REGION 5 RAC2

380441

REMEDIAL ACTION CONTRACT FOR

Remedial, Enforcement Oversight, and
Non-Time Critical Removal Activities at Sites of Release
or Threatened Release of Hazardous Substances in Region 5

FINAL SITE-SPECIFIC PLANS
Eagle Zinc OU2 Site
Revision #1
Hillsboro, Illinois
Supplemental Remedial Investigation

WA No. 69-RICO-B5Y7/Contract No. EP-S5-06-01

November 2010

PREPARED FOR

U.S. Environmental Protection Agency

PREPARED BY

CH2M HILL

FOR OFFICIAL USE ONLY

FINAL UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN
Revision #1

Eagle Zinc OU2 Site
Hillsboro, Illinois

Supplemental Remedial Investigation

WA No. 69-RICO-B5Y7 / Contract No. EP-S5-06-01

November 2010

Contents

Worksheet No.	Title	Page No.	Type of Information
	Acronyms and Abbreviations	vii	General
#1	Title and Approval Page	1	General
#2	Work Plan Identifying Information	3	General
#3	Distribution List	7	General
#4	Project Personnel Sign-Off Sheet	9	General
#5	Project Organizational Chart	11	General
#6	Communication Pathways	13	General
#7	Personnel Responsibilities and Qualifications	17	General
#8	Special Personnel Training Requirements	19	General
#9	Project Scoping Sessions	21	Work Planning Process
#10	Problem Definition	25	Work Planning Process
#11	Project Quality Objectives/Systematic Planning Process Statements	55	Work Planning Process
#12	Measurement and Performance Criteria	57	Sampling Analytical Plan
#13	Secondary Data Criteria and Limitations	67	Work Planning Process
#14	Summary of Project Tasks	69	Project Overview and Schedule
#15	Reference Limits and Evaluation	75	Sampling Analytical Plan
#16	Project Schedule	81	Project Overview and Schedule
#17	Sampling Design and Rationale	85	Field Sampling Plan
#18	Sampling Locations and Sampling SOP Requirements	91	Field Sampling Plan
#19	Analytical SOP Requirements	93	Sampling Analytical Plan
#20	Field Quality Control Sample Summary	95	Field Sampling Plan

Worksheet No.	Title	Page No.	Type of Information
#21	Project Sampling SOP References	99	Field Sampling Plan
#22	Field Equipment Calibration, Maintenance, Testing, and Inspection	101	Field Sampling Plan
#23	Analytical SOP References	103	Sampling Analytical Plan
#24	Analytical Instrument Calibration	105	Sampling Analytical Plan
#25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	107	Sampling Analytical Plan
#26	Sampling Handling System	109	Field Sampling Plan
#27	Sample Custody Requirements	111	Field Sampling Plan
#28	Laboratory QC Sample Summary	115	Sampling Analytical Plan
#29	Project Documents and Records	121	Data Evaluation Processes and Reporting
#30	Analytical Services	123	Sampling Analytical Plan
#31	Planned Project Assessments	125	Data Evaluation Processes and Reporting
#32	Assessment Findings and Corrective Action Responses	127	Data Evaluation Processes and Reporting
#33	QA Management Reports	129	Data Evaluation Processes and Reporting
#34	Verification (Step I) Process	131	Data Evaluation Processes and Reporting
#35	Validation (Steps IIa and IIb) Process	133	Data Evaluation Processes and Reporting
#36	Validation (Steps IIa and IIb) Summary	135	Data Evaluation Processes and Reporting
#37	Usability Assessment	141	Data Evaluation Processes and Reporting
	References	145	General

Figures

1 Site Location Map
2 Site Features Map
3 Historical Residue Pile Samples Exceeding TCLP
4 Historical Soil Analytical Results
5 Historical Groundwater Analytical Results
6 Historical Surface Water and Sediment Analytical Results
7 Historical XRF Data – May 2008
8 Historical XRF Data – September 2008
9 Preliminary Conceptual Exposure Model for the Human Health Risk Assessment
10 Human Health Risk Exposure Areas
11 Proposed Monitoring Well Locations
12 Proposed Residue and Soil Sample Locations
13 Proposed Surface Water and Sediment Sampling Locations
14 Proposed Concrete Core Sample Locations

Appendices

A Health and Safety Plan
B Site Management Plan
C Field Standard Operation Procedures
D Analytical Standard Operation Procedures

Abbreviations and Acronyms

µg/L	micrograms per liter
ANSET	analytical services tracking system
ASTM	American Society of Testing and Materials
AVS/SEM	acid volatile sulfides/simultaneously extracted metals
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CEM	conceptual exposure model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	chain of custody
COI	conflict of interest
COPC	chemical of potential concern
CPR	cardiopulmonary resuscitation
CRQL	contract required quantitation limit
CRL	Contract Laboratory Program
CSM	conceptual site model
DO	dissolved oxygen
DPT	direct-push technology
DQI	data quality indicator
DQO	data quality objective
Eco-SS	ecological soil screening level
EDD	electronic data deliverable
EDI	Environmental Design International
eH	redox potential
EHE	Environmental Hazard Evaluation
ELCR	excess lifetime cancer risk
ERSE	ecological risk screening evaluation
ESL	ecological screening level
FD	field duplicate
FS	Feasibility Study
FTL	Field Team Leader
GIS	geographic information system
GPS	global positioning system
HHRA	human health risk assessment
HASP	Health and Safety Plan
IC	ion chromatography
ICP-AES	Inductively Coupled Plasma–Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma–Mass Spectrometry
ICS	interference check sample
ICV	initial calibration verification
IDPH	Illinois Department of Health
IDW	investigation-derived waste

IEPA	Illinois Environmental Protection Agency
LCL	lower control limit
LCS	laboratory control sample
LCSW	aqueous laboratory control sample
LCSS	solid laboratory control sample
LOE	level of effort
LUST	leaking underground storage tank
MD	method detection limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
MPC	measurement performance criteria
MS	matrix spike
MSD	matrix spike duplicate
mV	millivolt
NFR	no further remediation
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
PA	preliminary assessment
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PCOC	potential contaminant of concern
PDF	Portable Document Format
PID	photoionization detector
PM	Project Manager
PO	Program Officer
ppm	parts per million
PQO	project quality objective
QA	quality assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	quality control
QM	Quality Manager
RAC	Remedial Action Contract
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RR	rotary residue

RSD	relative standard deviation
RSI	Risk Science International
RSL	regional screening levels
SAP	Sampling and Analysis Plan
SAS	Special Analytical Services
SDG	Sample Delivery Group
SI	site inspection
SIC	standard industrial classification
SM	Site Manager
SME	subject matter experts
SMP	site management plan
SOP	standard operating procedure
SOW	statement of work
SPLP	Synthetic Precipitation Leaching Procedure
SRM	standard reference material
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
SWPPP	Stormwater Pollution Prevention Plan
TACO	tiered approach to corrective action
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TOC	total organic carbon
UCL	upper control limit
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plan
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
UTM	Universal Transverse Mercator
VOA	volatile organic analysis
VOC	volatile organic compound
WAM	work assignment manager
WGS	World Geodetic System
XRF	X-ray fluorescence

Worksheet #1—Title and Approval Page

Site Name:	Eagle Zinc, Operable Unit 2 (OU2)
Project Name and Site Location:	Supplemental Remedial Investigation/Feasibility Study, OU2 of the Eagle Zinc Site, Hillsboro, Illinois
Document Title:	Quality Assurance Project Plan (QAPP) for OU2 of the Eagle Zinc Site, Supplemental Remedial Investigation/Feasibility Study
Lead Organization:	U.S. Environmental Protection Agency (USEPA)
Preparer's Contact Information:	CH2M HILL 1034 S. Brentwood Blvd., Suite 2300 St. Louis, MO 63117 Telephone: (314) 335-3010 Fax: (414) 454-8898 E-mail: Lisa.Cundiff@CH2M.com
Preparation Date:	September 2010

Lisa R. Cundiff 11-10-2010

Lisa Cundiff/CH2M HILL Date
Investigative Organization's Site Manager

11-10-2010

Jewelle Keiser/CH2M HILL Date
Investigative Organization's Quality Assurance Manager

Nefertiti Simmons/USEPA Date
Lead Organization's Work Assignment Manager

Ida Levin/USEPA Date
Lead Organization's Quality Assurance Reviewer

(Note: This Uniform Federal Policy for Quality Assurance Project Plan [UFP QAPP] document is not controlled and therefore does not have a document control number).

Worksheet #2—Work Plan Identifying Information

Site Name:	Eagle Zinc
Project Name:	Supplemental Remedial Investigation/Feasibility Study (RI/FS)
Site Location:	Hillsboro, Illinois
Operable Unit:	OU2
Contractor Name:	CH2M HILL, St. Louis, MO
Contract Title:	USEPA Remedial Action Contract 2, Region 5
USEPA Contract Number:	EP-S5-06-01
Work Assignment Number:	69-RICO-B5Y7

1.	Identify Regulatory Program:	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
2.	Identify Approval Entity:	USEPA
3.	The QAPP is (select one):	☐Generic ☒Project-Specific
4.	List dates of scoping sessions that were held:	See Worksheet #9 (Project Scoping Sessions)
5.	List dates and titles of QAPP documents written for previous site work, if applicable:	Not Applicable
6.	List organizational partners (stakeholders) and connection with lead organization:	• USEPA – Lead Agency • Illinois Environmental Protection Agency (IEPA) – Regulatory Stakeholder • CH2M HILL – USEPA Contractor
7.	List data users:	• USEPA • CH2M HILL • IEPA

8. If any required Quality Assurance Project Plan (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:

   No exclusions

Table 2.1	QAPP Identifying Crosswalk	
Required QAPP Element(s) and Corresponding QAPP Section(s)	**Required Information**	**Crosswalk to Related Documents**
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	Worksheet #1
2.2 Work Plan Identifying Information 2.2.1 Document Control Format 2.2.2 Document Control Numbering System	- QAPP Identifying Information	Worksheet #2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	Worksheet #3 Worksheet #4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	Worksheet #5 Worksheet #6 Worksheet #7 Worksheet #8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	Worksheet #9 Worksheet #10 Worksheet #13
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria Table	Worksheet #11 Worksheet #12
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	Worksheet #13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table	Worksheet #14 Worksheet #15 Worksheet #16

Table 2.1	QAPP Identifying Crosswalk	
Required QAPP Element(s) and Corresponding QAPP Section(s)	**Required Information**	**Crosswalk to Related Documents**
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/ SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Worksheet #17 Worksheet #18 Worksheet #19 Worksheet #20 Worksheet #21 Worksheet #22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Worksheet #23 Worksheet #24 Worksheet #25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification	Worksheet #26 Worksheet #27
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree	Worksheet #28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs	Worksheet #29 Worksheet #30
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Assessment Findings and Corrective Action Responses Table	Worksheet #31 Worksheet #32
4.2 QA Management Reports	- QA Management Reports Table	Worksheet #33
4.3 Verification Process 4.3.1 Verification (Step I) Process 4.3.2 Validation (Steps IIa and IIb) Process 4.3.3 Validation (Steps IIa and IIb) Summary 4.3.4 Usability Assessment	- Verification Process - Validation Process - Validation Summary - Usability Assessment	Worksheet #34 Worksheet #35 Worksheet #36 Worksheet #37

Worksheet #3—Distribution List

Recipient	Organization/Title	Hard Copies
Nefertiti Simmons	USEPA Region 5/Work Assignment Manager	1
Rick Lanham	IEPA Representative	2
Ike Johnson	CH2M HILL/Program Manager	1[a]
Dan Plomb	CH2M HILL/Deputy Program Manager	1[a]
Jewelle Keiser	CH2M HILL/Quality Assurance Manager	1 [a]
Cherie Wilson	CH2M HILL/Project Controls Specialist	1
Lisa Cundiff	CH2M HILL/Site Manager (SM)	1 [a]
Laura Crause	CH2M HILL/RI Leader	1
Sam Shannon	CH2M HILL/Senior Reviewer	1
Brian Schroth	CH2M HILL/Senior Reviewer	1 [a]
Phil Smith	CH2M HILL/Senior Reviewer	1
Barrie Selcoe	CH2M HILL/Human Health Risk Assessor	1
Ryan Loveridge	CH2M HILL/Ecological Risk Assessor	1
Shannon Olson	CH2M HILL/Project Chemist	1[a]
Ceress Berwanger	CT Laboratories	1
Dan Moore	Critigen/Data Manager	1[a]
Patricia Feeley	EDI/Team Subcontractor	2

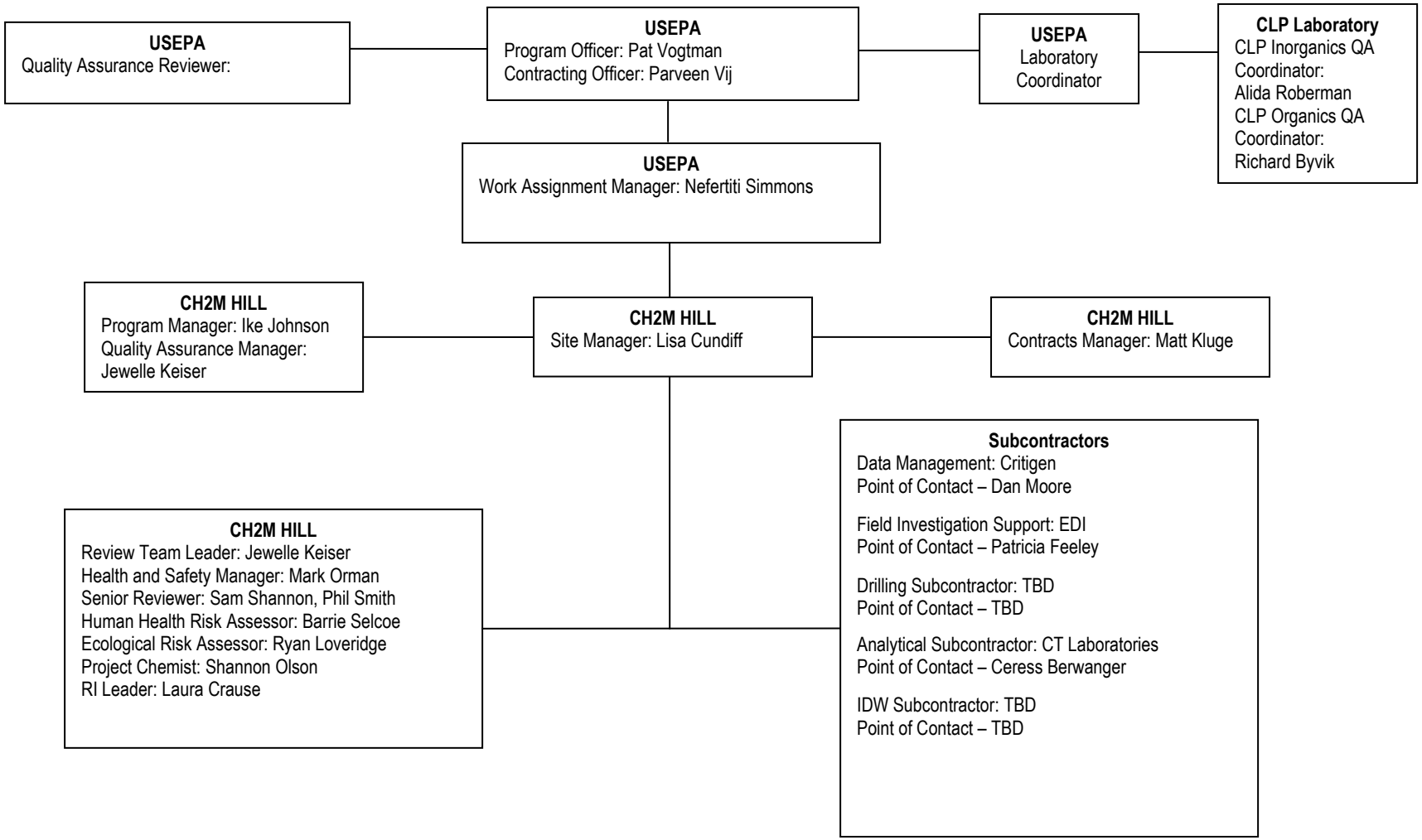
Note:

[a]Electronic submittal

Worksheet #4—Project Personnel Sign-Off Sheet

Project Personnel	Title	Telephone Number	Signature	Date QAPP Approved
Organization: USEPA				
Nefertiti Simmons	USEPA Region 5 Work Assignment Manager)	(312) 886-6148		
Ida Levin	USEPA Region 5, Quality Assurance Reviewer	(312) 886-6254		
Organization: CH2M HILL and Team Subcontractors				
Lisa Cundiff	SM, CH2M HILL	(314) 335-3010	Lisa R. Cundiff	11/10/2010
Jewelle Keiser	Quality Assurance Manager, CH2M HILL	(414) 847-0469	Jewelle F. K	11/13/2010
Sam Shannon	Senior Hydrogeologist, CH2M HILL	(334) 371-1445		
Brian Schroth	Senior Geochemist CH2M HILL	(916) 920-0212		
Phil Smith	Senior Reviewer, CH2M HILL	(414) 272-1052 x 40362		
Barrie Selcoe	Human Health Risk Assessor, CH2M HILL	(713) 392-8707		
Ryan Loveridge	Ecological Risk Assessor, CH2M HILL	(617) 626-7036		
Shannon Olson	Project Chemist, CH2M HILL	(414) 847-0227		
Dan Moore	Senior Chemist, Critigen	(314) 335-3029		
Laura Crause	RI Leader	(314) 335-3008		

Worksheet #5—Project Organizational Chart



Worksheet #6—Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Communication with CH2M HILL Program Manager	USEPA Program Officer	Pat Vogtman	(312) 886-9553	Provides administrative direction to CH2M HILL Program Manager and project team, authorizes changes to plan and can stop work, if needed.
Communication with CH2M HILL Contract Manager	USEPA Contracting Officer	Parveen Vij	(312) 353-1173	Provides administrative direction to CH2M HILL Contracts Manager.
Communication with USEPA Program Officer and Contracting Officer	CH2M HILL Program Manager	Ike Johnson	(414) 847-0304	Receives contractual direction from USEPA Program Officer and Contracting Officer, and notifies USEPA of contractual deviations (changes in scope of work, budget, or schedule) via e-mail or letter.
Communication with CH2M HILL SM	USEPA Work Assignment Manager	Nefertiti Simmons	(312) 886-6148	Serves as primary point of contact for USEPA, and provides approval of technical direction to CH2M HILL SM.
Point of contact for USEPA Work Assignment Manager (WAM)	CH2M HILL SM	Lisa Cundiff	W: (314) 335-3010 C: (618) 910-7728	Serves as primary point of contact for CH2M HILL, provides technical support to USEPA WAM, and directs project team.
Field staff discussion and inquiry	CH2M HILL Senior Consultants/Subject Matter Experts (SMEs)	Brian Schroth Sam Shannon Barrie Selcoe Ryan Loveridge Phil Smith	(916) 920-0212 (334) 371-1445 (713) 392-8707 (617) 626-7036 (414) 272-1052 x 40362	Serves as a primary point of contact for field team before, during, and after the investigation; communicates back to the SM, Quality Manager (QM), and project chemist, as needed. Communication by phone as needed with field staff during field sampling events, followed up with e-mail to document decisions and actions.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Health and Safety	CH2M HILL Site Safety Coordinator (SSC)	Laura Crause	W: (314) 335-3008 C: (217) 899-5498	Responsible for the adherence of team members to the site safety requirements described in the health and safety plan (HASP). Will report health and safety incidents and near misses to SM.
QAPP Field Changes/Field Progress Reports	CH2M HILL RI Leader	Laura Crause	W: (314) 335-3008 C: (217) 899-5498	Documentation of field activities and work plan deviations (made with the approval of the SM and/or SME; will provide daily progress reports to SM, SME, and project chemist. Deviations to the Sampling and Analysis Plan (SAP) made in the field and the reasons need to be reported to the SM, SME, and/or project chemist before conducting any actions that may be affected by them. Documentation of deviations from the work plan will be kept in the field logbook.
Field corrective actions	CH2M HILL RI Leader	Laura Crause	W: (314) 335-3008 C: (217) 899-5498	Field issues requiring corrective action will be identified by the FTL and brought to the attention of the SM and/or SME who, in turn, will notify the QM before decisions on action are made. Communications and decisions should be made on a daily basis and before conducting actions that may be affected by them. Communications will be by phone and followed up with e-mail to document decisions and actions.
	CH2M HILL Field Team Leader (FTL)	Jayson Burkard	C: (314) 477-7284	
Reporting lab data quality issues	CLP Inorganics Quality Assurance (QA) Coordinator	Alida Roberman	(312) 886-7185	Quality assurance/quality control (QA/QC) issues with field samples will be reported to the project chemist immediately.
	CLP Organics Quality Assurance Coordinator	Richard Byvik	(312) 353-3114	
	CRL	Marilyn Jupp	(312) 353-7444	

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Release of analytical data	CLP, CRL, or Subcontracted Laboratory	CLP Laboratory Marilyn Jupp/CRL TBD	TBD (312) 353-7444 (603) 926-3345 x213	No analytical data can be released to CH2M HILL and USEPA until it has been reviewed by the laboratory. No final data from the CLP can be released to CH2M HILL until the laboratory has approved the release and validation is completed by USEPA validators.
Management of analytical laboratories. Analytical corrective actions. Release of analytical data	CH2M HILL Project Chemist	Shannon Olson	(414) 847-0227	Analytical laboratory corrective actions will be identified by, or brought to the attention of, the project chemist on a daily basis. The project chemist will facilitate resolution on a same-day basis after consulting with the SM and QM to verify the QAPP requirements are met by the laboratory. No analytical data can be released until validation and data usability is completed and approved by the project chemist. The project chemist will review data as soon as possible upon receipt from the validator. Communications with the laboratories will be by phone and followed up with e-mail to document decisions and actions.

