop
Aqueous/Solid	EPA 8151A	GC-ECD	Dinoseb
Aqueous/Solid	EPA 8151A	GC-ECD	MCPA
Aqueous/Solid	EPA 8151A	GC-ECD	MCPP
Aqueous/Solid	EPA 8260B, C	GC-MS	1-phenylpropane
Aqueous/Solid	EPA 8260B, C	GC-MS	Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	DIPE
Aqueous/Solid	EPA 8260B, C	GC-MS	ETBE
Aqueous/Solid	EPA 8260B, C	GC-MS	Ethyl Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Freon 11
Aqueous/Solid	EPA 8260B, C	GC-MS	Freon 113
Aqueous/Solid	EPA 8260B, C	GC-MS	MTBE
Aqueous/Solid	EPA 8260B, C	GC-MS	TAME
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-Butyl alcohol
Aqueous/Solid	EPA 8260B, C	GC-MS	Toluene
Aqueous/Solid	EPA 8260B, C	GC-MS	Xylene, total
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1,2-Trichloroethane

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8260B, C	GC-MS	1,1-Dichloroethane
Aqueous/Solid	EPA 8260B,C	GC-MS	1,1-Dichloroethene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,1-Dichloropropene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8260B,C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dibromoethane (EDB)
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,2-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	1,3-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	2,2-Dichloropropane
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Butanone (MEK)
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Chloroethylvinylether
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Chlorotoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	2-Hexanone
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Chlorotoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Isopropyltoluene
Aqueous/Solid	EPA 8260B, C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solid	EPA 8260B, C	GC-MS	Acetone
Aqueous/Solid	EPA 8260B, C	GC-MS	Acetonitrile
Aqueous/Solid	EPA 8260B, C	GC-MS	Acrolein
Aqueous/Solid	EPA 8260B, C	GC-MS	Acrylonitrile
Aqueous/Solid	EPA 8260B, C	GC-MS	Benzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromochloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromodichloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromoform
Aqueous/Solid	EPA 8260B, C	GC-MS	Bromomethane

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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8260B, C	GC-MS	Carbon disulfide
Aqueous/Solid	EPA 8260B, C	GC-MS	Carbon Tetrachloride
Aqueous/Solid	EPA 8260B, C	GC-MS	Chlorobenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Chlorodibromomethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloroethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloroform
Aqueous/Solid	EPA 8260B, C	GC-MS	Chloromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	cis-1,3-Dichloropropene
Aqueous/Solid	EPA 8260B, C	GC-MS	Dibromomethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Dichlorodifluoromethane
Aqueous/Solid	EPA 8260B, C	GC-MS	Dichloromethane (Methylene Chloride)
Aqueous/Solid	EPA 8260B, C	GC-MS	Di-isopropylether (DIPE)
Aqueous/Solid	EPA 8260B, C	GC-MS	Ethylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8260B, C	GC-MS	Isopropylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Methyl-tert-butylether (MTBE)
Aqueous/Solid	EPA 8260B, C	GC-MS	Naphthalene
Aqueous/Solid	EPA 8260B, C	GC-MS	n-Butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	n-Propylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	sec-Butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Styrene
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-amylmethylether (TAME)
Aqueous/Solid	EPA 8260B, C	GC-MS	tert-butylbenzene
Aqueous/Solid	EPA 8260B, C	GC-MS	Tetrachloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	Toluene
Aqueous/Solid	EPA 8260B, C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solid	EPA 8260B, C	GC-MS	Trichloroethene
Aqueous/Solid	EPA 8260B, C	GC-MS	Trichlorofluoromethane (Freon 11)
Aqueous/Solid	EPA 8260B, C	GC-MS	Vinyl acetate
Aqueous/Solid	EPA 8260B, C	GC-MS	Vinyl chloride
Aqueous/solid	EPA 8260B, C	GC-MS	Xylenes, total

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8270C, D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,2-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,3-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dimethylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dinitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8270C, D	GC-MS	2,6-Dichlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Chloronaphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Chlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Methylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	2-Nitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	3,3-Dichlorobenzidine
Aqueous/Solid	EPA 8270C, D	GC-MS	3-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chloroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Nitroaniline
Aqueous/Solid	EPA 8270C, D	GC-MS	4-Nitrophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C, D	GC-MS	Aniline
Aqueous/Solid	EPA 8270C, D	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Azinphos-methyl (Guthion)