Worksheet #7—Personnel Responsibilities and Qualifications

Name	Title	Organizational Affiliation	Responsibilities	Education	Experience Qualifications
Organization: USEPA					
Nefertiti Simmons	Region 5 Work Assignment Manager	USEPA	Overall responsibility for all phases of work, review, and approval.	TBD	TBD
	Region 5 Quality Assurance Reviewer	USEPA	Conducts QAPP review and approval.	TBD	TBD
Organization: CH2M HILL and RAC Team Subcontractor					
Ike Johnson	Program Manager	CH2M HILL	Receives contractual direction from USEPA; notifies the project officer and contracting officer of contractual deviations (changes in scope of work, budget, or schedule).	MS	30
Lisa Cundiff	SM	CH2M HILL	Manages and supports CH2M HILL's project team; tracks project budget and schedule.	BS	25
Jewelle Keiser	Quality Assurance Manager/Review Team Leader	CH2M HILL	Responsible for overall quality assurance and provides guidance to the site manager on managing the review team.	MS	25
Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	Conducts human health risk assessment for the Supplemental RI and develops site-specific risk-based cleanup goals for the site.	MPH	23
Ryan Loveridge	Ecological Risk Assessor	CH2M HILL	Conducts ecological risk assessment for the Supplemental RI and develops site-specific risk-based cleanup goals for the site.	MS	11
Sam Shannon	Hydrogeologist	CH2M HILL	Provides technical support and reviews technical deliverables.	MS	35
Phil Smith	Environmental Engineer	CH2M HILL	Provides technical support and reviews technical deliverables	MS	33

Name	Title	Organizational Affiliation	Responsibilities	Education	Experience Qualifications
Brian Schroth	Geochemist	CH2M HILL	Provides technical support and reviews technical deliverables.	PhD	28
Mark Orman	Health and Safety Operations Manager	CH2M HILL	Conducts health and safety audit.	BS	16
Laura Crause	RI Team Leader	CH2M HILL	Coordinates RI activities and lead author for the RI Report.	MS	4
Jayson Burkard	Field Team Leader	CH2M HILL	Coordinates, directs, and participates in site activities. Ensures adherence to the QAPP, reports field activities, and communicates issues to project manager and field team. Performs contractor oversight.	MS	4
Jayson Burkard	Site Safety Coordinator	CH2M HILL	Oversees health and safety for all field activities.	MS	4
Shannon Olson	Sampling and Analytical Coordinator	CH2M HILL	Coordinate field and laboratory schedules and sample management.	MS	2
Shannon Olson	Project Chemist/Data Manager	CH2M HILL	Responsible for ensuring that the requirements of the site-specific plans are met by the laboratory, performs sample tracking and communication with the data validator, provides direction regarding the requirements for corrective actions for analytical issues, and evaluates validated analytical results.	MS	2
Dan Moore	Data Management Advisor	Critigen	Performs management of team subcontract and provides senior technical support for data management activities.	TBD	TBD
Patricia Feeley	Project Manager	EDI	Performs management of team subcontract and coordinates EDI field staff resources.	TBD	TBD
Organization: Analytical Laboratory					
TBD	Laboratory Project Manager	CLP Laboratory	Manages samples tracking and maintains communication with project chemist.	NA	NA
Marilyn Jupp	Laboratory Project Manager	CRL	Manages samples tracking and maintains communication with project chemist.	NA	NA

Worksheet #8—Special Personnel Training Requirements

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
Field Activities	Hazwoper 40-hour Training; 8-hour refresher	Registered Training Organization	Annually	All Field Staff	FTL, Field Team Staff	CH2M HILL Human Resources Department
Field Activities	Cardiopulmonary Resuscitation (CPR) and First Aid	Registered Training Organization	Annually (CPR), Every 3 Years (First Aid)	All Field Staff	FTL, Field Team Staff	CH2M HILL Human Resources Department
Field Activities	Site Safety Coordinator	Registered Training Organization	Every 3 Years	All Field Staff	FTL/SSC	CH2M HILL Human Resources Department
Field Activities	HASP	CH2M HILL	Various	All Field Staff	All Field Staff	Sign-off sheet at the end of the HASP

Worksheet #9—Project Scoping Sessions

Multiple project scoping sessions were held throughout the Work Planning process and development of the site-specific plans, either among internal team members or with team subcontractors or USEPA representatives. During these meetings, the team identified data gaps and uncertainties to develop the current understanding of the conceptual site model (CSM) and developed the technical approach for filling data gaps and performing field investigations. A site visit was conducted to verify current site conditions and identify sampling locations.

Site Name:	Eagle Zinc Site, OU2
Project Name and Site Location:	Supplemental Remedial Investigation/Feasibility Study, OU2 of the Eagle Zinc Site, Hillsboro, Illinois
Projected Date(s) of Sampling:	November through December 2010
Site Manager:	Lisa Cundiff

9.1 May 17, 2010, Project Scoping Session

Date of Session: **May 17, 2010**

Scoping Session Purpose: **Work Assignment 069 Kick-Off Call**

Name	Title/Role	Affiliation	Phone #	E-mail Address
Pat Vogtman	PO	USEPA	(312) 886-9553	Vogtman.Pat@epamail.epa.gov
Parveen Vij	Contracting Officer (CO)	USEPA	(312) 353-1173	Vij.Parveen@epamail.epa.gov
Nefertiti Simmons	WAM	USEPA	(312) 886-6148	Simmons.Nefertiti@epamail.epa.gov
Ike Johnson	Program Manager (PM)	CH2M HILL	(414) 847-0304	Ike.Johnson@CH2M.com
Lisa Cundiff	SM	CH2M HILL	(314) 335-3010	Lisa.Cundiff@CH2M.com

Decisions/Discussion Items

- CH2M HILL will include cost and level of effort (LOE) for an updated human health risk assessment (HHRA) and updated ecological risk assessment (ERA) for OU2.
- CH2M HILL will perform an independent review of the existing data to identify data gaps.
- For Task 5, assume USEPA will perform data validation.

- Cost and LOE should only be included for tasks specified in the statement of work (SOW) that can be completed by March 15, 2011.

Action Items

- CH2M HILL PM will update conflict of interest (COI) for Millennium/Lyondell.
- USEPA will amend the SOW to reflect that Tasks 9, 10, and 12 are not applicable as they cannot be completed within the timeframe.
- CH2M HILL will prepare the draft Work Plan for USEPA review.

9.2 May 26, 2010, Project Scoping Session

Date of Session: **May 26, 2010**

Scoping Session Purpose: **IEPA Scoping Session**

Name	Title/Role	Affiliation	Phone #	E-mail Address
Lisa Cundiff	SM	CH2M HILL	(314) 335-3010	Lisa.Cundiff@CH2M.com
Rick Lanham	IEPA PM	IEPA	(217) 782-3397	rick.lanham@illinois.gov
Clarence Smith	IEPA	IEPA	(217) 524-1655	clarence.smith@illinois.gov
Bob Carson	IEPA	IEPA	(217) 524-1655	robert.carson@illinois.gov
Laura Crause	FTL	CH2M HILL	(314) 335-3008	Laura.Crause@CH2M.com

Decisions/Discussion Items

- IEPA's expectations for RI investigation activities were discussed.
- CH2M HILL will include soil sampling in the residential area to the northwest and within the drainage in this area.
- Residue samples will be analyzed using Synthetic Precipitation Leaching Procedure (SPLP)

Action Items

- IEPA to provide historical reports
- IEPA will attend the site visit

9.3 June 3, 2010, Project Scoping Session

Date of Session: **June 3, 2010**

Scoping Session Purpose: **Site Visit**

Name	Title/Role	Affiliation	Phone #	E-mail Address
Barrie Selcoe	Human Health Risk Assessement (HHRA)	CH2M HILL	(713) 392-8707	Barrie.Selcoe@CH2M.com
Sam Shannon	Senior Technical Consultant (STC)	CH2M HILL	(334) 371-1445	Sam.Shannon@CH2M.com
Brian Schroth	STC	CH2M HILL	(916) 920-0212	Brian.Schroth@CH2M.com
Lisa Cundiff	SM	CH2M HILL	(314) 335-3010	Lisa.Cundiff@CH2M.com
Clarence Smith		IEPA	(217) 524-1655	clarence.smith@illinois.gov
Bob Carson		IEPA	(217) 524-1655	robert.carson@illinois.gov
Morris Dodd	Former plant employee		(217) 532-5055	none

Decisions/Discussion Items

- Clarence Smith of IEPA provided a copy of the gate key to CH2M HILL for future use. IEPA provided a description of the historic operations and began a site tour within the vicinity of the oldest area of site operations.
- Later in the day, the team was able to meet with Morris Dodd, who spent many years working onsite and who has institutional knowledge of past operations. Morris Dodd's contact information is as follows: (217) 532-5055, P.O. Box 562, Hillsboro, IL.
- Team consensus is that additional time is needed to complete the draft Work Plan because of (1) the amount of existing data to review and (2) the level of detail related to the technical approach USEPA has indicated they want in the draft Work Plan.

Action Items

- SM to ask PM to request a schedule extension from USEPA for the draft Work Plan submittal.

9.4 August 30, 2010, Project Scoping Session

Date of Session: **August 30, 2010**

Scoping Session Purpose: **Email direction from the work assignment manager**

Name	Title/Role	Affiliation	Phone #	E-mail Address
Nefertiti Simmons	WAM	USEPA	(312) 886-6148	Simmons.Nefertiti@epamail.epa.gov
Lisa Cundiff	SM	CH2M HILL	(314) 335-3010	Lisa.Cundiff@CH2M.com

Decisions/Discussion Items

- CH2M HILL will include cost and LOE for collecting concrete core samples from building slabs that are safely accessible during the RI field work and to run analyses for site-specific metals and Toxicity Characteristic Leaching Procedure (TCLP).

Action Items

- CH2M HILL will provide to the work assignment manager a round order magnitude cost for collecting concrete core samples.
- CH2M HILL will include this scope in the UFP QAPP.

9.5 November 03, 2010, Project Scoping Session

Date of Session: **November 03, 2010**

Scoping Session Purpose: **Site visit with former Eagle Zinc worker to identify location of old lead hopper.**

Name	Title/Role	Affiliation	Phone #	E-mail Address
Morris Dodd	NA	Former Site Worker	(217) 532-5055	NA
Jayson Burkard	FTL	CH2M HILL	(314) 477-7284	Jayson.Burkard@CH2M.com
Laura Crause	RI Lead	CH2M HILL	(3140 335-3008	Laura.Crause@CH2M.com

Decisions/Discussion Items

- Locate the former lead hopper in order to identify sample locations.

Action Items

- CH2M HILL field staff met with Morris Dodd on November 03, 2010. Morris Dodd identified the location of the old lead hopper at Eagle Zinc to CH2M HILL staff.

Worksheet #10—Problem Definition

This worksheet describes the environmental problem in terms of the CSM for the Eagle Zinc Site. The CSM integrates existing information and working assumptions about the physical site conditions; the nature, occurrence, and distribution of chemicals; fate and transport processes; and potential exposures to human and ecological receptors. The CSM is based on the current understanding of site history and conditions and will be updated as necessary based on information from the Supplemental RI.

Site Description and History

The site is located in a mixed industrial/commercial/residential area in Hillsboro, Montgomery County, Illinois (Figure 1). The site is approximately 132 acres, with about 30 acres of buildings and associated structures (Figure 2). There are about 23 buildings onsite that were previously used for facility operations; buildings were used as offices, laboratories, bag houses and maintenance facilities and for manufacturing and processing and equipment/raw material/finished product storage. The site also contains railroad spurs, residual material, two stormwater retention ponds, a small pond, and several roads. Active industrial operations ceased in 2003. The area has been zoned commercial/industrial and there are no plans to rezone the area for other uses.

Description of Historical Manufacturing Operations

Zinc oxide, which is used in many applications (including the paint and ceramics industries and for agricultural products, rubber products and cosmetics), was manufactured at the site using both direct and indirect processes. The indirect process reportedly involved the processing of zinc metal in a muffle furnace, while the direct process, which was used until the plant closed in early 2003, involved the processing of zinc ores and stockpiled furnace residues in a rotary kiln furnace. While it is likely that Eagle-Picher, Sherwin-Williams, and Eagle Zinc Company all used the direct process, only Eagle-Picher and Sherwin-Williams used the indirect process (muffle furnace). Residual materials historically generated by the manufacturing operations have included rotary kiln residue, muffle dross, metallic zinc particles, and refractory bricks from the facility's furnaces, and is also referred to as "waste material."

Other products historically manufactured at the site (and their manufacturers) include leaded zinc oxide (Eagle-Picher), metallic zinc (Eagle Zinc Company), and sulfuric acid (Eagle-Picher). Sulfuric acid was reportedly manufactured at the site by roasting zinc sulfide to remove the sulfur, with the southwest surface water pond used to provide non-contact cooling water. In addition, by screening stockpiled rotary residues using a rotary screen as well as through other methods, Eagle Zinc Company produced a fine-grained product that is rich in carbon.

The pyrometallurgical process known as the American process involved mixing zinc-bearing feed stocks with anthracite coal at the mix room. The coal was delivered to the site by railcar; the zinc ore was delivered to the site by railcar and truck. The furnace mix was

fed into a natural gas-fired rotary furnace (8 feet in diameter by 50 feet long) at the Block 2 Furnace Building. The natural gas provided the heat source and the anthracite coal provided a reducing atmosphere to reduce the zinc feed stocks to zinc vapor. The zinc vapor was drawn from the rotary furnace into a refractory brick combustion chamber and combusted to zinc oxide by the addition of ambient air. The zinc oxide, suspended in the vapor stream (products of combustion and air), was drawn into a steel flue and a series of steel cooling loops to cool the zinc oxide and vapor stream before it was collected in a bag house. The residue left in the rotary furnace was expelled from the rotary furnace into the discharge chamber, quenched in water and hauled to a pad for storage. The zinc oxide collected in the bag house was conveyed to the refinery and stored in bins before refining. Based on the physical and chemical properties of the zinc oxide, bins of zinc oxide were sometimes blended while being refined. The refining process involved conveying the zinc oxide through a natural gas fired rotary dryer in which the temperature of the zinc oxide was varied to achieve the desired product characteristics.

Until closure of the plant in early 2003, the Eagle Zinc Company produced two products: zinc oxide by the American process (described above), and a carbon-rich by-product by a screening process. The facility screened stockpiled rotary residues using a double rotary screen with 1/4-inch and 2-inch screen sizes to produce a carbon-rich, fine-grained product. This operation was conducted on a concrete pad located immediately west of the zebra building. Large and medium oversize materials created by this process were stockpiled to the west of the concrete pad.

As part of a pilot project, Eagle Zinc Company also produced zinc oxide using a Waelz Kiln in the Block 3 Building. The Waelz Kiln process feedstock was the furnace residue from Block 2 and other onsite stored residue. The Waelz Kiln operated similarly to the Block 2 process, where the zinc oxide was collected in a bag house and used as a feed for Block 2. The Waelz Kiln was not used after October 2000.

Finally, Eagle Zinc Company conducted a metallic zinc granule process in the zebra building, located in the northern part of the manufacturing plant. Crude zinc granules were conveyed to a Stedman Mill and then screened. The granule product was screened to a desired size fraction. The oversize material (metallic zinc) was collected and shipped offsite to a different zinc processing facility. The undersized fraction was zinc oxide, which was sold in bulk. This operation ceased in September 2001.

Regulatory History

The following information concerning the regulatory history of the site is summarized from the 2005 RI Report (Environ, 2005). The facility was initially listed on the Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) on June 1, 1981, as a discovery action initiated during Sherwin-Williams' ownership of the site.

Sherwin-Williams reportedly filed USEPA form 8900-1, Notification of Hazardous Waste Site, in accordance with Section 103(c) of CERCLA, which indicated that slag had been disposed of onsite property. A Preliminary Assessment (PA) was conducted in 1984 by the IEPA pursuant to CERCLA, which culminated in the submission of a PA Report to USEPA Region 5. Sampling of residual materials by IEPA in the early 1980s resulted in a determination that the materials were not hazardous waste and the site was not subject to Resource Conservation and Recovery Act (RCRA) permitting.

In addition to the CERCLA activities described above, IEPA collected several sets of surface water samples between 1980 and 1982 from the southwest stormwater discharge and had them analyzed for metals. Detected concentrations above applicable state surface water quality standards of zinc, iron, lead, and copper in the surface runoff (on one or more occasions) resulted in a Notice of Violation (NOV) from the IEPA. This reportedly prompted Sherwin-Williams to remove approximately 18,000 tons of residue materials from 10 acres of the site.

A CERCLA Expanded Site Inspection (SI) was conducted by IEPA on October 26 and 27, 1993; SI results are summarized in the section below. Based on information provided by IEPA and as reported in the CERCLA Expanded SI Report, the USEPA's Chief of Emergency Response for Illinois, Mr. Donald Bruce, determined that the site did not require a time-critical or non time-critical removal action and that the site property did not pose an immediate threat to human health or the environment.

On May 22, 1998, Eagle Zinc Company entered into an Interim Consent Order with the Illinois Attorney General and IEPA, which contained an interim Site Plan for:

- Preparation and submittal of a Stormwater Pollution Prevention Plan (SWPPP)
- Sampling of onsite materials
- Sampling of stormwater discharges
- Development and implementation of a groundwater monitoring plan
- Disposal of construction and demolition debris

Pursuant to the Interim Consent Order, a monitoring well installation and groundwater sampling program was conducted, which included the installation and sampling of nine shallow monitoring wells. IEPA representatives collected split samples from the monitoring wells. This investigation culminated in the submission to the IEPA of the March 1999 *Monitoring Well Installation and Ground Water Sampling Interim Report* (Goodwin & Broms, Inc. [GBI], 1999). Sampling of residual piles and underlying soils was also conducted pursuant to the Interim Consent Order. The results of this investigation, which also included the collection of split samples by IEPA, were submitted to IEPA in a March 1999 report entitled *Interim Report of Residue Sampling and Analysis*.

Based on discharges of stormwater from the site at two point sources, the occurrence of "regulated industrial activities" at the site, and the facility's standard industrial classification (SIC) code, the site was determined to be subject to National Pollutant Discharge Elimination System (NPDES) stormwater permitting requirements as per 40 *Code of Federal Regulations* (CFR) 122.26 (b)(14)(ii). A NPDES Notice of Intent (NOI) was prepared by Eagle Zinc and submitted to the IEPA. On June 20, 2000, IEPA issued NPDES Permit No. IL0074519. The NPDES permit required monthly monitoring of NPDES Outfall 002, preparation and implementation of a SWPPP, and submission of an annual inspection report to IEPA.

A SWPPP was prepared for the site in December 2000. Among the structural improvements and best management practices specified in the SWPPP was the construction of a new stormwater retention system in the northeast area of the site, to allow for settling of runoff prior to discharge to Outfall 002. The stormwater retention system, which consists of a two-cell retention basin, was completed in 2001. Following closure of the plant in early 2003, the

IEPA issued a public notice of the termination of the facility's NPDES stormwater permit on May 23, 2003, which stated "the facility has closed, all industrial activity has ceased, and the discharges have ceased."

The removal of a 500-gallon gasoline underground storage tank (UST) in April 1998 resulted in the reporting of a Leaking UST (LUST) incident to IEPA, because a limited amount of impacted soil was observed in the tank excavation and a pin-size hole was observed in the tank itself. No free-phase gasoline or groundwater was observed in the tank excavation. No contaminated soil was excavated or transported offsite. The location of the former UST is shown on Figure I-2 of the RI Report (Environ 2005). The monitoring wells used for the UST investigation (MW-A, MW-B, MW-C/G-106, MW-D and MW-E) are also shown on Figure I-2 of the RI Report.

To address the LUST incident, site classification and assessment activities were performed by GBI and Philip Services Corporation (Philip), including:

- Screening soil samples collected from soil borings using a photoionization detector (PID)
- Collecting a soil sample for laboratory analysis of benzene, toluene, ethyl benzene and xylenes (BTEX)
- Collecting soil samples for particle size analysis
- Installing four new monitoring wells
- Sampling five monitoring wells for BTEX compounds
- Completing slug tests to estimate hydraulic conductivity
- Completion of a well search

Neither the soil sample nor any of the groundwater samples collected from the monitoring wells contained detectable concentrations of BTEX compounds. Based on these results and discussions with IEPA, the LUST incident was classified as "low priority" and groundwater in the former tank area was monitored periodically for 3 years. As there were no detections of contaminants above applicable groundwater standards, the IEPA issued a No Further Remediation (NFR) letter for the former UST on August 31, 2004. The groundwater monitoring program associated with the former UST was completed independently from the RI/FS.

Summary of Previous Investigations

The previous investigations described in the sections below have taken place since the early 1980s. The initial RI started in 2001 and a draft RI Report was produced in 2005.

Risk Assessment Report, Risk Science International (RSI) 1982

The 1982 Environmental Risk Assessment report prepared by Risk Science International (RSI) presented the results of soil samples collected at various locations on the site property in October 1980. RSI's report stated that the soil samples did not contain concentrations of metals significantly above background soil samples collected in the Hillsboro area. The 1982 report concluded that "much of the lead, cadmium, copper, and zinc, although high in concentrations in the dross, kiln residues and ore spoils, appears to be relatively inert and

fixed in these materials." An accurate location map for the soil samples collected by RSI is not available. Therefore, the soil data collected by RSI are not included in the nature and extent evaluation and the conclusions made by RSI are discussed herein for informational purposes only.

IEPA Expanded Site Inspection and Follow on Sampling

The Expanded SI conducted by IEPA in October 1993 included the collection of 18 soil samples: a background sample and duplicate sample collected from a location in the nearby town of Butler and 16 samples collected at various offsite residential locations. All soil samples were collected from the ground surface (0 to 4 inches below grade) and analyzed for Target Compound List (TCL) inorganic compounds. The Illinois Department of Health (IDPH) stated in a letter to IEPA that the soil data collected by IEPA at offsite residences indicated "no apparent health concern." Table II-1 and figure II-1 of the RI Addendum depict the analytical results of the offsite sampling effort (RI Addendum Report, Environ 2005).

Sediment

Eight sediment samples were collected by IEPA as part of its October 1993 Expanded SI, with three of the samples collected onsite. The remaining samples were collected at offsite locations in the eastern and western drainageways. A background sample and a duplicate sample were collected from an unnamed tributary to Middle Fork Shoal Creek, upgradient of the point at which NPDES Outfall 001discharges to this tributary. All sediment samples were analyzed for the full TCL, including both organic and inorganic compounds.

Residues

Two samples of residue piles were collected by IEPA as part of the 1993 Expanded SI and 68 samples of residue piles were collected by GBI in May 1998, with split samples collected by IEPA. The samples collected by IEPA in 1993 were analyzed for TCL inorganics; the samples collected by GBI in May 1998 were analyzed for lead and cadmium, with selected samples analyzed for TCLP lead and TCLP cadmium. The residue samples collected by GBI represented 15 discrete stockpiles that were categorized as the following types: RRO (Rotary Residue Oversize); RR1 (Rotary Residue Type 1); RR2 (Rotary Residue Type 2); RCO (Rotary Clean Out); CPH (Carbon Plant Hutch); and MP (Miscellaneous Piles).

Surface Water

Stormwater samples were collected from the outlet for the southwest pond (general area of current NPDES Outfall 001) for laboratory analysis of inorganic constituents on four occasions between 1980 and 1982. Data were available for two of these sampling rounds: November 19, 1981, and March 23, 1982.

On June 9, 1998, pursuant to the Interim Consent Order with the IEPA, first flush and composite samples were collected from Outfall 001 by GBI and analyzed for metals and other inorganic parameters. On June 29 and 30, 1998, GBI collected first flush and composite samples from Outfall 002 and analyzed the samples for metals and other inorganic parameters. These samples were collected before the installation of an engineered stormwater retention basin to capture stormwater before it was discharged to the eastern drainageway. In 2000 and 2001, the facility sampled Outfall 002 on a monthly basis as required under the NPDES permit, which regulated the site's stormwater discharges. The

analytical parameters for the monthly sampling rounds were total suspended solids, sulfate, cadmium, and zinc.

Several rounds of surface water samples were collected from Lake Hillsboro between April and October 2001 by IEPA's Division of Public Water Supply. The samples were collected from the area of the City's potable water intake, which is located near the dam for the reservoir, approximately one mile north of the site. The samples were analyzed for metals, pesticides, and certain inorganic and physical parameters.

Groundwater

In December 1998, GBI collected groundwater samples from nine shallow onsite monitoring wells. The samples were split with IEPA and analyzed for 35 IAC Part 620.410 inorganic and organic parameters. As discussed above, four monitoring wells were installed by GBI in the area of a former 500-gallon gasoline UST that exhibited evidence of leakage. The sampling results, which indicated no detectable BTEX compounds, show that groundwater has not been impacted. As these data were not collected to assess environmental conditions on the site as a whole and were all nondetect, neither the data nor the ongoing UST monitoring program were discussed in any of the RI documents. Based on their locations and relative spacing, none of the monitoring wells installed for the purpose of evaluating potential impacts from the tank (that is, MW-A, MW-B, MW-D, and MW-E) were used during the RI. As noted above, an NFR letter dated August 31, 2004 was issued by IEPA for the former UST.

Remedial Investigation & Remedial Investigation Addendum

The RI and the RI Addendum examined site soils, the residue piles remaining on the site, offsite soils, groundwater, surface water, and sediments.

Residue Piles

Based on previous investigations (Environ, March 2003; Environ, November 2003; Environ, March 2005; and Environ, April 2005) a total of 15 residue piles or groups of piles have been identified onsite. Over time, residue from the piles has been distributed across the central, southern and southwestern portion of the site. The RI identified the following areas:

- Onsite areas previously identified as Areas 1 through 4
- Onsite areas located north and west of the manufacturing plant
- The manufacturing plant area itself

Based on boring logs from the Phase 1 RI in the south-western area (designated as Area 1), residue thickness varies from 0 to 28 feet with an average of 6.5 feet. Residue thickness in the central southern-most portion of the site (designated as Area 2) varies from 0 to 6 feet with an average of 1.6 feet. Residue thickness in the central portion of the site (designated as Area 3) varies from 0 to 9 feet with an average of 2.4 feet. Residue thickness in an area immediately north of the central portion of the site (designated as Area 4) varies from 0 to 6 feet, with an average of 1.8 feet. Residue thickness across the manufacturing area (designated as MA) varies from 0 to 5 feet with an average of 1.9 feet. Within the western area (designated as WA) only one out of ten soil borings encountered residue (1.5 feet thick), no residue was found in the remaining nine borings. Residue was not encountered in any soil borings completed in the northern area of the site.

During Phase 1 of the RI, 15 composite samples were obtained from the 15 piles identified onsite and were analyzed for TCLP. These composite samples were collected from trenches completed at six locations within each pile/pile group. The trenches extended through the depth of the pile/pile group and samples were collected from the excavator bucket at approximately one-quarter, one-half, and three-quarter depths from the top of each excavation. Three of the composite samples for residue piles failed TCLP for lead (5mg/L): RR1-3 (14 milligrams per liter [mg/L]), RR2-11 (6 mg/L) and MP1-21 (83 mg/L). During Phase 2 of the RI, a supplemental sampling effort was completed for the three residue piles identified in the Phase 1 effort as having failed for TCLP lead and those piles were again sampled for TCLP lead. Results of the TCLP analyses revealed that all three piles again failed for lead (Figure 3).

Residue pile sampling was conducted as part of the RI Addendum (Environ, April 2005); 15 piles/pile groups were sampled and analyzed for TAL metals. These samples were collected from non-crusted portions of each of the piles/pile groups (0 to 3 inches of outermost portion of the pile) to represent that which would be expected to have the greatest potential for emission of particulates. A direct comparison to Illinois TACO levels for soil is not appropriate, as the residue is not a soil. However, results for zinc ranged from 7,700 milligrams per kilogram (mg/kg) to 210,000 mg/kg, lead levels ranged from 74 mg/kg to 31,000 mg/kg, cadmium ranged from 6.1 mg/kg to 50 mg/kg, and arsenic was detected in a range of 3.1 mg/kg to 200 mg/kg. In addition to the 15 residue samples collected, one composite sample was collected representing all 15 piles by combining the finest grained fraction from each residue sample (that passing a #200 sieve or < 7 microns) into one sample and analyzed for TAL metals.

Soil

A total of 130 soil borings were completed during the Phase I RI. All soil samples were collected in the natural soil found below the residue across the site at various depths. During the Phase I RI, soil samples were collected either four feet bgs or two feet below the depth at which undisturbed native soils were encountered, whichever was determined to be deeper. Soil samples were screened with a photo-ionization detector (PID) and an X-ray fluorescence (XRF) analyzer at each location. A total of 10 percent of all of the soil samples were submitted for TCL organic compounds and PCBs based on PID screening, and 20 percent of all soil samples were submitted for laboratory analysis of TAL metals based on XRF field screening. A total of 27 soil samples were collected from soil borings during the Phase 1 RI and were submitted for laboratory analysis.

Illinois TACO references surface soils as the top 1 meter of soil (Section 742, Table B:SSL Parameters). All soil samples were collected from the uppermost one-foot interval of native soils exhibiting undisturbed characteristics. Because of the presence of residue across the site, surface soil samples were collected at depths greater than 1 foot bgs to obtain a native surface soil sample. The RI Report did not clearly define the depths for surface soil samples; however, of the 27 soil samples submitted for laboratory analysis, 20 of the soil samples were collected between 1 and 3 feet bgs and were defined as surface soil, which were believed to be beneath the residue. During supplemental soil sampling conducted as part of the RI Addendum, four additional surface soil samples were collected in the southern portion of the site and four surface soil samples were collected along the northern boundary of the site. Historical analytical results for soils are presented in Figure 4.

Groundwater

The scope of the groundwater investigation for the RI included the following:

- Installation of six (6) permanent piezometers and four (4) temporary piezometers. All piezometers were installed between March 10, 2003, and March 12, 2003.
- Installation of eleven (11) additional permanent monitoring wells. Monitoring wells MW1 through MW10 were installed between March 12, 2003, and March 15, 2003. MW11 was installed on June 19, 2003.
- Installation of three (3) temporary monitoring wells on offsite properties not owned by Eagle Zinc Company, located west of the southwest portion of the site. These temporary wells were installed on June 19 and 20, 2003.
- Sampling of the newly installed and existing monitoring wells and offsite temporary monitoring wells, with the exception of MW11, which was installed in June 2003. All onsite permanent monitoring wells were sampled on March 18, 2003 and March 19, 2003. The three offsite temporary monitoring wells and MW11 were sampled on June 20, 2003.
- Installation of six (6) permanent and four (4) temporary piezometers to provide a preliminary confirmation of the pattern of groundwater flow and to confirm locations for additional permanent monitoring wells.

Based on the groundwater sampling results for dissolved metals samples, zinc, cadmium, iron, lead, manganese and thallium were designated as PCOCs for groundwater. The highest dissolved metals concentrations in groundwater were detected in MW7.

Approximately five of the existing monitoring wells are screened across the residue and yield turbid samples. Rainfall infiltration percolates through the relatively permeable residue, encounters the low permeability native soils, forms a thin saturated zone within the lower few feet of residue and slowly migrates laterally through the residue to the small drainage features onsite. Past sampling of the residue groundwater shows elevated total metals and much lower levels of dissolved metals.

The residue groundwater levels at the site exceed Illinois Class I and Class II groundwater standards for cadmium, zinc and manganese. The area of cadmium and zinc exceedance is about 20 acres and is located in the southwest area of the site. Cadmium in this area ranges from 25 to 330 micrograms per liter (µg/L) (Class I [drinking water standard] standard is 5 µg/L; Class II standard is 50 µg/L). Zinc in this area ranges from 13 to 120 mg/L (the Class I standard is 5 mg/L and Class II standard is 10 mg/L). Manganese exceeds only the Class I standard but exceeds over a much wider area. Figure 5 depicts the groundwater analytical results from the RI and the areal extent of the various site specific metals.

Surface Water and Sediment

During the RI, a surface water and sediment investigation was conducted in onsite and offsite portions of the stormwater/surface water drainageways that receive stormwater discharges from the site, border the site, and enter the site from adjacent upgradient properties. The objective of the sediment investigation was to characterize the nature and extent of metals impacts on the drainageways. Historical analytical results for surface water and sediment are presented in Figure 6.

IEPA XRF Sampling of Buildings and Confirmation Sampling

IEPA completed XRF sampling over a three day period from April 30, 2008, through May 2, 2008, using a Niton Corporation XRF field based site characterization instrument. A total of 65 samples were collected at locations on the eastern third of the property. Approximately one half of the samples were collected inside of the buildings and the remaining half were collected outside of the building structures (Figure 7). The depth of the outside samples was not reported but it appears they were likely taken from the upper few inches of waste materials. Ten samples were also collected and submitted for confirmatory total metals TCLP metal analysis. The highest concentration for lead was found at Sample ID#XRF-058, where lead was detected via XRF at 56,576 parts per million (ppm). The location of this sample is in the central area between the building structures. Other metals reported include arsenic, zinc, copper, nickel, chromium, barium and cadmium.

About 70 percent of the samples collected within the building structures exceeded USEPA's target screening level of 800 ppm, while 100 percent of the samples collected outside of the building structures exceeded the 800 ppm screening level. Results of the confirmatory laboratory analytical sampling were 1.2 to 5 times greater than the field XRF results. Nine of ten TCLP samples exceeded the 5 mg/L TCLP limit for lead, indicating that the waste would be categorized as hazardous waste once excavated.

In September 2008, IEPA completed XRF sampling throughout the western portion of the site. Locations of these samples are presented in Figure 8.

Previous Investigations Findings and Chemicals of Interest

The previous investigations show multiple residue piles throughout the site that exceed screening levels, with onsite contaminants of concern that include lead, cadmium, arsenic, copper, zinc, and manganese. In 2008, the buildings and associated structures onsite were sampled via XRF and revealed significantly high levels of lead concentrations in, on, and around the building structures. This sampling event led the USEPA decision to complete an interim action to address the immediate threat posed by the buildings. An interim action was conducted in January 2009 to quickly mitigate site access and exposure; the action consisted of fence installation around the most accessible areas of the site.

The USEPA has divided the site into two OUs to effectively deal with (1) the short-term risks, defined as lead in buildings, and (2) the long-term risks, contaminated soil and groundwater onsite. Contaminated soil and groundwater at OU-2 is the focus of this supplemental remedial investigation.

Potential Receptors and Exposure Pathways

The preliminary human health and ecological CSMs are based on information from previous investigations and consider current and reasonably foreseeable future land uses (Figure 9). As the Supplemental RI data are gathered and evaluated, the CSM will be refined as necessary.

Potential Human Receptors and Exposure Pathways

Various exposure areas will be addressed separately in the HHRA: one onsite area, two offsite areas, sitewide groundwater, and offsite groundwater (Figure 10). The current land

use and receptor group to be addressed in the HHRA for each area will be vacant land (former industrial) for adolescent trespassers. The future land use and receptor groups to be addressed in the HHRA for each onsite area will be industrial land use for industrial workers and construction workers.

Soil

Under current land uses, site trespassers could be exposed to chemicals of potential concern (COPCs) in surface materials (0 to 2 feet bgs) through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/dust in areas where soil is exposed (that is, not covered with asphalt or concrete). These potential current soil exposure scenarios will be quantified for trespassers at exposure areas where COPCs are identified in surface materials.

Under future land use, onsite construction workers could be exposed to COPCs in soil or residue that is situated at 0 to 10 feet bgs . Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with dust from soil/residue by construction workers at exposure areas where COPCs are identified in soil/residue.

In the future, assuming that residues are removed from most areas of the site and consolidated into a specific area onsite, industrial workers could be exposed to COPCs in native soil currently situated immediately below waste materials (termed "native soil"). Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/dust by industrial workers at exposure areas where COPCs are identified in native soil below waste materials.

Under current and/or future land uses, offsite residents could be exposed to site residue materials (if present) in surface soil (0 to 2 feet bgs) in the public housing area immediately to the west of the site. Potential exposure scenarios to be quantified are incidental ingestion, inhalation of dust (resulting from fugitive dust generated from soil on these properties), and dermal contact with soil/dust in areas where soil is exposed (that is, not covered with asphalt or concrete). These potential exposure scenarios will be quantified for residents if COPCs are identified in offsite soil. It should be noted that offsite properties were concluded to not be impacted by historic/current dust emissions from the site based on Illinois EPA sampling results, as discussed in the previous HHRA (Environ, 2005).

Under future land use, offsite construction workers could be exposed to COPCs in soil situated at 0 to 10 feet bgs ("total soil"). Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/dust by construction workers at offsite exposure areas if COPCs are identified in total soil.

Groundwater

Offsite (current and future) groundwater exposures by residents will be evaluated in the HHRA because groundwater may be used as a potable resource within a 1-mile radius of the site. Although it is unlikely that site groundwater will be used as a drinking water source in the future, future potable use of onsite groundwater by industrial workers will be evaluated for groundwater identified as Class I since there is no deed restriction in place or local regulations preventing use of site groundwater. Groundwater within the residue is not

considered Class I and that groundwater will be evaluated in the fate and transport discussion as a pathway to either surface water or class I groundwater. Groundwater ingestion, dermal contact, and inhalation exposures from potable use and showering exposures will be evaluated.

Surface Water and Sediment

The following groups of samples will be evaluated in the HHRA:

- Onsite
  - Southwestern pond—exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
  - Western drainage ditch— exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
  - Eastern drainage ditch— exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
  - Small southern pond—exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
  - Two retention basins—exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
- Offsite
  - Western drainage ditch—recreators (incidental ingestion and dermal contact)
  - Eastern drainage ditch—recreators (incidental ingestion and dermal contact), Lake Hillsboro surface water for potable use, and fish in Lake Hillsboro

Potential Ecological Receptors and Exposure Pathways

Ecological pathways are considered complete for terrestrial and aquatic ecological receptors and are described in the ecological risk screening evaluation (ERSE), technical memorandum, and addendum to the ERSE. No changes to the ecological receptors and exposures pathways from these previous reports are proposed for the Supplemental RI.

Data Quality Objectives

Site-specific data quality objectives (DQOs) were developed to address the data gaps and uncertainties identified in the CSM and to meet the RI objectives, using the USEPA seven-step process (USEPA, February 2006). Table 10-1 summarizes the DQOs for OU2 of the Eagle Zinc Site.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
1	*Problem:* The majority of the existing monitoring wells located within residue areas are screened within the residue. The vertical extent of groundwater contamination is not delineated. Groundwater flow rate below the residue piles is not defined. *Conceptual model of the potential hazard.* The contamination in groundwater may pose a risk to onsite and offsite human and ecological receptors. *General intended use of collected data.* The data in this study will be used to determine nature and vertical extent of contamination in the groundwater beneath the residue piles.	*Principal Study Question:* Determine whether contamination is present in groundwater beneath the residue piles. *Range of Possible Outcomes:* • The groundwater contamination does not extend to zones below the residue piles at concentrations above screening levels. • The groundwater contamination does extend to zones below the residue piles at concentrations above screening levels.	*Information Needed to Resolve the Decision Statement:* • Historic data were reviewed to identify that the vertical extent of groundwater contamination has not been defined. These data were used to identify the problem statement. • Historic data were reviewed and a site reconnaissance was performed to determine the location of the deeper groundwater monitoring wells. • Deeper monitoring wells need to be installed to determine the vertical extent of groundwater contamination. • Boring logs are needed to evaluate subsurface characteristics.	*Target Population:* Future construction workers – If groundwater is within 10 feet of the surface, current/future human health and ecological receptors in surface water bodies, and potential water users. *Spatial:* The project area is defined by the site boundary. *Temporal:* This is the first assessment as to whether contamination is present in groundwater zones beneath the residue piles. *Scale of estimates to be made.* The groundwater will be assumed to represent the hydrogeology of groundwater zones beneath the residue piles onsite.	*Population of interest and the theoretical decision rule.* The population of interest is onsite and offsite human and ecological receptors.	Data will be used to confirm or modify the groundwater CSM.	*Select the sampling design.* Six monitoring wells will be installed deeper in the native soils below the residue (up to 60 feet bgs). These wells will be installed adjacent to existing wells that are currently screened at or in the residue. Groundwater will be collected from existing and newly installed monitoring wells to verify levels of site-specific metals (total and dissolved). Water levels will be measured at all monitoring wells to evaluate groundwater flow direction and rate.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			Source of Information. Historic groundwater data were obtained from the RI. *How the action level will be determined.* USEPA Regional Screening Levels (RSLs) (May 2010) for human health (Worksheet #15). Groundwater concentrations will not be compared to ecological screening levels because ecological risks from groundwater will be evaluated where it discharges to surface water. For human health, RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. *Variables/characteristics to be measured:* Water levels, groundwater contaminant concentration. Based on review of existing data, analytical parameters for all groundwater samples will include the following site specific metals:	*Scale of inference for decision making.* The data will be used to define the sitewide interpretation of groundwater contamination beneath the residue piles.			In situ aquifer tests will be performed at each of the newly installed monitoring wells to determine hydraulic conductivity.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			cadmium, zinc, arsenic, copper, lead, and magnesium (total and dissolved). *Sampling and analysis methods.* The groundwater levels will be measured using a depth to water meter (accuracy of the water level measurement is defined in the SOP in Appendix C). The recorded water level will be used with the surveyed well elevation to determine the water elevation. The flow direction will be determined by comparing the groundwater elevations at the wells to each other. Hydraulic conductivity will be measured by performing in situ aquifer tests. Groundwater sampling procedures will be performed as defined in the SOPs in Appendix C.				