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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzidine
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzoic acid
Aqueous/Solid	EPA 8270C, D	GC-MS	Benzyl alcohol
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroethoxy)methane
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroethyl)ether
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-Chloroisopropyl)ether
Aqueous/Solid	EPA 8270C, D	GC-MS	bis(2-ethylhexy)phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Carbazole
Aqueous/Solid	EPA 8270C, D	GC-MS	Chlorpyrifos
Aqueous/Solid	EPA 8270C, D	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C, D	GC-MS	Demeton O & S
Aqueous/Solid	EPA 8270C, D	GC-MS	Diazinon
Aqueous/Solid	EPA 8270C, D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270C, D	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270C, D	GC-MS	Dichlorvos
Aqueous/Solid	EPA 8270C, D	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	dimethoate
Aqueous/Solid	EPA 8270C, D	GC-MS	Dimethylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	di-n-butylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270C, D	GC-MS	Disulfoton
Aqueous/Solid	EPA 8270C, D	GC-MS	Ethoprop
Aqueous/Solid	EPA 8270C, D	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C, D	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachlorocyclopentadiene

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ISO/IEC 17025:2005 and DoD-ELAP

ALS Environmental-Kelso

1317 South 13th Avenue, Kelso, WA 98626
Lee Wolf Phone: 360-577-7222

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8270C, D	GC-MS	Hexachloroethane
Aqueous/Solid	EPA 8270C, D	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Isophorone
Aqueous/Solid	EPA 8270C, D	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C, D	GC-MS	Nitrobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitrosodiethylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitrosodimethylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	N-Nitroso-di-n-propylamine
Aqueous/Solid	EPA 8270C, ~~D~~	GC-MS	N-Nitrosodiphenylamine
Aqueous/Solid	EPA 8270C, D	GC-MS	o-Toluidine
Aqueous/Solid	EPA 8270C, D	GC-MS	Parathion, ethyl
Aqueous/Solid	EPA 8270C, D	GC-MS	Parathion, methyl
Aqueous/Solid	EPA 8270C, D	GC-MS	Pentachlorobenzene
Aqueous/Solid	EPA 8270C, D	GC-MS	Pentachlorophenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Phenol
Aqueous/Solid	EPA 8270C, D	GC-MS	Phorate
Aqueous/Solid	EPA 8270C, D	GC-MS	Pyrene
Aqueous/Solid	EPA 8270C, D	GC-MS	Pyridine
Aqueous/Solid	EPA 8270C, D	GC-MS	Ronnel
Aqueous/Solid	EPA 8270C, D	GC-MS	Stirophos
Aqueous/Solid	EPA 8270C, D	GC-MS	Sulfotepp
Aqueous/Solid	EPA 8270C, D	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solid	EPA 8270C,D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8270SIM	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270SIM	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270SIM	GC-MS	Anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270SIM	GC-MS	Benzo(k)fluoranthene

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 8270SIM	GC-MS	Chrysene
Aqueous/Solid	EPA 8270SIM	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270SIM	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270SIM	GC-MS	Fluorene
Aqueous/Solid	EPA 8270SIM	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270SIM	GC-MS	p-Dioxane
Aqueous/Solid	EPA 8270SIM	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270SIM	GC-MS	Pyrene
Aqueous/Solid	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	2,4,6-Trinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2-Amino-4,6-dinitrtoluene
Aqueous/Solid	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solid	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-Amino-2,6-dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Aqueous/Solid	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	Nitroglycerin
Aqueous/Solid	EPA 8330B	HPLC	Pentachloronitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	Pentaerythritoltetranitrate
Aqueous/Solid	EPA 8330B	HPLC	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)
Aqueous/Solid	EPA 8330B	HPLC	Tetryl (methyl-2,4,6-trinitrophenylnitramine)
Aqueous/Solid	EPA 9012B,	Colorimetry	Total Cyanide
Aqueous/Solid	EPA 9030B	Distillation Unit	Sulfide
Aqueous/Solid	EPA 9056A	IC	Bromide
Aqueous/Solid	EPA 9056A	IC	Chloride
Aqueous/Solid	EPA 9056A	IC	Fluoride