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
2	*Problem:* The lateral extent of groundwater contamination is not sufficiently delineated. Groundwater flow rate is not defined. *Conceptual model of the potential hazard.* The contamination in groundwater may pose a risk to onsite and offsite human and ecological receptors. *General intended use of collected data.* The data in this study will be used to determine nature and lateral extent of contamination in groundwater and if the contamination poses a potential risk to onsite and offsite human and ecological receptors.	*Principle Study Question:* Determine if groundwater flowing off site is contaminated. *Range of Possible Outcomes:* • The groundwater contamination does not extend beyond the site boundaries at concentrations above screening levels. • The groundwater contamination does extend beyond the site boundaries at concentrations above screening levels.	*Information Needed to Resolve the Decision Statement:* • Twenty-eight existing monitoring wells will be sampled to determine the horizontal extent of the shallow groundwater contamination. • Historic data were reviewed to identify that the lateral extent of groundwater contamination has not been defined around site boundaries. These data were used to identify the problem statement. • Historic data were reviewed and a site reconnaissance was performed to determine the location of the groundwater monitoring wells. • Monitoring wells need to be installed in the deeper zones to determine the horizontal and vertical	*Target Population:* Future construction workers – If groundwater is within 10 feet of the surface, future human health and ecological receptors in surface water bodies, potential potable water users, and information that will be used to determine if there are risks to human and ecological receptors. *Spatial:* The project area is defined by the site boundary. *Temporal:* An assumption is being made that the chemistry of the site groundwater is stable. A comparison of historic and new data will be made	*Population of interest and the theoretical decision rule.* The population of interest is onsite and offsite human and ecological receptors.	Data will be used to develop the groundwater CSM.	*Select the sampling design.* Four monitoring wells will be installed where the groundwater is flowing offsite (i.e., adjacent to existing wells G-104, G-102, G-109, and TW-6). Groundwater from the newly installed monitoring wells will be collected for site-specific metals (total and dissolved). Water levels will be measured at wells to evaluate groundwater flow direction and rate. In situ aquifer tests will be performed at each newly installed monitoring well to determine hydraulic conductivity.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			extent of groundwater contamination of the deeper aquifer near the site boundaries. • Boring logs are needed to evaluate subsurface characteristics. *Source of Information.* Historic groundwater data were obtained from the 2005 RI. *How the action level will be determined.* USEPA RSLs (May 2010) for human health (Worksheet #15). Groundwater concentrations will not be compared to ecological screening levels because ecological risks from groundwater will be evaluated where it discharges to surface water. For human health, RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. *Variables/characteristics to be measured:* Water levels, groundwater	to determine temporal changes in water quality *Scale of estimates to be made.* The groundwater in the monitoring wells will be assumed to represent the groundwater flowing offsite. *Scale of inference for decision making.* The data will be used to define the sitewide interpretation of groundwater contamination.			

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			contaminant concentrations. Based on review of existing data, analytical parameters for all groundwater samples will include the following site specific metals: cadmium, zinc, arsenic, copper, lead, and magnesium (total and dissolved). *Sampling and analysis methods.* The groundwater levels will be measured using a depth to water meter (accuracy of the water level measurement is defined in the SOP in Appendix C). The recorded water level will be used with the surveyed well elevation to determine the water elevation. The flow direction will be determined by comparing the groundwater elevations at the wells to each other. Hydraulic conductivity will be measured by performing in situ aquifer tests. Groundwater sampling procedures will be performed as defined in the SOPs in Appendix C.				

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
3	*Problem:* The nature and extent of residue onsite has not been sufficiently delineated. The leaching potential of the residue onsite has not been fully evaluated. *Conceptual model of the potential hazard.* The contamination in residue may pose a risk to onsite human and ecological receptors. *General intended use of collected data.* The data in this study will be used to determine nature and extent of the residue and if the contamination poses a potential risk to onsite human and ecological receptors. The data will be used to determine whether the residue may continue to leach to groundwater at concentrations sufficient to cause exceedances of groundwater standards or ultimately surface water standards.	*Principle Study Question:* Determine the extent of the residue onsite and assess the potential human health and ecological risks. *Range of Possible Outcomes:* • The investigation will delineate the extent of residue onsite. • The investigation will not fully delineate the extent of the residue onsite. Determine the leaching potential of residue onsite. *Range of Possible Outcomes:* • The investigation will show that metals are leaching to groundwater. • The investigation will show that metals are not leaching to groundwater.	*Information Needed to Resolve the Decision Statement:* • Historic data were reviewed to identify that the extent of residue onsite has not been sufficiently defined. These data were used to identify the problem statement. • Soil borings will be completed in areas that have not been previously investigated to further delineate the residue onsite. • Residue samples will be collected using direct-push technology (DPT) methods to determine the thickness of residue and contaminant concentrations. • Boring logs are needed to evaluate subsurface characteristics. *Source of Information.* Historic information on residue extent was obtained from the 2005 RI.	*Target Population:* Onsite human and ecological receptors. *Spatial:* The project area is defined by the site boundary. *Temporal:* Temporal variation of the residue extent and contaminant contamination is not anticipated. *Scale of estimates to be made.* The sampling locations will be assumed to fill data gaps needed to characterize the extent of residue onsite. *Scale of inference for decision making.* The data will be used to refine the sitewide interpretation of residue concentrations.	*Population of interest and the theoretical decision rule.* The population of interest is onsite human and ecological receptors.	Data will be used to confirm or modify the CSM.	*Select the sampling design.* 31 soil borings will be completed onsite to log the thickness of the residue and to collect samples for analysis of pH. Depending on the pH results, residue samples will be analyzed for either SPLP or TCLP Metals. Ten of the 31 residue samples will also be sampled for site-specific metals.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			How the action level will be determined. USEPA RSLs (May 2010) for human health (Worksheet #15), ecological screening levels (Worksheet #15) will be compared to detected concentrations. For human health, RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. *Variables/characteristics to be measured:* Residue thickness and chemical characteristic. Based on review of existing data and the DQO, residue samples will be analyzed for pH. Depending on the pH results, residue samples will be analyzed for either SPLP or TCLP metals. 10 samples will also be analyzed for site-specific metals. *Sampling and analysis methods.* Soil and residue will be logged by a geologist; logs will be used to further define the geology of the site and document visual contamination. Residue samples will be collected as defined in the SOPs (Appendix C).				

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
4	*Problem:* The nature and extent of contamination in subsurface soil has not been sufficiently delineated on and offsite. *Conceptual model of the potential hazard.* The contamination in subsurface soil may pose a risk to onsite and offsite human receptors. *General intended use of collected data.* The data in this study will be used to determine nature and extent of contamination in subsurface soil and if the contamination poses a potential risk to onsite and offsite human receptors.	*Principle Study Question:* Determine the range of geochemical conditions and further characterize the site-specific metals contamination in subsurface soil onsite and offsite. *Range of Possible Outcomes:* • The investigation will delineate the extent of subsurface soil contamination onsite and offsite. • The investigation will not delineate the extent of subsurface soil contamination onsite and offsite.	*Information Needed to Resolve the Decision Statement:* • Historic data were reviewed to identify that subsurface soil has not been fully delineated from a contamination and geochemistry standpoint. • Soil will be collected from DPT boreholes to a maximum depth of 30 feet bgs to determine the contamination in subsurface soil and the geochemistry of the soil. • Subsurface soil samples from the residue borings will be collected between 1-2 feet below the residue / soil interface • Soil samples from the borings in the Offsite County Housing area and the triangular area will be taken from 0 to 2, 3 to 5, and 7 to 9 feet bgs	*Target Population:* Onsite and offsite human receptors. *Spatial:* The project area is defined by the site boundary and the adjacent properties. *Temporal:* Temporal variation of the soil geochemistry and contamination in soil is not anticipated. *Scale of estimates to be made.* The sampling locations will be assumed to fill data gaps needed to characterize geochemistry and contamination in subsurface soil. *Scale of inference for decision making.* The data will be used to refine the sitewide interpretation of subsurface soil contamination.	*Population of interest and the theoretical decision rule.* The population of interest is onsite and offsite human receptors.	Data will be used to confirm or modify the CSM.	*Select the sampling design.* Subsurface soil samples will be collected from the 31 co-located residue soil borings completed onsite. These samples will be analyzed for site-specific metals and sieved lead. Three of these samples will also be analyzed for TCLP metals. Eighteen subsurface soil samples will be collected from six soil borings (three samples per boring) offsite in the County Housing area northwest of the site. These samples

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			• Boring logs are needed to evaluate subsurface characteristics. *Source of Information.* Historic soil data were obtained from the 2005 RI. *How the action level will be determined.* USEPA RSLs (May 2010) will be compared to detected concentrations. RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. *Variables/characteristics to be measured:* Subsurface soil contaminant concentrations. Based on review of existing data and the DQO, subsurface soil samples will be analyzed for site-specific metals and sieve analysis for lead. Three additional subsurface soil samples will be collected and analyzed for TCLP metals. Soil samples will be collected as specified by the SOP in Appendix C.				will be analyzed for site specific metals and sieved lead. Nine subsurface soil samples will be collected from three borings (three samples per boring) in the triangular area onsite to the east of Industrial Drive. These samples will be analyzed for site-specific metals and sieved lead.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			Sampling and analysis methods. Soil will be logged by a geologist and the logs will be used to further define the geology of the site and document visual contamination. Soil samples will be collected as defined in the SOPs in Appendix C.				

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
5	*Problem:* Potential source areas have not been defined or fully delineated. *Conceptual model of the potential hazard. General intended use of collected data.* The data in this study will be used to characterize the potential source areas.	*Principle Study Question:* Determine the range of geochemical conditions and further characterize the site-specific metals contamination in potential source areas. *Range of Possible Outcomes:* • The investigation will determine and delineate potential source areas. • The investigation will not determine or delineate the potential source areas.	*Information Needed to Resolve the Decision Statement:* • Historical information was obtained via a personal interview with a former employee and a site reconnaissance. Both concluded that potential source areas have not been fully delineated. • Surface soil will be collected from 0 to 2 feet bgs using a hand auger to evaluate contamination in surface soil. *Source of Information.* Historical information was obtained via personal interviews with a former employee. *How the action level will be determined.* USEPA RSLs (May 2010) for human health (Worksheet #15) and ecological screening levels	*Target Population:* Onsite and offsite human and ecological receptors. *Spatial:* The project area is defined by the site boundary and drainage area within the County Housing area. *Temporal:* Temporal variation of the soil geochemistry and contamination in soil is not anticipated. *Scale of estimates to be made.* The sampling locations will be assumed to fill data gaps needed to define the potential source areas.	*Population of interest and the theoretical decision rule.* The population of interest is onsite and offsite human and ecological receptors.	Data will be used to confirm or modify the CSM.	*Select the sampling design.* Thirteen surface soil samples will be collected from three locations including: • The northeast area (eight samples) • The former lead hopper (two samples) • The drainage area within the County Housing area located northwest of the site (three samples)

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			presented in Worksheet #15 will be compared to detected concentrations. For human health, RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. *Variables/characteristics to be measured:* Surface soil contaminant concentrations. Based on review of existing data and the DQO, soil samples from 0 to 2 feet bgs will be analyzed for site specific metals and sieve analysis for lead. Surface soil samples will be collected as specified by the SOP in Appendix C. *Sampling and analysis methods.* Surface soil will be characterized by a geologist and the descriptions will be used to further define the site conditions and document visual contamination. Soil samples will be collected as described in the SOPs in Appendix C.	*Scale of inference for decision making.* The data will be used to refine the sitewide interpretation of the source areas.			

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
6	*Problem:* Sediment and surface water have not been fully characterized to assess potential human health and ecological impacts to receptors. Ecological risks presented in the ERSE, technical memorandum, and addendum to the ERSE, based on the previously collected data, may not be protective of ecological receptors. *Conceptual model of the potential hazard.* The contamination in sediment and/or surface water may pose a risk to onsite and offsite human and ecological receptors. *General intended use of collected data.* The data in this study will be	*Principle Study Question:* Determine the exposure point concentrations for human exposures from sediment and surface water contamination. Determine if ecological risks described in the ERSE, technical memorandum, and addendum to the ERSE are protective of ecological receptors. *Range of Possible Outcomes:* • The investigation will provide exposure point concentrations for human health exposures and provide data to support the characterization of risks to ecological receptors.	*Information Needed to Resolve the Decision Statement:* • Historic sediment and surface water data were reviewed. The data were used to identify the problem statement. • Historic data were reviewed and a site reconnaissance was performed to determine sampling locations. • Samples will be collected to determine current contamination in waterways and onsite ponds. • Ecological risks described in the ERSE, technical memorandum, and addendum to the ERSE. • Comparison of analytical chemistry and physical data for sediment (0-6 inches), and surface water to ecological screening	*Target Population:* Onsite and offsite human and ecological receptors. *Spatial:* The project area is defined by the 5 onsite water bodies (cooling water pond, 2 retention ponds, a small pond in the southeast portion of the site, and an onsite underground culvert) and the downgradient extent of surface water and sediment contamination at Outfalls #1 and 2. *Temporal:* Previous sampling and proposed sampling will provide data to evaluate temporal changes.	*Population of interest and the theoretical decision rule.* The population of interest is onsite and offsite human and ecological receptors.	Data will be used to confirm or modify the human health CSM. Additional data to determine exposure point concentrations for human exposures is not anticipated. Performance criteria established to ensure both the overall quality of the analytical chemistry and physical data, and to ensure these data will support the underlying evaluation and conclusions have been incorporated.	*Select the sampling design.* Surface water and sediment will be collected from the following: • Three locations from within the former cooling water pond and one location at the inlet and one location at the outlet. • Resample locations SD-WD-6, SD-WD-7, SD-WD-8, SD-WD-9, and SD-WD-10. • Resample two locations on drainage to Hillsborough Lake (SD-ED-13 and SD-ED-16) • Two locations within each of the two retention ponds and one location in the inlet of each pond. • Two locations within the pond located in the southeast portion of the site.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
	used to determine nature and extent of contamination and if the contamination poses a potential risk to onsite and offsite human and ecological receptors.	• Risks described in previous reports are protective of ecological receptors for current and future conditions, and no further investigation is necessary • Additional investigation is needed and will be proposed as an additional investigation phase.	levels presented in Worksheet #15 to estimate ecological risks on a screening-level basis. • Comparison of previously described ecological risks to ecological risk estimated in this study *Source of Information.* Historic data were obtained from the RI. *How the action level will be determined.* Action levels will be the screening levels discussed in DQO #1. Results that exceed ecological screening levels will be compared to historic results to determine if large differences in the frequency and magnitude of exceedances are present. *Variables/characteristics to be measured:* Sediment and surface water contaminant concentrations Exceedance of ecological	*Scale of estimates to be made.* The sampling locations will be assumed to fill data gaps needed to characterize surface water and sediment contamination and the affects of the contamination on receptors. *Scale of inference for decision making.* The data will be used to assess the potential human health and ecological risks in surface water and sediment.			• Two locations in onsite underground culvert (if present). Sediment samples will be analyzed for site-specific metals, AVS/SEM, total organic carbon, and grain size. Surface water samples will be analyzed for total and dissolved site-specific metals, pH (by field instrument), and hardness by calculation.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
			screening levels and comparisons of the frequency of magnitude of exceedances. *Sampling and analysis methods.* Sediment and surface water data will be collected. Analytical results will be compared to ecological screening levels on a sample-by-sample basis.				

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
7	*Problem:* Building slabs and building material onsite may be contaminated with site specific metals? *General intended use of collected data.* The data in this study will be used to characterize the building slabs onsite to determine if it should be removed and how it needs to be disposed of.	*Principle Study Question:* *Determine is site specific metals are present in onsite building slabs.* Building concrete slab contaminant characteristics. *Range of Possible Outcomes:* • Concrete slab and building material including bricks and concrete contains site specific metals and will be characteristic of non-hazardous waste. • Building concrete slabs and building material including bricks and concrete will contain site specific metals and will be characteristic of hazardous	*Information Needed to Resolve the Decision Statement:* • A site reconnaissance was conducted to determine the problem statement and sampling locations. • Building concrete slab core samples will be collected at locations defined during the site reconnaissance to characterize onsite building demolition debris. • Logs are needed to document building concrete slab samples. *Source of Information.* Visual observations. *How the action level will be determined.* Action levels are TCLP limits. *Variables/characteristics to be measured:* Concrete and building material contaminant	*Target Population:* The information that will be used to determine if building concrete slabs and building material including bricks and concrete are characteristic of non-hazardous or hazardous waste. *Spatial:* The project area is defined by the site boundary. *Temporal:* Temporal variation is not anticipated. *Scale of estimates to be made.* The sampling locations will be assumed to obtain information needed to characterize concrete and building	*Population of interest and the theoretical decision rule:* The population of interest is the concrete slabs onsite and the information will be used to determine if building concrete slabs are is characteristic of non-hazardous or hazardous waste. Additional concrete slab sampling is not anticipated.	Data will be used to determine if building material is characteristic of non-hazardous or hazardous waste. Additional concrete and building material sampling is not anticipated.	*Select the sampling design:* Building concrete core and building material samples will be collected from locations representative of onsite building slabs and construction materials.

TABLE 10-1
Data Quality Objectives

DQO #	Step 1–State the Problem	Step 2–Goal of the Study	Step 3–Information Inputs	Step 4–Study Boundaries	Step 5–Analytic Approach	Step 6–Performance or Acceptance Criteria	Step 7–Plan for Obtaining Data
		waste.	concentrations. The following parameters will be analyzed in concrete and building material samples; TCLP metals. *Sampling and analysis methods. Concrete and* building material samples will be collected as defined in the SOPs in Appendix C.	materials to determine the appropriate offsite disposal. *Scale of inference for decision making.* The data will be used to obtain information needed to characterize concrete and building material to determine the appropriate offsite disposal.			

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

Project quality objectives (PQOs) define the type, quantity, and quality needed to answer specific environmental questions and support proper environmental decisions. The PQOs were developed during the work planning process.

Who will use the data?

The USEPA will use the data to support the environmental decisions to be made, as outlined in Worksheet #10 (Problem Definition).

What will the data be used for?

The data will be used to complete a Supplemental RI/FS, which includes the following objectives:

- Determine the areal and vertical extent of contamination, particularly at exposure points.
- Determine the rate of migration and the fate of contaminants through various migration pathways.
- Evaluate the potential human health and environmental risks associated with the site under a no-action alternative.

What types of data are needed?

The sampling design and rationale is presented in Worksheet #17 (Sampling Design and Rationale). A complete listing of the sample analytes are provided in Worksheet #15 (Reference Limits and Evaluation).

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

Detected concentrations from definitive quality data will be screened against USEPA Regional Screening Levels (RSLs) for human health (Worksheet #15), ecological screening levels presented in Worksheet #15. For human health, RSLs will be adjusted downward by a factor of 0.1 to incorporate cumulative effects from multiple chemicals. The comparison of detected concentrations against screening levels will be used to support the environmental decisions (such as risk assessment and remedial alternatives selection). The data will be generated using rigorous analytical methods such as USEPA Contract Laboratory Program, approved EPA SW-846, or other published reference methods, and are not restricted in their use unless there is a quality problem associated with the data. The reporting limits of the

analytical methods should meet the screening level objectives unless otherwise justified (see Worksheet #15 [Reference Limits and Evaluation]).

How much data are needed? Where, when, and how should the data be collected/generated?

Worksheet #17 (Sampling Design and Rationale) describes the field investigation activities planned for the SRI/FS at OU2 to fill data gaps identified during work planning. Worksheet #18 (Sampling Locations and Methods/SOP Requirements) summarizes the number of samples and the analytical parameters. Standard operating procedures (SOPs) for field sampling and analytical procedures provided in Appendices C and D will be followed. Currently, the field work is planned to begin in fall of 2010.

Who will collect and generate the data?

CH2M HILL will collect the data on behalf of USEPA. Samples will be submitted to a laboratory in the USEPA's Contract Laboratory Program (CLP) or to the Central Regional Laboratory (CRL) for analysis. An analytical subcontractor will perform the sediment analysis for acid volatile sulfides/simultaneously extracted metals (AVS/SEM).

How will the data be reported? How will the data be archived?

The data will be reported in accordance with procedures outlined in Worksheet #36 (Verification [Steps IIa and IIb] Summary). Hard copy and electronic (such as database management system and geographic information system [GIS]) data will be stored by CH2M HILL for 5 years after project completion. Project reports will be archived on CD-ROM or DVD+R media and stored in the project file.

Worksheet #12—Measurement and Performance Criteria

This worksheet contains tables summarizing the measurement performance criteria (MPC) established for each matrix and analytical parameter, with the MPCs following those defined in the USEPA method or laboratory SOPs referenced. See the following pages for the measurement performance criteria table for the chemical analyses being performed. The quality of the data to be collected for this project will be verified through appropriate MPCs established for both sampling procedures and analytical methods. The criteria should relate to data quality indicators (DQIs) consisting of precision, accuracy, representativeness, comparability, completeness, and sensitivity, commonly referred to as PARCCS parameters. The DQIs are defined as follows:

- **Precision** refers to the reproducibility of measurements. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms.
- **Accuracy** refers to the degree of agreement between an observed value (such as sample results) and an accepted reference value. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits.
- **Representativeness** describes the extent to which a sampling design adequately reflects the environmental conditions of a site. Representativeness is determined by appropriate program design, with consideration of elements such as proper well locations, drilling and installation procedures, operations process locations, and sampling locations.
- **Comparability** addresses the degree to which different methods or data agree or can be represented as similar. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats.
- **Completeness** is a measure of the amount of valid data collected using a measurement system and is expressed as a percentage of the number of measurements specified in this UFP QAPP.
- **Sensitivity** is the ability of a method or instrument to detect the target analytes at the level of interest. Sensitivity can be measured by calculating the percent recovery of the analytes at the quantitation limit, which is the minimum concentration of an analyte that can be routinely identified and quantified above the method detection limit by a laboratory.

The quality of the sampling procedures and laboratory results will be evaluated for compliance with project DQOs through a review of overall PARCC, in accordance with procedures described in Worksheet #37 (Usability Assessment). The results will be summarized in an overall data usability assessment report, which will be included as an appendix to the Supplemental RI/FS Report.

QAPP Worksheet #12-1
Measurement Performance Criteria Table

Matrix	Soil/Sediment/Residue/Concrete/Building Material				
Analytical Group	Site Specific Metals (arsenic, cadmium, copper, lead, manganese and zinc)				
Concentration Level	Low (mg/kg)				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-03, 09, 10, 11	ILM05.4 (sediment) SW6010C/SW6020 (soil, residue, concrete, building material)	Precision (field)	≤ 20% Relative Percent Difference (RPD)	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 20% RPD	Duplicate Sample **	A
		Accuracy (laboratory)	75–125%; 80–120 %	*** Matrix Spike; LCSS****	A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23
*Reference USEPA CLP ILM05.4 (CRQL – contract required quantitation limit)
**Reference USEPA CLP ILM05.4, Exhibit D of Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES) for Duplicate Sample Criteria
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for solid Laboratory Control Sample (LCSS)
Note: Control Limits established by USEPA for LCSS

QAPP Worksheet #12-2
Measurement Performance Criteria Table

Matrix	Soil/Sediment				
Analytical Group	Grain Size				
Concentration Level	Low				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-09, 11	American Society for Testing and Materials (ASTM) D-422	Precision (field/laboratory)	≤ 50% RPD	Field and/or laboratory duplicate	S & A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23

QAPP Worksheet #12-3
Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	**250-micron sieve lead**				
Concentration Level	**Low (mg/kg)**				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-03, 09	Prep/SW6010C/6020	Precision (field)	≤ 20% RPD	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL	Field Blank	S & A
		Precision (laboratory)	≤ 20% RPD	Duplicate Sample	A
		Accuracy (laboratory)	75–125%; 80–120%	Matrix Spike; LCSS	A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23

QAPP Worksheet #12-4
Measurement Performance Criteria Table

Matrix	Sediment				
Analytical Group	Total Organic Carbon				
Concentration Level	Low (mg/kg)				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-11	Lloyd-Kahn	Precision (field)	≤ 30% RPD	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL of 1915 mg/kg	Field Blank	S & A
		Precision (laboratory)	≤ 30% RPD	Duplicate Sample	A
		Accuracy (laboratory)	75-125%; 80-120%	Matrix Spike; LCSS	A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23

QAPP Worksheet #12-5
Measurement Performance Criteria Table

Matrix	Sediment				
Analytical Group	**AVS/SEM Metals**				
Concentration Level	**Low (mg/kg)**				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-11	EPA 821 R91-100	Precision (field)	≤ 40% RPD	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL[3]	Field Blank	S & A
		Precision (laboratory)	≤ 40% RPD	Duplicate Sample	A
		Accuracy (laboratory)	40-160%; 70-130%	Matrix Spike; LCSS	A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23
[3]CRQL for AVS/SEM Metals is as follows:
AVS = 0.05 uMol/g
SEM Cadmium = 0.09 uMol/g
SEM Copper = 0.001 uMol/g
SEM Lead = 0.0001 uMol/g
SEM Mercury = 0.01 uMol/g
SEM Nickel = 0.002 uMol/g
SEM Zinc = 0.005 uMol/g
Sum of SEM = 0.1 uMol/g

QAPP Worksheet #12-6
Measurement Performance Criteria Table

Matrix	Residue/Soil/Concrete/Building Material				
Analytical Group	**SPLP Metals (Residue)/TCLP Metals and site specific metals (Concrete, Soil, Building Material)**				
Concentration Level	**Low (mg/L)**				
Sampling Procedure[1]	**Analytical Method/SOP[2]**	**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 & A)**
SOP-03, 09, 10, 11	SW1312/6010C/SW 6020 (SPLP) SW1311/6010C/SW 6020 (TCLP)	Precision (field)	≤ 20% RPD	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL	Field Blank	S & A
		Precision (laboratory)	≤ 20% RPD	Duplicate Sample	A
		Accuracy (laboratory)	75–125%; 80–120%	Matrix Spike; LCSS	A

[1]Reference number from UFP QAPP Worksheet #21
[2]Reference number from UFP QAPP Worksheet #23

QAPP Worksheet #12-7
Measurement Performance Criteria Table

Matrix	Aqueous (Groundwater and Surface Water)				
Analytical Group	Site Specific Metals (arsenic, cadmium, copper, lead, manganese and zinc)				
Concentration Level	Low (mg/L)				
Sampling Procedure[1]	Analytical Method/SOP[2]	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 & A)
SOP-08,11	ILM05.4	Precision (field)	≤ 20% RPD	Field Duplicate	S & A
		Accuracy (field)	No analyte > CRQL*	Field Blank	S & A
		Precision (laboratory)	≤ 20% RPD	Duplicate Sample **	A
		Accuracy (laboratory)	75–125%; 80–120%	*** Matrix Spike; LCSW****	A

[1]Reference number from QAPP Worksheet #21
[2]Reference number from QAPP Worksheet #23
*Reference USEPA CLP ILM05.4
**Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Duplicate Sample Criteria
***Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for Spike Sample Criteria
****Reference USEPA CLP ILM05.4, Exhibit D of ICP-AES for aqueous Laboratory Control Sample (LCSW) Criteria

Worksheet #13—Secondary Data Criteria and Limitations

Secondary data refer to historical data previously collected. The source(s) of the data, date of collection, planned uses, and limitations of the secondary data for each site are summarized in the following table.

Secondary Data	Data Source (Originating Organization, Report Title)	Date of Collection	How Data Will Be Used	Limitations on Data Use
IEPA collected 18 soil samples, 8 sediment samples, and 2 residue pile samples	Expanded Site Investigation completed by IEPA	October 1993	For information purposes only	**Do not have the data from IEPA**
IEPA collected 68 residue samples and 44 soil samples	IEPA follow on sampling	1998 and 2001	For information purposes only	**Do not have the data from IEPA**
Stormwater samples were collected and analyzed for total suspended solids, sulfate, cadmium, and zinc	NPDES permit	Monthly during 2000 and 2001	For information purposes only	**Do not have the data from IEPA**
Groundwater samples collected and analyzed for volatile organic compounds and total and dissolved metals.	Monitoring Well Installation and Groundwater Sampling Interim Report, IEPA	March 1999	Nature of contaminants in groundwater support understanding of the hydrogeological conditions at the site including groundwater flow paths and identification of likely source areas and support evaluation of site specific geology.	
Collected 12 residue pile samples, 21 offsite soil/cinder samples, and 8 sediment samples.	Expanded Site Investigation Addendum, IEPA	April 2005	XRF data will be used to evaluate the nature of the soil and residue contamination. Soil and sediment data will be compared to data collected in the present study as part of the ecological risk assessment.	**XRF data will not be used in the HHRA.**
130 soil borings completed onsite, soil boring cores were screened with an XRF analyzer. Twenty percent of the samples collected were submitted for laboratory analyses for TAL metals. A total of 26 soil samples were submitted for analyses and all were collected below the residue. Sixteen sediment samples were collected for analyses; all samples were analyzed for TAL metals and 20 percent were analyzed for TCL organics and PCBs. Fifteen residue samples were collected to represent residue piles onsite and analyzed for TAL metals and also leaching tests were completed using both TCLP and SPLP.	Phase I Source Characterization Technical Memorandum	March 2003	Support the characterization of the nature and extent of contamination and contaminant migration pathways. Sediment data will be compared to data collected in the present study as part of the ecological risk assessment. Laboratory analyses of soil, sediment, and residue samples will used in the HHRA.	**XRF data will not be used in the HHRA.**
Installed six new permanent piezometers and four temporary piezometers; installed 11 new permanent monitoring wells and three temporary monitoring wells. All new wells and exiting wells were sampled. Collected surface water samples co-located with the sediment samples collected in Phase 1. Completed additional sampling of residue piles for further evaluation. A total of 13 residue samples were collected from the piles and analyzed for lead using TCLP. Soil pH analysis was completed for one sample collected from each of the 20 soil borings used to install monitoring wells/piezometers.	Phase 2 Migration Pathway Assessment Technical Memorandum	November 2003	Support the characterization of the nature and extent of contamination and contaminant migration pathways. Surface water data will be compared to data collected in the present study as part of the ecological risk assessment.	**Groundwater and surface water will not be used in the HHRA due to its age.**

Secondary Data	Data Source (Originating Organization, Report Title)	Date of Collection	How Data Will Be Used	Limitations on Data Use
Summarized all of the data collected from the Phase 1 Source Characterization, the Phase 2 Migration Pathway Assessment, Human Health Risk Assessment and the Ecological Risk Screening Report.	Remedial Investigation Report	January 2005	Support the characterization of the nature and extent of contamination in soil, groundwater, surface water, and sediment. Ecological risks will be re-evaluated using the data collected in the present study.	**XRF data will not be used to evaluate the extent of contamination since sampling locations are unknown. XRF data will not be used in the HHRA.**
Residue pile sampling and analyses for TAL metals. One residue sample was collected from each of the 15 piles that were sampled in the RI. Samples were analyzed for TAL metals and particle size. Supplemental surface soil sampling was completed. Three surface soil samples were collected along the northern site boundary of the site and four surface soil samples were collected along the southern boundary of the site.	Remedial Investigation Addendum Report	April 2005	Residue data were used in the RI addendum to document levels of metals found in the piles. Soil data were used in the HHRA. Soil data will be compared to data collected in the present study as part of the ecological risk assessment.	
In March, IEPA collected a total of 65 XRF samples of residue and 10 samples for confirmatory laboratory analysis for total metals and TCLP. During the sampling event, the IEPA used a Niton XRF field-based site characterization instrument. The XRF documented numerous samples containing total lead and other inorganic/metals concentrations in excess of regulatory limits. The laboratory analysis also documented that the majority of the confirmation samples would be classified as hazardous waste. A strong correlation did not exist between the XRF instrument readings and the laboratory analysis at a number of sample locations for lead. The laboratory results determined that total lead concentrations were two to five times greater than the concentrations documented with the XRF in the field. A discussion with the Niton XRF technical representative concluded that the field sampling results were approximately two to five times lower than the laboratory analyses due to the extremely high zinc concentrations present in many of the samples, therefore “masking” the actual, higher lead concentration levels.	Illinois EPA Sampling Results Report for the Eagle Zinc NPL Site Buildings and Associated Structures	April – May 2008	Further documentation of the metals concentrations in the residue piles. Residue data will be used in the HHRA.	**XRF data will not be used in the human health or ecological risk assessments.**
In September 2008 IEPA collected additional XRF samples of residue throughout the western portion of the site.	IEPA XRF Sampling	September 2008	Further documentation of the metal concentrations in the residue piles across the site.	**XRF data will not be used in the human health or ecological risk assessments.**

Worksheet #14—Summary of Project Tasks

This worksheet provides a summary of project tasks as the outcome of project scoping activities. The following project tasks will be discussed:

- Pre-investigation activities
- Field investigation
- Laboratory analysis and data validation
- Data evaluation
- Updated human health risk assessment
- Updated ecological risk assessment
- Reporting

Pre-Investigation Activities

Health and safety is of paramount importance on the project and will be implemented with pre-investigation activities and throughout the field investigations following the project-specific health and safety plan (Appendix A). The following activities will take place before beginning field activities: performing site reconnaissance, obtaining utility clearances, acquiring subcontractors and materials, and mobilizing equipment to the site. The site management plan (SMP) addresses the pre-investigation and investigation activities (Appendix B). The SMP describes the management responsibilities during field activities with respect to access, security, contingency procedures, connection of utilities, storage and disposal of investigation-derived waste, and other procedures to be followed in the field.

Field Investigation Tasks

Field investigation activities are described in detail in Worksheet #17 (Sampling Design and Rationale) and are summarized below:

- Monitoring well installation
- Water level measurements
- Concrete slab and building material sampling
- In situ hydraulic testing
- Residue sampling
- Subsurface soil sampling
- Sediment sampling
- Surface water sampling
- Groundwater sampling
- Surface soil sampling

The field sampling will be conducted in accordance with the SOPs provided in Appendix C.

Laboratory Analysis and Data Validation

Laboratory analyses are described in Worksheet #17 (Sampling Design and Rationale). CH2M HILL will arrange for the analysis of environmental samples collected during the field investigation tasks. The analysis and validation process follows.

- Based on the proposed field activities, it is anticipated that the majority of groundwater, soil, sediment, and surface water samples will be submitted to a laboratory contracted through the USEPA's CLP or sent to the CRL for analyses. Special analyses will be contracted to an outside laboratory.
- The laboratory analyses will be performed in accordance with the SOPs provided in Appendix D.
- USEPA will perform the data validation on 100 percent of the chemical results from the CLP laboratory. CH2M HILL will perform the data validation of the non-CLP data collected. CH2M HILL staff will also process electronic data, perform data completeness and verification, and perform the data evaluation of the field QC results.
- A review of the data validation performed by USEPA will be conducted to assess the quality and defensibility of the data and to check the chain-of-custody forms. The CH2M HILL chemist will review the validated analytical results against the DQOs to determine whether the data are acceptable. The CH2M HILL chemist will also review the data validation technical memorandum completed by USEPA. To conduct a holistic review of the data set, additional data evaluation will be performed by subject matter and site experts.
- Upon completion, the data quality information will be summarized in a data validation report. This report will summarize the data validation findings, including evaluation of field QC samples, as well as provide the USEPA validation reports.

Data Evaluation

Data evaluation begins with the receipt of analytical data from the sample analysis task and ends with the generation of report-ready data tables. The following data will be uploaded to a database; electronic data deliverables (EDDs) of validated Supplemental RI data, EDDs of validated data from previous investigations (for example, RI and USEPA residential sampling) that will be used in the Supplemental RI (see Worksheet #13, Secondary Data Criteria and Limitations), and screening levels for each analyte by matrix. The database will be evaluated for completeness and quality by performing a review of the upload, reducing the data, and producing data summary tables that include a comparison of the data to screening levels.

Baseline Human Health Risk Assessment

An updated HHRA will be prepared for OU2, providing an evaluation of the potential current and future risks to human health posed by detected chemicals at the site in accordance with USEPA guidance for conducting HHRA. The detailed scope and overall approach for the HHRA will follow USEPA *Risk Assessment Guidance for Superfund, Part A*.

Analytical results for soil (surface and subsurface), groundwater, surface water, and sediment samples from previous investigations, including the RI as well as from the RI Addendum conducted in 2005 will be used in the assessment. Dividing the site into one onsite and two offsite exposure areas (Figure 10) will facilitate risk-based decisions. The division make-up is as follows:

- One Onsite Area (Exposure Area 2)—the area encompassing the entire onsite area
- Offsite Area 1 (Exposure Area 1)—the area encompassing the western offsite area, including the public housing area and grassy knoll located immediately to the west of the site and the western drainage ditch, downstream of Stormwater Outfall 001
- Offsite Area 2 (Exposure Area 3)—the area encompassing the eastern offsite area, including the triangular-shaped property immediately to the east of the site and the eastern drainage ditch, downstream of Stormwater Outfall 002

Each area will be evaluated separately in the HHRA. The following data will be used to evaluate the exposure areas. It is assumed that asbestos, if present, will not be evaluated in the HHRA. Laboratory data will be used; XRF data will not be used.

- **Soil:** The following groups of soil samples will be used in the HHRA:
  - 0 to 2 feet bgs—used to evaluate current trespasser scenarios
  - 0 to 10 feet bgs—used to evaluate future construction worker scenarios
  - Native soil below residue materials—used to evaluate future industrial worker scenarios
- **Groundwater:** The following groups of samples will be used to evaluate potable groundwater scenarios in the HHRA; the most recent two rounds of groundwater data will be used.
  - Shallow groundwater onsite—used to evaluate a hypothetical future scenario for industrial workers (note that water perched in the residue is not considered groundwater)
  - Shallow groundwater offsite—used to evaluate a current scenario for residents if offsite groundwater is impacted and private wells are identified within the area of impact
- **Surface water and sediment:** The following groups of samples will be evaluated in the HHRA:
  - Surface water onsite—all onsite surface water bodies grouped together
  - Surface water offsite—all offsite surface water bodes grouped together
  - Sediment onsite—all onsite sediment grouped together
  - Sediment offsite—all offsite sediment grouped together

Exposure Assessment

A conceptual exposure model (CEM) will be prepared for each exposure area—one onsite area, and two offsite areas; including sitewide groundwater and soil, sitewide sediment and surface water, offsite groundwater and soil, and offsite sediment and surface water. The following sections present the exposure settings and potential exposures scenarios that will be confirmed or modified after discussions with USEPA, and presented in USEPA's Risk Assessment Guidance for Superfund (RAGS) Part D, Table 1.

The current land use and receptor group to be addressed in the HHRA for each area will be vacant land (former industrial) for adolescent trespassers. The future land use and receptor groups to be addressed in the HHRA for each onsite area will be industrial land use for industrial workers and construction workers. At this time, it is expected that the following potential exposure pathways will be evaluated.

Soil

Under current land uses, site trespassers could be exposed to COPCs in surface soil or surface residues (0 to 2 feet bgs) through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/residue or dust in areas where soil/residue is exposed (i.e., not covered with asphalt or concrete). These potential current soil/residue exposure scenarios will be quantified for trespassers at exposure areas where COPCs are identified in surface soil/residue.

Under future land use, onsite construction workers could be exposed to COPCs in soil/residue that are situated at 0 to 10 feet bgs (termed "total soil"). Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/residue or dust by construction workers at exposure areas where COPCs are identified in total soil.

In the future, assuming that residues are removed from most areas of the site and consolidated into a specific area onsite, industrial workers could be exposed to COPCs in native soil currently situated immediately below residue (termed "native soil"). Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil or dust by industrial workers at exposure areas where COPCs are identified in native soil below residue.

Under both current and future land uses, offsite residents could be exposed to COPCs in surface soil (0 to 2 feet bgs). Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil or dust in areas where soil is exposed (i.e., not covered with asphalt or concrete). These potential exposure scenarios will be quantified for residents if COPCs are identified in offsite soil.

Under future land use, offsite construction workers could be exposed to COPCs in soil situated at 0 to 10 feet bgs. Potential exposure scenarios to be quantified are incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil or dust by construction workers at offsite exposure areas if COPCs are identified in total soil.