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Matrix	Standard / Method	Technology	Analyte
Aqueous/Solid	EPA 9056A	IC	Sulfate
Aqueous/Solid	EPA 9065	Spectrophotometer	Total Phenolics
Aqueous/Solid	LCP-NITG	HPLC/UV	Nitroguanidine
Aqueous/Solid	SM4500 NH3 G	Colorimetry	Ammonia
Aqueous/Solid	SOC-OTTO	GC-ECD	Otto Fuel
Aqueous/Solid	SOC-Butyl	GC-FPD	Di-n-butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	n-Butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	Tetra-n-butyltin
Aqueous/Solid	SOC-Butyl	GC-FPD	Tri-n-butyltin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Aldrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Alpha-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	beta-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDD (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDE (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	DDT (4,4)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	delta-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Dieldrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan I
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan II
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endosulfan sulfate
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin aldehyde
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Endrin ketone
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	gamma-BHC
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Heptachlor
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Heptachlor Epoxide (beta)
Aqueous/Solid	SOC-PESTMS2	GC/MS/MS/MS	Methoxychlor
Drinking Water	EPA 504.1	GC-ECD	1,2-Dibromo-3-chloropropane (DBCP)
Drinking Water	EPA 504.1	GC-ECD	1,2-Dibromoethane (EDB)
Drinking Water	EPA 524.2	GC-MS	1,1,1,2-Tetrachloroethane
Drinking Water	EPA 524.2	GC-MS	1,1,1-Trichloroethane
Drinking Water	EPA 524.2	GC-MS	1,1,2,2-Tetrachloroethane
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloroethane
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloroethene

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Matrix	Standard / Method	Technology	Analyte
Drinking Water	EPA 524.2	GC-MS	1,1-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	1,2,3-Trichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2,3-Trichloropropane
Drinking Water	EPA 524.2	GC-MS	1,2,4-Trichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2,4-Trimethylbenzene
Drinking Water	EPA 524.2	GC-MS	1,2-Dibromoethane (EDB)
Drinking Water	EPA 524.2	GC-MS	1,2-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,2-Dichloroethane
Drinking Water	EPA 524.2	GC-MS	1,2-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	1,3,5-Trimethylbenzene
Drinking Water	EPA 524.2	GC-MS	1,3-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	1,3-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	1,4-Dichlorobenzene
Drinking Water	EPA 524.2	GC-MS	2,2-Dichloropropane
Drinking Water	EPA 524.2	GC-MS	2-Chlorotoluene
Drinking Water	EPA 524.2	GC-MS	4-Chlorotoluene
Drinking Water	EPA 524.2	GC-MS	4-Isopropyltoluene
Drinking Water	EPA 524.2	GC-MS	Benzene
Drinking Water	EPA 524.2	GC-MS	Bromobenzene
Drinking Water	EPA 524.2	GC-MS	Bromochloromethane
Drinking Water	EPA 524.2	GC-MS	Bromodichloromethane
Drinking Water	EPA 524.2	GC-MS	Bromoform
Drinking Water	EPA 524.2	GC-MS	Bromomethane
Drinking Water	EPA 524.2	GC-MS	Carbon Tetrachloride
Drinking Water	EPA 524.2	GC-MS	Chlorobenzene
Drinking Water	EPA 524.2	GC-MS	Chlorodibromomethane
Drinking Water	EPA 524.2	GC-MS	Chloroethane
Drinking Water	EPA 524.2	GC-MS	Chloroform
Drinking Water	EPA 524.2	GC-MS	Chloromethane
Drinking Water	EPA 524.2	GC-MS	cis-1,2-Dichloroethene
Drinking Water	EPA 524.2	GC-MS	cis-1,3-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	Dibromomethane
Drinking Water	EPA 524.2	GC-MS	Dichlorodifluoromethane
Drinking Water	EPA 524.2	GC-MS	Dichloromethane (Methylene Chloride)