Groundwater

Offsite (current and future) groundwater exposures by residents will be evaluated in the HHRA because groundwater may be used as a potable resource within a 1-mile radius of the site. Although it is unlikely that site groundwater will be used as a drinking water source in the future, future potable use of onsite groundwater by industrial workers will be evaluated (for shallow groundwater and groundwater at all depths if groundwater is identified as Class I) since there is no deed restriction in place or local regulations preventing use of site groundwater. Groundwater ingestion, dermal contact, and inhalation exposures from potable use and showering exposures will be evaluated.

Surface Water and Sediment

The following groups of samples will be evaluated in the HHRA:

- Onsite—exposures by trespassers (surface water and sediment incidental ingestion and dermal contact)
  - Southwestern pond
  - Western drainage ditch
  - Eastern drainage ditch
  - Small southern pond
  - Two retention basins
- Offsite
  - Western drainage ditch—recreators (incidental ingestion and dermal contact)
  - Eastern drainage ditch—recreators (incidental ingestion and dermal contact), Lake Hillsboro surface water for potable use, and fish in Lake Hillsboro.

Ecological Risk Assessment

An ERSE was conducted as part of the RI in 2005. The ERSE concluded that the ecological risks were negligible and that there was no need for further action. A subsequent technical memorandum was prepared in 2005 to evaluate a future risk scenario involving disturbance of the residue piles. An addendum to the ERSE was prepared in 2006 to evaluate risks from the residue piles. Unacceptable risks were identified for extensive disturbance of the residue piles, when a fine fraction was deposited over previously undisturbed onsite areas.

New surface soil, sediment, and surface water data will be evaluated to determine if ecological risks identified in the ERSE, technical memorandum, and addendum to the ERSE are protective of ecological receptors (that is, negligible unless residue piles are disturbed). The problem formulation and assumptions presented in the ERSE will not be revised for this evaluation. Results from each of the surface soil, sediment, and surface water samples will be compared to ecological screening levels and compared to results and screening level exceedances from the previous reports. If additional potential risks are identified based on this comparison, further sampling may be necessary.

Reporting

This section summarizes the key deliverables that will be submitted following this UFP QAPP and the proposed field investigations defined herein.

HHRA Interim Deliverables

Two deliverables will be prepared in association with the HHRA:

- **Interim Deliverable:** Following discussions with USEPA, a preliminary CEM will be prepared for each exposure area to confirm the applicable media screening levels and realistic current and future exposure scenarios. RAGS Part D, Tables 1 through 6 (Appendix A; USEPA, 2001), and lead worksheets will be prepared after the proposed data have been collected, validated, and received. Analytical data will be grouped by exposure area. The interim deliverable will be provided for USEPA review before preparing the draft HHRA. This step is intended to reduce the number of iterations of risk calculations by obtaining USEPA concurrence on the data and assumptions to be used in the HHRA.
- **Baseline HHRA:** USEPA comments on the interim deliverable will be incorporated into the draft HHRA, and RAGS Part D, Tables 7 through 10, will be prepared along with HHRA text. The draft HHRA will be prepared and submitted to USEPA for review, and an in-person meeting will be held with USEPA to present the results of the HHRA. USEPA comments on the draft HHRA will be addressed, and the final HHRA will be prepared.

ERA Interim Deliverables

A draft technical memorandum will be submitted to USEPA that presents the following:

- Surface soil, sediment, and surface water results compared to ecological screening levels
- Results and screening level exceedances compared to those from the ERSE
- Text describing any potential risks in addition to those presented in previous reports
- Recommendations for further sampling, if necessary

USEPA comments on the draft technical memorandum will be addressed and the final technical memorandum will be prepared. If additional sampling is necessary, a Baseline Ecological Risk Assessment Work Plan may be necessary as part of the Supplemental RI. If not necessary, the contents of the technical memorandum will be included in the Supplemental RI report.

Supplemental Remedial Investigation Reports

A Supplemental RI Report will be developed for OU2 that establishes the site characteristics, such as contaminated media, extent of contamination, and the physical boundaries of the contamination. To accomplish this, only the amount of detailed data necessary to fill data gaps for the purpose of determining the nature and extent and fate and transport of contamination was proposed for field investigations. The contaminants of interest will be verified based on persistence and mobility in the environment and the degree of hazard. The tabulated data from previous investigations and the new data obtained from field investigations will be used as the basis for the Supplemental RI report. The human health and ecological interim deliverables described above will be incorporated into the HHRA and ERA included in the Supplemental RI reports.

Worksheet #15—Reference Limits and Evaluation

One of the primary goals of the project-specific quality assurance project plan (QAPP) is to select the appropriate analytical methods to achieve the method detection limits (MDLs) and/or reporting limits (RLs) in order to satisfy the overall project DQOs (as defined in Worksheet #10 [Problem Definition]). To determine whether the achievable MDLs and RLs will meet the analytical DQOs, the achievable MDLs and RLs have been compared to the project-specific screening levels, which were derived from the following sources:

- USEPA Regional Screening Levels, May 2010
- National Recommended Water Quality Criteria, USEPA, 2009
- USEPA Region 5 Ecological Screening Levels, 2003
- Ecological Soil Screening Levels (Eco-SSLs), USEPA 2005-2007
- Consensus-Based Sediment Quality Guidelines, WDNR, 2003

Tables 15-1 through 15-4 show that the achievable MDLs and the RLs for each listed target analyte will, in almost all cases, meet the analytical DQOs. If the achievable MDL (which represents half of the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual method detection limits from the Central Regional Laboratory or an outside lab to be selected) is below the screening criterion, the achievable MDL and/or the RL are sufficient for quantitative use in the risk assessment. The MDL will be used to evaluate project objectives in the event that the RL exceeds the screening criterion. In addition, other constituent-specific factors (potential use at the site, mobility, and toxicity) may be discussed and included in the risk assessment on a more qualitative basis.

Note that sample dilution due to target and/or non-target analyte concentrations or matrix interference may prevent RLs from being achieved. All samples must be initially analyzed undiluted when reasonable. If a dilution is necessary, deliver both the original and diluted result. Appropriate cleanup procedures must be followed to minimize the matrix effects on the RLs. If the screening level objective cannot be met with the best, commonly-used analytical technology available in laboratories, the sample-specific RL may be used to show compliance with the screening level objective.

Analytes for which screening objectives will not be met are indicated with a “no” in the appropriate column and are summarized below.

Achievable Reporting Limits/Method Detection Limits Greater than Screening Levels

Soil

Achievable RLs and MDLs, as well as human health and ecological screening levels for soil are presented in Table 15-1. With the exception of arsenic, the achievable MDLs and RLs for each listed target compound are all below the human health soil screening levels.

Although the achievable MDL and RL of arsenic exceed the human health sediment screening level, arsenic is ubiquitous in the environment and is expected to be detected in soil at concentrations above its achievable MDL/RL. Therefore, the achievable MDL and RL established for arsenic is considered sufficient for quantitative use in the risk assessment.

The achievable RL of cadmium is also expected to be detected in soil at concentrations above the achievable RL due to its somewhat ubiquitous nature in the environment. Therefore, the achievable RL is considered sufficient for quantitative use in the risk assessment.

Sediment

Achievable RLs and MDLs, along with human health and ecological screening levels for sediment are presented in Table 15-2. The achievable MDL and RL of arsenic exceed the human health sediment screening level. Although the achievable MDL and RL of arsenic exceeds the human health sediment screening level, arsenic is ubiquitous in the environment and is expected to be detected in sediment at concentrations above its achievable MDL/RL. Therefore, the achievable MDL and RL established for arsenic is considered sufficient for quantitative use in the risk assessment.

Surface Water

Achievable RLs, achievable MDLs, and human health and ecological screening levels for surface water are presented in Table 15-3. The achievable MDL of arsenic exceeds the human health surface water screening level. The achievable MDLs of cadmium and copper and the RL of cadmium exceed their respective ecological surface water screening levels. However, these detection/quantification limits are established based on the lowest detection levels achievable using the current best available technology. Therefore, the achievable MDLs and RLs of these analytes are considered to be adequate.

Groundwater

Achievable RLs, achievable MDLs, and human health screening levels for groundwater are presented in Table 15-4.

Although the achievable MDL of arsenic exceeds the human health groundwater screening levels, the detection/quantification limits are established based on the lowest detection levels achievable using the current best available technology. Therefore, the achievable MDL of this analyte is considered adequate.

TABLE 15-1
Soil Achievable Reporting Limits, Achievable Method Detection Limits, Ecological and Human Health Screening Levels

				Project Action Levels[1]									
Method	Analyte	CAS Number	Units	Ecological Screening Level	Human Health Screening Level	Achievable Reporting Limit[2]	Achievable Method Detection Limit[3]	Achievable Reporting Limit < Ecological SL	Achievable Method Detection Limit < Ecological SL	Achievable Reporting Limit < HHRA SL	Achievable Method Detection Limit < HHRA SL	Ecological SL Reference[4]	HHRA SL Reference[5]
ILM05.4	Arsenic	7440-38-2	mg/kg	18	0.39	1	0.5	yes	yes	no	no	EPA 2005a	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Cadmium	7440-43-9	mg/kg	0.36	7	0.5	0.25	no	yes	yes	yes	EPA 2005b	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Copper	7440-50-8	mg/kg	28	310	2.5	1.25	yes	yes	yes	yes	EPA 2007a	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Lead	7439-92-1	mg/kg	11	400	1	0.5	yes	yes	yes	yes	EPA 2005c	EPA Residential Soil RSL (EPA, 2010)
ILM05.4	Manganese	7439-96-5	mg/kg	220	2300	1.5	0.75	yes	yes	yes	yes	EPA 2007b	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Zinc	7440-66-6	mg/kg	6.62	2300	6	3	yes	yes	yes	yes	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)

Notes:

[1] Project Action Levels represent the screening levels required for initial ecological and human health risk screening assessments.

[2] Achievable reporting limits represent the contract-required detection limit or contract-required quantitation limits from the USEPA Contract Laboratory Program or actual reporting limits from the Central Regional Laboratory.

[3] Achievable method detection limits represent half of the contract-required detection limit or contract-required quantitation limits from the USEPA Contract Laboratory Program or actual method detection limits from the Central Regional Laboratory.

[4] Eco-SSLs are the lowest available from any receptor (plants, invertebrates, mammals, or birds)

[5] Regional Screening Levels (RSLs) based on non-carcinogenic health effects are adjusted using HQ=0.1.

References:

EPA 2003. Region 5 RCRA Corrective Action Ecological Screening Levels. Available at http://www.epa.gov/reg5rcra/ca/edql.

EPA 2005a. Ecological Soil Screening Levels for Arsenic. Office of Solid Waste and Emergency Response. Available at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

EPA 2005b. Ecological Soil Screening Levels for Cadmium. Office of Solid Waste and Emergency Response. Available at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

EPA 2005c. Ecological Soil Screening Levels for Lead. Office of Solid Waste and Emergency Response. Available at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

EPA 2007a. Ecological Soil Screening Levels for Cadmium. Office of Solid Waste and Emergency Response. Available at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

EPA 2007b. Ecological Soil Screening Levels for Manganese. Office of Solid Waste and Emergency Response. Available at http://www.epa.gov/oswer/riskassessment/ecorisk/ecossl.htm

EPA. 2010. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. May 2010.

Eco-SSL - Ecological Soil Screening Level
NA - Screening level not available, screening level comparison not applicable
HHRA - Human Health Risk Assessment
mg/kg - milligrams per kilograms
SL - Screening Level
RL - Reporting Limit

TABLE 15-2
Sediment Achievable Reporting Limits, Achievable Method Detection Limits, Ecological and Human Health Screening Levels

				Project Action Levels [1]									
Method	Analyte	CAS Number	Units	Ecological Screening Level	Human Health Screening Level	Achievable Reporting Limit [2]	Achievable Method Detection Limit [3]	Achievable Reporting Limit < Ecological SL	Achievable Method Detection Limit < Ecological SL	Achievable Reporting Limit < HHRA SL	Achievable Method Detection Limit < HHRA SL	Ecological SL Reference	HHRA SL Reference [4]
ILM05.4	Arsenic	7440-38-2	mg/kg	9.79	0.39	1	0.5	yes	yes	no	no	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Cadmium	7440-43-9	mg/kg	0.99	7	0.5	0.25	yes	yes	yes	yes	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Copper	7440-50-8	mg/kg	31.6	310	2.5	1.25	yes	yes	yes	yes	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Lead	7439-92-1	mg/kg	35.8	400	1	0.5	yes	yes	yes	yes	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (EPA, 2010)
ILM05.4	Manganese	7439-96-5	mg/kg	460	180	1.5	0.75	yes	yes	yes	yes	WDNR, 2003	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Zinc	7440-66-6	mg/kg	121	2300	6	3	yes	yes	yes	yes	ESL (EPA Region 5, 2003)	EPA Residential Soil RSL (ELCR = $1x10^{-6}$ or HQ=0.1) (EPA, 2010)

Notes:

[1] Project Action Levels represent the screening levels required for initial ecological and human health risk screening assessments.

[2] Achievable reporting limits represent the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual reporting limits from the Central Regional Laboratory.

[3] Achievable method detection limits represent half of the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual method detection limits from the Central Regional Laboratory.

[4] Regional Screening Levels (RSLs) based on non-carcinogenic health effects are adjusted using HQ=0.1.

There are no Project Action Levels for TOC.

The Project Action Level for AVS/SEM Metals is 130 umol/g OC.

HHRA - Human Health Risk Assessment

mg/kg - milligrams per kilograms

SL - Screening Level

RL - Reporting Limit

References:

EPA 2003. Region 5 RCRA Corrective Action Ecological Screening Levels. Available at http://www.epa.gov/reg5rcra/ca/edql.

EPA. 2010. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. May 2010.

WDNR, 2003. Consensus-Based Sediment Quality Guidelines, Recommendations for Use and Applications. WT-732-2003

TABLE 15-3
Surface Water Achievable Reporting Limits, Achievable Method Detection Limits, Ecological and Human Health Screening Levels

Method	Analyte	CAS Number	Units	Ecological Screening Level	Human Health Screening Level	Reporting Limit	Estimated Method Detection Limit	RL < Ecological SL	EMDL < Ecological SL	RL < HHRA SL	EMDL < HHRA SL	Ecological SL Reference	HHRS SL Reference (1)
ILM05.4	Arsenic	7440-38-2	mg/L	0.148	0.000018	0.001	0.0005	yes	yes	no	no	NRWQC (EPA 2009)	NRWQC (EPA, 2009)
ILM05.4	Cadmium	7440-43-9	mg/L	0.00015	0.0018	0.001	0.0005	no	no	yes	yes	NRWQC (EPA 2009)	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Copper	7440-50-8	mg/L	0.00158	0.15	0.002	0.001	no	yes	yes	yes	NRWQC (EPA 2009)	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Lead	7439-92-1	mg/L	0.00117	0.0075	0.001	0.0005	yes	yes	yes	yes	NRWQC (EPA 2009)	IEPA Class 1 Groundwater Standard
ILM05.4	Manganese	7439-96-5	mg/L	NA	0.05	0.015	0.0075	NA	NA	yes	yes	NA	NRWQC (EPA, 2009)
ILM05.4	Zinc	7440-66-6	mg/L	0.0657	1.1	0.06	0.03	yes	yes	yes	yes	NRWQC (EPA 2009)	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)

Notes:

[1] Project Action Levels represent the screening levels required for initial ecological and human health risk screening assessments.

[2] Achievable reporting limits represent the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual reporting limits from the Central Regional Laboratory.

[3] Achievable method detection limits represent half of the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual method detection limits from the Central Regional Laboratory.

[4] The lower of RSL Tapwater value (HQ=0.1) and NRWQC (ingestion of water + organisms) is used as HHRA SL.

NA - Screening level not available, screening level comparison not applicable

HHRA - Human Health Risk Assessment

mg/L - milligrams per liter

SL - Screening Level

RL - Reporting Limit

References:

EPA. 2009. National Recommended Water Quality Criteria. Available on-line: http://www.epa.gov/waterscience/criteria/wqctable/

EPA. 2010. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. May 2010.

TABLE 15-4
Groundwater Achievable Reporting Limits, Achievable Method Detection Limits, and Human Health Screening Levels

Method	Analyte	CAS Number	Units	Project Action Levels[1] (Human Health Screening Level)	Achievable Reporting Limit[2]	Achievable Method Detection Limit[3]	Achievable Reporting Limit < HHRA SL	Achievable Method Detection Limit < HHRA SL	HHRA SL Reference[4]
ILM05.4	Arsenic	7440-38-2	mg/L	0.000045	0.001	0.0005	no	no	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Cadmium	7440-43-9	mg/L	0.0018	0.001	0.0005	yes	yes	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Copper	7440-50-8	mg/L	0.15	0.002	0.001	yes	yes	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Lead	7439-92-1	mg/L	0.0075	0.001	0.0005	yes	yes	IEPA Class 1 Groundwater Standard
ILM05.4	Manganese	7439-96-5	mg/L	0.088	0.015	0.0075	yes	yes	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)
ILM05.4	Zinc	7440-66-6	mg/L	1.1	0.06	0.03	yes	yes	EPA Tapwater RSL (ELCR=$1x10^{-6}$ or HQ=0.1) (EPA, 2010)

Notes:

[1] Project Action Levels represent the screening levels required for the initial human health risk screening assessment.

[2] Achievable reporting limits represent the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual reporting limits from the Central Regional Laboratory.

[3] Achievable method detection limits represent half of the contract required detection limit or contract required quantitation limits from the USEPA Contract Laboratory Program or actual method detection limits from the Central Regional Laboratory.

[4] RSLs based on non-carcinogenic health effects are adjusted using HQ=0.1.

NA - Screening level not available, screening level comparison not applicable

HHRA - Human Health Risk Assessment

mg/L - milligrams per liter

SL - Screening Level

RL - Reporting Limit

References:

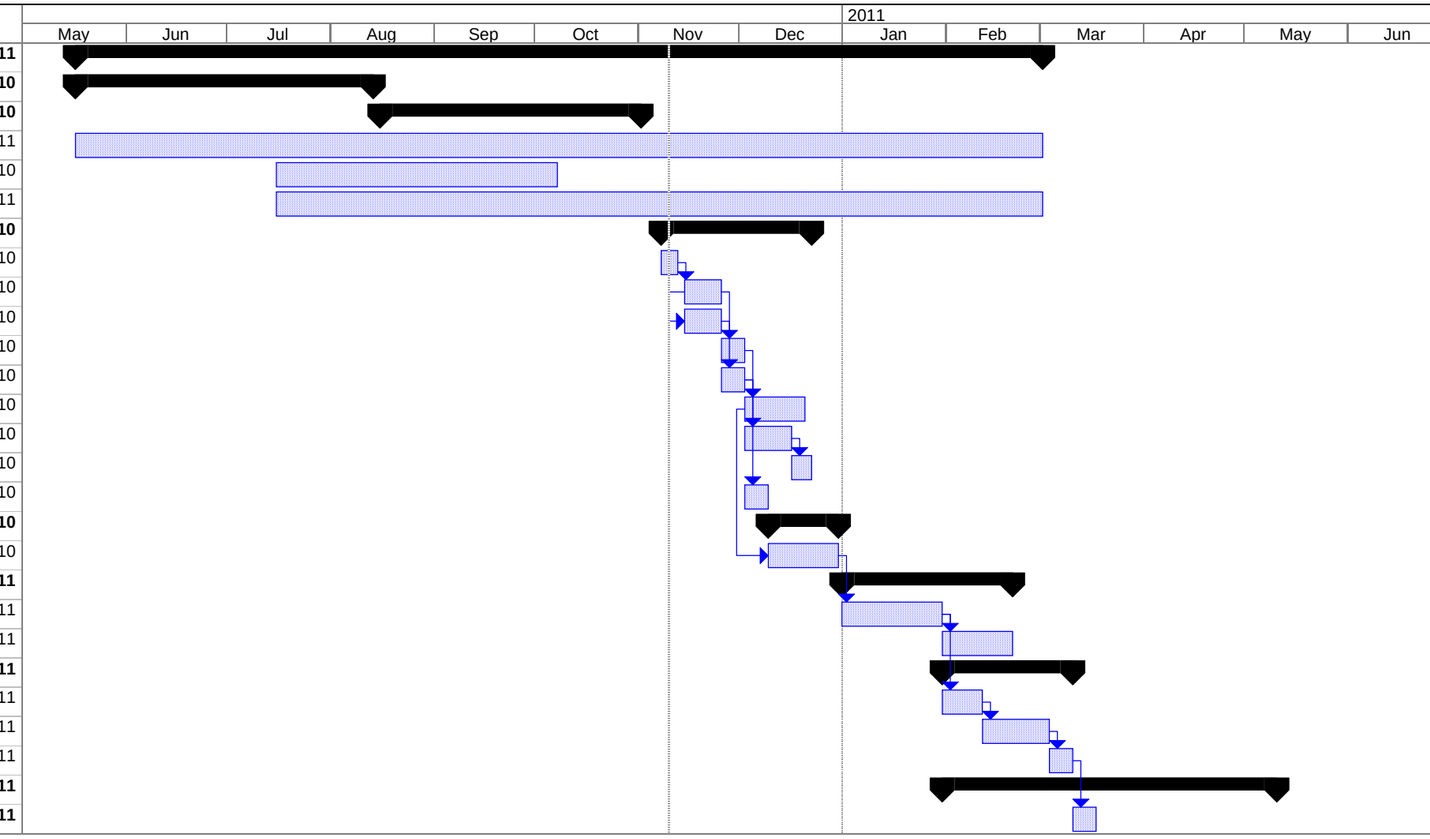
EPA. 2010. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. May 2010.