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Matrix	Standard / Method	Technology	Analyte
Drinking Water	EPA 524.2	GC-MS	Ethylbenzene
Drinking Water	EPA 524.2	GC-MS	Hexachlorobutadiene
Drinking Water	EPA 524.2	GC-MS	Isopropylbenzene
Drinking Water	EPA 524.2	GC-MS	m+p-Xylene
Drinking Water	EPA 524.2	GC-MS	Naphthalene
Drinking Water	EPA 524.2	GC-MS	n-Butylbenzene
Drinking Water	EPA 524.2	GC-MS	n-Propylbenzene
Drinking Water	EPA 524.2	GC-MS	o-Xylene
Drinking Water	EPA 524.2	GC-MS	sec-Butylbenzene
Drinking Water	EPA 524.2	GC-MS	Styrene
Drinking Water	EPA 524.2	GC-MS	tert-butylbenzene
Drinking Water	EPA 524.2	GC-MS	Tetrachloroethene
Drinking Water	EPA 524.2	GC-MS	Toluene
Drinking Water	EPA 524.2	GC-MS	trans-1,2-Dichloroethene
Drinking Water	EPA 524.2	GC-MS	trans-1,3-Dichloropropene
Drinking Water	EPA 524.2	GC-MS	Trichloroethene
Drinking Water	EPA 524.2	GC-MS	Trichlorofluoromethane (Freon 11)
Drinking Water	EPA 524.2	GC-MS	Vinyl chloride
Drinking Water	EPA 524.2	GC-MS	Xylenes, total
Solid	ASTMD4129-92M, Lloyd Kahn	TOC Meter	Total Organic Carbons (TOC)
Solid	EPA 160.3M	Gravimetry	Solids, Total
Solid	EPA 7471A, B	CVAA	Mercury
Solid	EPA 9045D	pH Meter	pH
Solid	EPA 9056A	IC	Nitrate as N
Solid	EPA 9056A	IC	Nitrite as N
Solid	EPA 9071B	Gravimetry	Hexane Extractable Material (HEM)
Solid	GEN-AVS	Colorimetry	Acid Volatile Sulfides
Solid	GEN-NCEL	Colorimetry	Nitrocellulose
Solid	LCP-LCMS4	HPLC/MS/MS	1,3,5-Trinitrobenzene
Solid	LCP-LCMS4	HPLC/MS/MS	1,3-Dinitrobenzene
Solid	LCP-LCMS4	HPLC/MS/MS	2,4,6-Trinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2,4-Dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2,6-Dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	2-Amino-4,6-dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	3,5-Dinitroaniline

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Matrix	Standard / Method	Technology	Analyte
Solid	LCP-LCMS4	HPLC/MS/MS	4-Amino-2,6-dinitrotoluene
Solid	LCP-LCMS4	HPLC/MS/MS	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Solid	LCP-LCMS4	HPLC/MS/MS	Pentaerythritoltetranitrate
Solid	LCP-LCMS4	HPLC/MS/MS	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)
Solid	LCP-LCMS4	HPLC/MS/MS	Tetryl (methyl-2,4,6-trinitrophenylnitramine)
Solid	LCP-Nitro	HPLC/MS/MS	2,4-Dinitrophenol
Solid	LCP-Nitro	HPLC/MS/MS	Picramic Acid
Solid	LCP-Nitro	HPLC/MS/MS	Picric Acid
Solid	PSEP	Gravimetry	Particle Size

Matrix	Standard / Method	Technology	Analyte
Aqueous	EPA 1640	Reductive Metals Precipitation	Prep Method
Aqueous	EPA 3010A	Acid Digestion	Metals Digestion
Aqueous	EPA 3020A	Acid Digestion	Metals Digestion
Aqueous	EPA 3520C	Continuous Liquid-Liquid Extraction	Extractable Prep
Aqueous	EPA 3535A	Solid Phase Extraction	Prep Method
Aqueous	EPA 5030B	Purge and Trap for Volatiles	Volatile Prep
Aqueous	SOP-MET-DIG	Acid Digestion	Metals Digestion
Aqueous/Solids	EPA 1311	TCLP Extraction	Physical Extraction
Aqueous/Solids	EPA 3620C	Florisil clean up	Extractable Cleanup
Aqueous/Solids	EPA 3630C	Silica gel clean up	Extractable Prep
Aqueous/Solids	EPA 3640A	Gel-Permeation Clean-up	Extractable Cleanup
Aqueous/Solids	EPA 3660	Sulfur Clean-up	Extractable Prep
Aqueous/Solids	EPA 3665A	Acid clean up	Extractable Cleanup
Aqueous/Solids	ASTM D3590-89	Digestion	TKN
Solid	EPA 3050B	Acid Digestion	Metals Digestion
Solid	EPA 3060	Alkaline Digestion for Cr(VI)	Alkaline Digestion for Cr(VI) only
Solid	EPA 3541	Automated Soxhlet Extraction	Extractable Prep
Solid	EPA 3550B	Ultrasonic Extraction	Extractable Prep
Solid	EPA 5035A	Purge and Trap for Volatiles	Voc Organics
Solid	EPA 5050	Bomb Digestion	Prep Method
Solids	EPA 9013	Midi-Distillation	Cyanides

END

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DOCUMENT