Worksheet #16—Project Schedule

The project schedule is shown on the following page.

Figure 1 - Project Schedule
Eagle Zinc Superfund Site, Hillsboro, Illinois

ID	Task Name	Start	Finish
1	**Task 1 - Project Planning and Support**	**Mon 5/17/10**	**Tue 3/1/11**
2	**Subtask 1.1 - Work Plan**	**Mon 5/17/10**	**Fri 8/13/10**
8	**Subtask 1.2 - Site-Specific Plans**	**Mon 8/16/10**	**Mon 11/1/10**
13	**Subtask 1.4 - Project Management and Reporting**	Mon 5/17/10	Tue 3/1/11
14	**Subtask 1.5 - Subcontractor Procurement and Support Activities**	Fri 7/16/10	Thu 10/7/10
15	**Task 2 - Community Involvement**	Fri 7/16/10	Tue 3/1/11
16	**Task 3 - Field Investigation/Data Acquisition**	**Mon 11/8/10**	**Wed 12/22/10**
17	Mobilization	Mon 11/8/10	Fri 11/12/10
18	Installation of monitoring wells Sonic drilling (10-day shift)	Mon 11/15/10	Thu 11/25/10
19	DPT of soil borings (10-day shift)	Mon 11/15/10	Thu 11/25/10
20	Surface soil sampling	Fri 11/26/10	Thu 12/2/10
21	develop MWs	Fri 11/26/10	Thu 12/2/10
22	Surface Water & Sediment Sampling	Fri 12/3/10	Mon 12/20/10
23	Groundwater sampling	Fri 12/3/10	Thu 12/16/10
24	Slug testing of new MWs	Fri 12/17/10	Wed 12/22/10
25	Survey	Fri 12/3/10	Thu 12/9/10
26	**Task 4 - Sample Analysis**	**Thu 12/9/10**	**Thu 12/30/10**
27	analysis	Thu 12/9/10	Thu 12/30/10
28	**Task 5 - Analytical Support and Data Validation**	**Fri 12/31/10**	**Sun 2/20/11**
29	OU2 - Analytical Support & Data Validation	Fri 12/31/10	Sun 1/30/11
30	Data Validation Letter Report	Sun 1/30/11	Sun 2/20/11
31	**Task 6 - Data Evaluation**	**Mon 1/31/11**	**Thu 3/10/11**
32	OU2	Mon 1/31/11	Fri 2/11/11
33	USEPA Review of Recommendations	Fri 2/11/11	Thu 3/3/11
34	Prepare and Submit Revised Recommendations	Thu 3/3/11	Thu 3/10/11
35	**Task 7 - Risk Assessment**	**Sun 1/30/11**	**Tue 5/10/11**
39	**Task 15 - Work Assignment Closeout**	**Fri 3/11/11**	**Thu 3/17/11**



Project: WA 069 Scheduler_rev_09-17
Date: Wed 11/10/10

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Worksheet #17—Sampling Design and Rationale

This worksheet describes the field investigation activities planned for the Supplemental RI/FS to fill data gaps identified during work planning. The field activities will be conducted according to the field SOPs provided in Appendix C. The number of samples and the analytical parameters planned are summarized in Worksheet #18 (Sampling Locations and Methods/SOP Requirements).

Groundwater Investigation

Hydrogeological investigations will be conducted to fill the groundwater data gaps defined in Table 10-1, Worksheet #10 (Problem Definition). Ten new monitoring wells will be installed, developed, and sampled. Twenty-six existing monitoring wells will also be sampled. Two existing monitoring wells (MW-2 and MW-3) that are damaged will be abandoned and two replacement monitoring wells will be installed. At the end of field data collection activities, new monitoring wells will be surveyed for location and elevation. Existing monitoring wells will need to be redeveloped and sampled; newly installed monitoring wells will also be developed and sampled. Proposed sample locations for new monitoring wells are presented in Figure 11. The various sampling locations are defined in Worksheet #18.

Monitoring Well Installation

The anticipated activities for the monitoring well installation are based on 10-hour days and involve the following:

- Advance and continuously log 10 borings within and beneath the slag piles to maximum depths of 60 feet bgs and install 2-inch–inside-diameter monitoring wells. Advance and continuously log 2 borings within and beneath the slag piles to maximum depths of 30 feet bgs and install 2-inch-inside-diameter monitoring wells. The boring and well installation will be conducted by a two-person field team.
- Develop existing wells and newly installed monitoring wells. Development will be conducted by a two-person field team.
- Oversee survey of new monitoring wells. One person will be onsite to oversee the surveying subcontractor.

Groundwater Sampling

The following field activities will be performed for the groundwater sampling:

- Collect water levels and groundwater samples from 38 monitoring well locations (26 existing monitoring wells, 10 new monitoring wells, and 2 replacement monitoring wells) for analysis of site-specific metals (arsenic, cadmium, copper, lead, manganese, and zinc), total and dissolved.

- Develop potentiometric surface maps of the groundwater using water levels collected.
- Perform in situ hydraulic testing (i.e., slug tests) at the 10 new monitoring well locations. Slug tests will be conducted by a two-person field team.

Surface and Subsurface Residue and Soil Investigations

The surface and subsurface residue and soil investigations will be conducted using a direct-push technology (DPT) drill rig or during monitoring well installation (as described above).

Residue and soil samples will be collected, as defined below, to fill surface and subsurface soil data gaps for the purpose of defining nature and extent of contamination and assessing potential human health risks. Surface soil data for ecological investigations are discussed separately in the ecological investigations section below. Surface and subsurface soil sampling locations are defined in Worksheet #18 and shown in Figure 12. A handheld global positioning system (GPS) unit will be used to navigate to the soil sampling locations shown on Figure 12. If a location requires adjustment, the coordinates of the adjusted location will be determined using a handheld GPS unit and the reason for the adjustment will be documented in the field logbook.

Residue Sampling and Subsurface Soil Sampling

Further evaluation is necessary in order to delineate the existing onsite residue. The following field activities will be performed:

- Thirty-one residue samples and 31 co-located subsurface soil samples will be collected from 31 borings advanced using DPT within the areas of residue between the formerly identified residue piles (Figure 12).
- All residue samples will be collected from 0 to 12 inches and submitted and analyzed for pH. Depending on the pH results, either SPLP (pH of 4) or TCLP metals (pH of 2) will be analyzed. Up to 10 of the residue samples will also be submitted and analyzed for site-specific metals (arsenic, cadmium, copper, lead, manganese, and zinc). The SPLP or TCLP metals analyses will support the identification of residue that could leach and affect either groundwater or surface water.
- All subsurface soil samples will be collected 1 foot beneath the residue and will be analyzed for site-specific metals (arsenic, cadmium, copper, lead, manganese, and zinc), and lead will be analyzed by 250 micron sieve analysis to support human health evaluations. Three of the subsurface soil samples will also be analyzed for TCLP metals. Boreholes will be logged continuously during drilling.

County Housing Soil Sampling

Soil borings will be collected in the County Housing area, which is a residential area northwest of the site, to determine if residue is present in this area. Data will be used to assess potential risks to human receptors and to determine whether this area will need to be included as part of the overall remedy. The following field activities will be performed:

- A total of six soil borings will be completed in this area (Figure 12). A total of three soil samples will be collected from each boring location.

- All soil samples will be analyzed for site-specific metals (arsenic, cadmium, copper, lead, manganese, and zinc), and lead will be analyzed by 250 micron sieve analysis to support human health evaluations.
- Borings will be advanced to 10 feet bgs using DPT and logged continuously during drilling to assess the presence or absence of residue material.

Triangular Property across Industrial Drive Soil Sampling

Up to three soil borings will be completed in the property located across Industrial Drive that is owned by Eagle Pitcher (Figure 12). The property has not been investigated in the past and may have been impacted by site operations. The following field activities will be performed:

- Up to three samples per soil boring will be collected for analysis.
- All soil samples will be submitted for site-specific metals (arsenic, cadmium, copper, lead, manganese, and zinc), and lead will be analyzed by 250 micron sieve analysis to support human health evaluations.
- Borings will be advanced to 10 feet bgs using DPT and logged continuously during drilling to assess the presence or absence of residue material.

Surface Soil Sampling

Based on a review of existing data, there are potential source areas that were either not investigated or not fully delineated during the RI. During the site visit, CH2M HILL interviewed a long-time employee of Eagle Zinc; based on the site walk and on that interview, the following two additional areas of concern are proposed to be investigated:

- Northeast area with dead trees
- Former lead hopper

Surface soil samples will be collected from 0 to 2 feet bgs. Up to eight surface soil samples are proposed to be collected in the northeast area, and two surface soil samples are proposed to be collected in the area of the former lead hopper (Figure 12). In addition, a total of three surface soil samples will be collected from drainage areas in the County Housing located adjacent to the northwest portion of the site. All samples will be collected within a 2-day period by a 2-person field team, using a hand auger.

Sediment and Surface Water Investigations

Sediment and surface water investigations will be conducted by a two-person field team. Surface water and sediment sampling in the ponds will require use of a small boat.

A total of 21 sediment samples and 21 surface water samples will be collected from waterways and ponds (Figure 13). The surface water and sediment data will be used to assess potential effects of contamination on human receptors and are needed to determine if the current conditions in the ponds and waterways differ from those described in the previous RI. Data collection points of sediment and surface water sample locations will be located using a hand-held GPS unit.

The anticipated activities involve the following:

- Co-located sediment and surface water samples will be collected from the former cooling water pond in the southwest portion of the site. Three samples will be collected in the pond and one each at the inlet and outlet waterways. Previous co-located sediment and surface water samples will also be collected at five locations in the southeast (SD-WD-6, SD-WD-7, SD-WD-8, SD-WD-9, and SD-WD-10). Sediment will be collected from 0 to 6 inches and analyzed for site-specific metals, total organic compounds (TOC), grain size, and AVS/SEM. Surface water will be collected from the surface of the waterway and analyzed for site-specific metals (total and dissolved).

- To evaluate current conditions, co-located sediment and surface water samples will be collected from the stream that discharges to Lake Hillsboro. Samples will be collected at two locations (SD-ED-13 and SD-ED-16). Both locations showed elevated zinc or cadmium levels in the original sampling; however, the City recently dredged the creek along the northern portion of the property, and conditions may have changed. Sediment will be collected from 0 to 6 inches and analyzed for site-specific metals, TOC, grain size, and AVS/SEM. Surface water will be collected from the surface of the waterway and analyzed for site-specific metals (total and dissolved), pH measurements will be collected using a field instrument and hardness will be calculated based on metal detections.

- Sediment and surface water samples will be collected from the two settling ponds onsite. A total of five sediment and surface water samples will be collected from the onsite settling ponds. In addition, co-located sediment and surface water samples will be collected from two former locations in the stream that discharges to Lake Hillsboro. Sediment samples collected from 0 to 6 inches will be analyzed for site-specific metals, AVS/SEM, TOC, and grain size. Surface water in the settling ponds will be analyzed for site-specific metals (total and dissolved). pH measurements will be collected using a field instrument and hardness will be calculated based on metal detections..

- Sediment and surface water samples will be collected from the pond located in the southeast portion of the site. A total of two co-located sediment and surface water samples will be collected from the pond. Sediment samples collected from 0 to 6 inches will be analyzed for site-specific metals, AVS/SEM, TOC, and grain size. Surface water in the settling ponds will be analyzed for site-specific metals (total and dissolved), pH measurements will be collected using a field instrument and hardness will be calculated based on metal detections.

- Two sediment and surface water samples (if present) will be collected in the onsite underground culvert. Sediment samples collected from 0 to 6 inches will be analyzed for site-specific metals, AVS/SEM, TOC, and grain size. Surface water in the settling ponds will be analyzed for site-specific metals (total and dissolved), pH measurements will be collected using a field instrument and hardness will be calculated based on metal detections..

Concrete Slab Investigation

Based on direction from the USEPA on August 31, 2010, concrete slab and building materials (including concrete and bricks) sampling has been added to the sampling scope of work. Currently it is unknown if site-specific metals have contaminated the remaining onsite building slabs. The buildings remaining onsite are in various stages of disrepair and will be demolished as part of a separate work assignment with the USEPA. In order to determine if the remaining building slabs and building materials are contaminated, concrete core samples and building material samples will be collected from the slabs and building materials during the Supplemental RI field investigation activities. Up to 40 concrete core samples and 30 building material samples will be collected and submitted for the analysis of site specific metals and also for TCLP. Proposed locations for the concrete core samples are presented in Figure 14. The building material samples will be field determined. Actual locations will be adjusted based on field conditions and safety of buildings to be entered. Data collection points of concrete slab sample locations will be located using a hand-held GPS unit.

Surveying

All newly installed monitoring wells will be surveyed by an Illinois licensed surveyor. The vertical elevations of the north side of the top of each monitoring well casing, the ground surface, and the horizontal coordinates (northings and eastings) of the center of each well vault will be surveyed relative to North American Vertical Datum (NAVD) 88. Soil borings, surface soil, sediment, surface water, and concrete slab locations will be located using a field GPS.

Investigation-Derived Waste Characterization and Disposal

An estimated forty 55-gallon drums each of soil and aqueous investigation-derived waste (IDW) will be generated during field investigations. IDW will be characterized and disposed of in accordance with local, state, and federal regulations as specified in Appendix B, Site Management Plan. It is assumed that the IDW subcontractor will provide sample containers for the waste characterization and that that the IDW is characteristic of non-hazardous waste. CH2M HILL will collect the characterization samples and the samples will be analyzed before offsite disposal.

Worksheet #18—Sampling Locations and Methods/SOP Requirements

The following table summarizes the sampling media, number of samples to be collected, analytical parameters, and the rationale for sampling locations described in Worksheet #17 (Sampling Design and Rationale).

Sampling Locations	General Location Description	Data Gap	Media	Depth	Analysis[1]	Number of Samples[2]	Field SOP Reference[3]	Rationale for Sampling
Groundwater and Subsurface Geochemistry Investigations (Figure 10)								
MW-1, MW-4 through MW-11, P-01 through P-06, G-101 through G-107 and G-109, and TW-5 through TW-7	Redevelop and sample 26 existing onsite wells.	Lateral extent of groundwater contamination not delineated.	Groundwater	11 feet bgs (MW-4) to 30 feet bgs (TW-6)	Site specific metals (total and dissolved)	26	SOP-06 SOP-07 SOP-08	Assess current groundwater contamination onsite. Verify accuracy of historic data, verify current conditions of these wells and assess changes, if any, in groundwater quality to evaluate fate and transport of contamination.
MW-12 (near G-109) MW-13 (near TW-6) MW-14 (near MW-2) MW-15 (near MW-3) MW-16 (near MW-6) MW-17 (near MW-11) MW-18 (near G-106) MW-19 (near G-107) MW-20 (near G-102) MW-21 (near G-104) MW-22 (replacing MW-2) MW-23 (replacing MW-3)	Install and sample 10 new deeper wells adjacent to existing wells MW-2, MW-3, MW-6, MW-11, G-102, G-104, G-106, G-107, G-109, and TW-6, screened up to 45 feet deeper than the existing wells. Install and sample 2 new replacement wells.	Vertical extent of groundwater contamination not delineated.	Groundwater	60 feet bgs (10 new wells) 30 feet bgs (replacement wells)	Site specific metals (total and dissolved)	12	SOP-04 through -08	Assess vertical gradients and vertical extent of groundwater contamination; assess geochemical conditions in monitoring well boreholes.
MW-12 through MW-21	Perform in situ hydraulic tests on the 10 newly installed monitoring wells	Groundwater flow rate in mid-depth and deep zones not defined.	Groundwater	N/A	None	N/A	SOP-16	Assess aquifer property to evaluate groundwater flow velocity in the mid-depth and deep zone onsite.
Surface and Subsurface Soil Investigations (Figure 11)								
RS-1 through RS-31	Collect 31 co-located residue and subsurface soil samples for chemical analysis from the site.	Exposure area not delineated.	Residue/surface soil (Note surface residue samples will be collect below the upper crusted layer, if it exists)	0 to 1 feet bgs	pH SPLP or TCLP[5] Site specific metals	31 31 10	SOP-03, SOP-04, SOP-09	Evaluate the potential for residue across the site to leach to groundwater. Evaluate concentrations of metals in residue in support of risk assessment.
RSB-1 through RSB-31	Collect 31 co-located residue and subsurface soil samples for chemical analysis from the site. Advance each boring to up to 30 feet bgs depending on residue thickness to assess the presence or absence of residue material.	Subsurface soil characteristics not fully delineated.	Subsurface soil	Will vary upon residue thickness; sample will be collected 1 to 2 feet below the residue	Site-specific metals, sieve analysis for lead	31	SOP-03, SOP-04, SOP-09	Subsurface soil geochemistry and contamination has not been adequately characterized at the site.

Sampling Locations	General Location Description	Data Gap	Media	Depth	Analysis[1]	Number of Samples[2]	Field SOP Reference[3]	Rationale for Sampling
SB-1 through SB-6	Collect 18 subsurface soil samples (3 soil samples from 6 boring locations) from the County Housing northwest of the site. Advance each boring to 10 feet bgs to assess the presence or absence of the residue material.	Subsurface soil characteristics not fully delineated.	Subsurface soil	0-10 feet bgs collect a surface soil and 2 sub surface soil samples. Depth for subsurface will be determined based on field conditions	Site-specific metals, sieve analysis for lead	18	SOP-03, SOP-04, SOP-09	Data will be used to assess potential risks to human receptors and to determine whether this area will need to be included as part of the overall remedy
SB-7 through SB-9	Collect 9 subsurface soil samples (3 soil samples from 3 boring locations) from the triangular property across Industrial Drive. Advance each boring to 10 feet bgs to assess the presence or absence of the residue material.	Subsurface soil characteristics not fully delineated.	Subsurface soil	0-10 feet bgs collect a surface soil and 2 sub surface soil samples. Depth for subsurface will be determined based on field conditions	Site-specific metals, sieve analysis for lead	9	SOP-03, SOP-04, SOP-09	The property has not been investigated in the past and may have been impacted by site operations.
SS-1 through SS-13	Collect 13 surface soil samples from three locations defined as potential localized source areas based on existing data.	Potential localized source areas are not fully characterized.	Surface soil	0 to 2 feet bgs	Site-specific metals, sieve analysis for lead	13	SOP-03, SOP-04, SOP-09	Delineate extent of contamination.
Sediment and Surface Water Investigations (Figure 12)								
SD-WD-06 through SD-WD-10, SD-WD-17 through SD-WD-23, SD-ED-13, SD-ED-16, SD-ED-24 through SD-ED-30	Collect 21 co-located sediment samples and surface water samples from four locations.	Impact of onsite surface water on human receptors and environmental condition assessment.	Surface water	Collect surface water at depth	Site-specific metals (total and dissolved), pH, and hardness	21	SOP-11	The surface water and sediment data will be used to assess potential effects of contamination on human receptors and are needed to determine if the current conditions in the ponds and waterways differ from those described in the previous RI.
SD-WD-06 through SD-WD-10, SD-WD-17 through SD-WD-23, SD-ED-13, SD-ED-16, SD-ED-24 through SD-ED-30	Collect 21 co-located sediment samples and surface water samples from four locations.	Impact of onsite sediment on human receptors and environmental condition assessment.	Sediment	0 to 6 inches	Site-specific metals, TOC, grain size, and AVS/SEM	21	SOP-11	The surface water and sediment data will be used to assess potential effects of contamination on human receptors and are needed to determine if the current conditions in the ponds and waterways differ from those described in the previous RI.
Concrete Slab and Building Material Investigations (Figure 13)								
CCS-1 through CCS-40 BCS-1 through BCS-30	Collect up to 40 concrete core samples from building slabs across the site. Collect up to 30 building material samples from the bricks and concrete across the site.	Impact of site specific metals on concrete slabs and building materials.	Concrete Building Materials	Width of concrete slab or building material	Site-specific metals, TCLP	40 30	SOP-10	The concrete analytical data will be used to assess need to include the demolition of the concrete slabs along with the buildings as well as support the waste characterization needs for disposal of the concrete.

Notes:

[1] Site-specific metals (total and dissolved) includes arsenic, cadmium, copper, lead, manganese, and zinc.
[2] Sample count does not include quality control samples. Refer to Worksheet #20 for the field quality control sample summary.
[3] Refer to the Project Sampling SOP References table (Worksheet #21).
[4] Residue samples will be analyzed for either SPLP or TCLP depending on pH.

Worksheet #19—Analytical SOP Requirements

This worksheet summarizes the analytical methods for each sampling matrix, including the required sample volume, containers, preservation, and holding time requirements. The analytical SOPs are provided in Appendix D of this QAPP.

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	250-micron sieve lead [Subcontract Lab]	Low	SW6010C/6020	50 grams	(1) 4-oz. glass jar w/Teflon lined cap	None	180 days
Soil/Residue/ Concrete	Site specific Metals[2] [Subcontract Lab]	Low	SW6010C/6020	50 grams	(1) 4-oz. glass jar w/Teflon lined cap	None	180 days
Sediment	Grain Size [Subcontract Lab]	Low	ASTM D-422	500 grams	Plastic Bag	None	None
Sediment	Site specific Metals[2] [CLP]	Low	ILM05.4	25 grams	(1) 8-oz. glass jar w/Teflon lined cap	Cool to 4°C	180 days
Sediment	AVS/SEM metals [Subcontract Lab]	Low	EPA 821 R9-100	250 grams	(1) 8-oz. glass jar w/Teflon lined cap	Cool to 4°C	180 days
Sediment	TOC [Subcontract Lab]	Low	Lloyd-Kahn	50 grams	(1) 8-oz. glass jar w/Teflon lined cap	Cool to 4°C	28 days
Residue	SPLP Metals [Subcontract Lab]	Low	SW1312/6010C/ 6020	50 grams	(1) 4-oz. glass jar w/Teflon lined cap	None	180 days

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)
Concrete/building materials	TCLP Metals [Subcontract Lab]	Low	SW1311/6010C/ 6020	50 grams	(1) 4-oz. glass jar w/Teflon lined cap	None	180 days
Groundwater/ Surface Water	Site specific Metals[2] (total and dissolved) [CLP]	Low	ILM05.4	250 ml	(1) 1-liter HDPE	HNO_3 to pH<2; cool to 4°C	180 days

Notes:
[1] The Analytical SOP References are found in Worksheet #23.
[2] Site-specific metals include arsenic, cadmium, copper, lead, manganese, and zinc.

CLP = Contract laboratory program
AVS/SEM = Acid volatile sufilde/simultaneously extracted metals
SPLP = Synthetic Precipitation Leachate Procedure
TCLP = Toxicity Characteristic Leachate Procedure

Worksheet #20—Field Quality Control Sample Summary

This worksheet summarizes the field QC samples planned to be collected during the sampling activities.

Field Duplicate (Replicate) Samples

Field duplicates are two (or more) field samples taken at the same time in the same location. They are intended to represent the same population and are taken through all steps of the analytical procedure in an identical manner. These samples are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and are treated in an identical manner during storage, transportation, and analysis. The samples may be either co-located samples or sub-samples (replicates) of a single sample collection. Example of co-located samples includes side-by-side soil core samples, while sub-samples may be taken from one soil boring core. The sample containers are assigned a unique identification number in the field. Specific locations should be designated for collection of field duplicate samples before the beginning of sample collection. The standard collection frequency for duplicate samples is one for every 10 field samples.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) Samples

MS/MSD is an aliquot of sample spiked with known concentrations of specific analytes. The spiking occurs before sample preparation and analysis at the laboratory. To allow the analytical laboratory to run MS/MSD analyses, additional sample will be collected in the field to provide sufficient sample volume. One MS and one MSD sample will be analyzed at a rate of approximately every 20 samples collected.

Equipment Blanks

An equipment blank is a sample of laboratory-grade deionzed water poured into, over, or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. These may also be called rinse blanks or rinsate blanks. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks shall be collected immediately after the equipment has been decontaminated and included for each sampling event as appropriate. At a minimum, equipment rinsate blanks will be collected at a frequency of one per week or one per event (whichever is more frequent) per sampling crew for each decontaminated equipment type. The equipment blank samples shall be analyzed for all laboratory analyses requested for the environmental samples collected onsite.

Trip Blanks

Trip blanks are used only when volatile organic compound (VOC) samples are taken. Because no VOC samples will be collected, trip blanks are not necessary for this sampling effort.

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations [2]	No. of Field Duplicates	No. of MS/ MSDs	No. of Equip. Blanks[3]	No. of Trip Blanks	Total No. of Samples to Lab
Soil	250-micron sieve lead Site-Specific Metals[4]	Low	Refer to Worksheet #23	72	10% (8)	5% (4)	1/week[3] (2)	NA	86
Residue	SPLP or TCLP Metals	Low	Refer to Worksheet #23	31	10% (4)	NA	NA	NA	35
Residue	pH	NA	Refer to Worksheet #23	31	10% (4)	NA	NA	NA	35
Residue	Site-Specific Metals[4]	Low	Refer to Worksheet #23	10	10% (1)	5% (1)	1/week	NA	12
Sediment	Site-Specific Metals[4]	Low	Refer to Worksheet #23	21	10% (3)	5% (2)	1/week (2)	NA	28
Sediment	AVS/SEM	Low	Refer to Worksheet #23	21	10% (3)	5% (2)	NA	NA	33
Sediment	TOC Grain Size	Low	Refer to Worksheet #23	21	10% (3)	NA	NA	NA	24
Groundwater	Site Specific Metals[4] (total & dissolved)	Low	Refer to Worksheet #23	80	10% (8)	5% (4)	1/week	NA	92
Surface Water	Site Specific Metals[4] (total and dissolved)	Low	Refer to Worksheet #23	42	10% (5)	5% (3)	1/week (1)	NA	51
Concrete	Site Specific Metals[4]	Low	Refer to Worksheet #23	40	10% (4)	5% (2)	1/week (2)	NA	46
Concrete	TCLP Metals	Low	Refer to Worksheet #23	40	10% (4)	NA	NA	NA	44
Building Material	TCLP Metals	Low	Refer to Worksheet #23	30	10 % (3)	NA	NA	NA	33

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).
[2] The number of samples is subject to change based on field conditions.
[3] Equipment blanks will be collected at a minimum of once per week (for each type of sampling equipment used), at the discretion of the field team leader, only if non-dedicated sampling equipment is used. Dedicated sampling equipment will be used as much as possible to minimize decontamination and the collection of equipment blanks.
[4]Site specific metals include arsenic, cadmium, copper, lead, manganese, and zinc.
NA – Not applicable

Worksheet #21—Project Sampling SOP References

This worksheet summarizes the field methods to be used to perform sampling. The field SOPs are provided in Appendix C of this QAPP.

Procedure Number	Procedure Title	Issue Date
SOP-01	Note Taking and Field Logbook	12/2009
SOP-02	Utility Clearance for Intrusive Operations	03/2010
SOP-03	Soil Sample Collection from Sonic and/or Direct Push Drilling Methods	03/2010
SOP-04	Soil Boring Logging	12/2009
SOP-05	Monitoring Well Installation	03/2010
SOP-06	Monitoring Well Development	12/2009
SOP-07	Water Level and Total Depth Measurements	12/2009
SOP-08	Groundwater Sampling Procedures	03/2010
SOP-09	Soil and Building Debris Sampling	12/2009
SOP-10	Concrete Slab Sampling	03/2010
SOP-11	Surface Water and Sediment Sampling	12/2009
SOP-12	Field Water Quality Measurements and Calibration	12/2009
SOP-13	Equipment Decontamination Procedures	12/2009
SOP-14	Packing and Shipping of Environmental Samples	12/2009
SOP-15	Sample Handling and Chain-of-Custody Procedures	12/2009
SOP-16	Aquifer Testing	12/2009
SOP-17	Monitoring Well and Borehole Abandonment	3/2010

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

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Water Level Indicator or Oil/Water interface probe	Calibrate annually to determine the accuracy of the measurement.	Per manufacturer's instructions	Measures depth-to-liquid and total well depth.	Per manufacturer's instructions	Daily before use	+/- 0.01 foot	If meter fails to calibrate, do not use this meter.	FTL	SOP-07 SOP-08
Water Quality Meter – YSI 600XLM or similar	Calibrate daily prior to collecting water quality data according to manufacturer calibration specifications developed for the instrument being calibrated .	Per manufacturer's instructions	Measures dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, pH, and temperature.	Per manufacturer's instructions	Daily before use	Check operations manual for acceptable range of calibrated probes	If meter fails to calibrate, do not use this meter.	FTL	SOP-08 SOP-11 SOP-12
HACH turbidity Meter	Calibrate daily per manufacturer's instructions.	Per manufacturer's instructions	Measures turbidity (NTUs).	Per manufacturer's instructions	Daily before use	Check operations manual for acceptable range of calibration	If meter fails to calibrate correctly, do not use this meter.	FTL	SOP-08 SOP-11 SOP-12

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
PID	Calibrate for organic vapors using compressed gas cylinders, per manufacturer's instructions.	Charge batteries; Allow the batteries to totally discharge before recharging to prevent battery memory from occurring; Perform maintenance per manufacturer's instructions.	Screens for potential volatile compound concentrations.	Per manufacturer's instructions	Daily before use	Calibrates to +/- respective values for the probe for the specific lamp model (refer to operations manual).	If meter fails to calibrate correctly, do not use this meter.	FTL	SOP-03 SOP-09
Handheld GPS Unit	NA	Charge batteries.	Measures the horizontal geographic position of location.	Per manufacturer's instructions	Daily before use	A sufficient signal is available to obtain an accurate measurement of horizontal position.	If a sufficient signal is not available, measurement should not be taken. If significant time has passed and a sufficient signal is not available, contact the equipment supplier or manufacturer.	FTL	SOP-02 SOP-03 SOP-05 SOP-08 SOP-09 SOP-11

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

Worksheet #23—Analytical SOP References

The analytical SOP reference numbers below are the method references for the analyses performed by the USEPA CLP or a subcontract laboratory. For all other analyses, the laboratory SOP is referenced. Appendix D of this UFP QAPP includes these methods. Note that the methods have not been modified specifically for this project and may not reflect the exact requirements of this QAPP. The actual laboratory SOPs will be followed and supplemented by internal communication systems within the laboratory to disseminate the project requirements to technical staff.

Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ILM05.4	USEPA Contract Laboratory Program Statement of Work for Multi-Media, Multi-Concentration Inorganic Analysis; April 2007	Definitive	Site-Specific Metals[1]	ICP-AES/ICP-MS	CLP Laboratory	N
SW846 6010C/6020	Inductively Coupled Plasma-Atomic Emission Spectrometry/Inductively Coupled Plasma-Mass Spectrometry	Definitive	Site-Specific Metals[1]	ICP-AES/ICP-MS	Subcontract Laboratory	N
	Soil Fraction Preparation for Lead Analysis	Definitive	250-micron sieve lead	250-micron Sieve	Subcontract Laboratory	N
ASTM D-422	Standard Test Method for Particle-Size Analysis of Soils, November 2002	Definitive	Grain Size	Sieve and Hydrometer Analysis	Subcontract Laboratory	N
EPA 821 R91-100	Analytical Method for the Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable in Sediment; December 1991	Definitive	AVS/SEM	Titration	Subcontract Laboratory	N
Lloyd-Kahn Method	Determination of Total Organic Carbon in Sediment; July 1998	Definitive	Total Organic Carbon	NA	Subcontract Laboratory	N

Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SW846 1312/6010C/ 6020	SW-846 Methods 1312 SPLP for metals	Definitive	Synthetic Precipitation Leaching Procedure Metals	ICP-AES/ICP-MS	Subcontract Laboratory	N
SW846 1311/6010C/ 6020	SW-846 Methods 1311 TCLP for Metals	Definitive	Toxicity Characteristic Leaching Procedure Metals	ICP-AES/ICP-MS	Subcontract Laboratory	N
SW84 6	Soil and residue pH	Definitive	GenChem	Probe	Subcontract Laboratory	N

Notes:
ICP – Inductively Coupled Plasma
ICP-AES – Inductively Coupled Plasma-Atomic Emission Spectrometry
ICP-MS – Inductively Coupled Plasma-Mass Spectrometry
[1]Site specific metals include arsenic, cadmium, copper, lead, manganese, and zinc.

Worksheet #24—Analytical Instrument Calibration

To ensure that the analytical methods and the selected instrumentation meet the project requirements, each analytical instrument will be calibrated according to the methods in Appendix D of this QAPP.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP-AES/ICP-MS	See ILM05.4 or as per instrument manufacturer's recommended procedures	ICP-AES or ICP-MS: Initial calibration—daily or once every 24 hours and each time the instrument is set up. ICP-AES or ICP-MS: Continuing calibration—beginning and end of run, and frequency of 10% or every 2 hours during an analysis run.	ICP-AES: As per instrument manufacturer's recommended procedures, with at least two standards. ICP-MS: As per instrument manufacturer's recommended procedures, with at least two standards. A minimum of three replicate integrations are required for data acquisition.	ICP-AES or ICP-MS: inspect the system, correct problem, recalibrate, reanalyze samples.	USEPA CLP Laboratory ICP-AES/ICP-MS Technician	ILM05.4
ICP-AES/ICP-MS	See SW6010C/6020 as per instrument manufacturer's recommended procedures	ICP-AES or ICP-MS: Initial calibration—daily or once every 24 hours and each time the instrument is set up. ICP-AES or ICP-MS: Continuing calibration—beginning and end of run, and frequency of 10% or every 2 hours during an analysis run.	ICP-AES: As per instrument manufacturer's recommended procedures, with at least two standards. ICP-MS: As per instrument manufacturer's recommended procedures, with at least two standards. A minimum of three replicate integrations are required for data acquisition.	ICP-AES or ICP-MS: inspect the system, correct problem, recalibrate, reanalyze samples.	Subcontract Laboratory ICP-AES/ICP-MS Technician	SW6010C/ SW6020
	Calibration blank	After every 10 samples and at the end of a sequence.	No analytes detected at or above the reporting limit.	Correct the problem, then reanalyze previous 10 samples.	Subcontract Laboratory ICP-AES/ICP-MS Technician	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence.	All analytes within ±10% of expected value.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.	Subcontract Laboratory ICP-AES/ICP-MS Technician	
General Chemistry (TOC and AVS)	Initial calibration single or multipoint, depending on method recommendation for instrumentation.	Daily before analysis.	For multipoint calibration curve, regression criteria of r > 0.995 must be met prior to sample analysis.	Correct problem then repeat initial calibration.	Subcontract Laboratory Inorganic Technician	Lloyd-Kahn EPA 821 R91-100
ICP-AES/ICP-MS (SPLP Metals/TCLP Metals)	Initial calibration (a blank and at least one standard)	Before sample analysis, every 24 hours, whenever modifications are made to the system, or when continuing calibration verification fails.	If more than one standard is used, correlation coefficient must be > 0.995.	Correct problem and repeat initial calibration.	Subcontract Laboratory ICP Technician	SW1312/6010C/SW6020 (SPLP) SW1311/6010C/SW6020 (TCLP)
	Calibration blank	After every 10 samples and at the end of a sequence.	No analytes detected at or above the reporting limit.	Correct the problem then reanalyze previous 10 samples.	Subcontract Laboratory ICP Technician	
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence.	All analytes within ±10% of expected value.	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.	Subcontract Laboratory ICP Technician	

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

To ensure the analytical instrument and equipment are available and in working order when needed, all laboratory analytical equipment will undergo maintenance and testing procedure in accordance with the methods provided in Appendix D of this QAPP.

Worksheet #26—Sample Handling System

To ensure sample authenticity and data defensibility, a proper sample handling system will be followed from the time of sample collection to final sample disposal. The field team leader or designee will be responsible for the sample collection, sample packing, and coordination of sample shipment. The samples will be sent to the USEPA CLP, CRL, or subcontract laboratory via FedEx overnight. The sample packing and shipping procedures are provided in SOP-14 and SOP-15 included in Appendix C. The laboratory sample custodian will acknowledge the sample receipts upon arrival. The laboratory analytical technicians will prepare and analyze the field samples in accordance with the methods provided in Appendix D. The field samples and all extracts/digestates will be stored at the laboratory for 30 days following a final report submission to CH2M HILL. The laboratory hazardous waste manager will be responsible for the final sample disposal.

Sample Collection, Packaging, and Shipment

Sample Collection (Personnel/Organization): FTL or designee, CH2M HILL

Sample Packaging (Personnel/Organization): FTL or designee, CH2M HILL

Coordination of Shipment (Personnel/Organization): FTL or designee, CH2M HILL

Type of Shipment/Carrier: FedEx overnight or local courier

Sample Receipt and Analysis

Sample Receipt (Personnel/Organization): Sample custodian, USEPA CLP Laboratory, CRL, or EnviroSystems

Sample Custody and Storage (Personnel/Organization): Sample custodian, USEPA CLP Laboratory, CRL, or EnviroSystems

Sample Preparation (Personnel/Organization): Sample technician, USEPA CLP Laboratory, CRL, or EnviroSystems

Sample Determinative Analysis (Personnel/Organization): Sample technician, USEPA CLP Laboratory, CRL, or EnviroSystems

Sample Archiving

Field Sample Storage (No. of days from sample collection): The laboratory shall retain samples for at least 90 days after receipt.

Sample Extract/Digestate Storage (No. of days from extraction/digestion): The laboratory sample custodian will store all extracts/digestates for 30 days after final report has been submitted.

Sample Disposal

Personnel/Organization: Laboratory hazardous waste manager

Number of Days from Analysis: The laboratory shall retain samples for at least 90 days and sample extracts for at least 30 days, after submittal, pending the need for reanalysis.

Worksheet #27—Sample Custody Requirements

Proper sample handling, shipment, and maintenance of a chain of custody (COC) are key components of building the documentation and support for data that can be used to make project decisions. It is important that sample handling and sample COC requirements be performed completely, accurately, and consistently.

Field Sample Custody Procedures

(Reference CH2M HILL SOP-01, 14, and 15)

Field sampling activities require several forms of documentation to maintain sample ID and COC and to record significant events or observations. Required documentation include logbooks and other field forms—including sample registers, field sampling forms, field change request documentation, and daily field progress reports—as appropriate.

Sample Labeling

All samples will be assigned a unique sample identifier. Self-adhesive sample labels will be printed and affixed to each sample container and covered with clear packaging tape. The sample label will include the following information:

- Case/SAS number (CLP and CRL samples only)
- The unique sample number for sample tracking
- CH2M HILL station location (that is, the sample identifier)
- Date of sampling
- Time the sample was collected (in military time)
- All parameters for which the sample will be analyzed
- Preservative used (if any)
- Sample type (grab or composite)
- Sample concentration (low, medium, or high)
- Sample matrix (such as sediment)
- The signature of sample team leader
- Identification when sample is intended to be used by the lab for MS/MSD duplicate

Sample labels will be preprinted with static information, minimizing the amount of data that must be entered in the field. The sampler will initial any change in the label information prepared prior to sample collection.

Packaging and Shipping Procedures

Each sample will be individually identified and labeled after collection, then enclosed in a plastic cooler sealed with custody seals. The sample information will be recorded on COC forms, and the samples shipped to the appropriate laboratory via overnight delivery service or courier. USEPA FORMS II Lite program will be used for field documentation.

Samples will immediately be placed in a cooler filled with ice for temporary storage prior to shipment to the laboratory and during final shipment to the laboratory. All samples will be packaged and labeled for shipment in compliance with current regulations. Only metal or plastic ice chests will be used for shipping samples. For shipment to the laboratory, samples will be properly padded to prevent breakage. Ice used in the coolers for shipping to the laboratories will be placed in double, 1-gallon, zip-lock bags with a minimum amount of air. The COC record will be placed inside a zip-lock plastic bag and taped to the inside of the cooler top. The cooler will be closed and taped shut with packing or duct tape, and a custody seal will be properly placed across two sides of the cooler lid. The shipping air bill, if needed, will be securely attached to the exterior of the cooler. Commercial carriers or sample pickup couriers are not required to sign the COC record if it is sealed inside the shipping cooler and the custody seals remain intact. The laboratory is responsible for storing the samples in a secure location and following all COC procedures. Samples will be collected in certified clean containers. All samples will be sent by commercial carrier overnight delivery to the laboratory.

Chain-of-Custody Procedures

A COC record establishes the documentation necessary to trace sample possession from time of collection through sample analysis and disposition. A sample is in the custody of a person if any 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 is in a person's physical possession and then locked up or sealed to prevent tampering.
- The sample is kept in a secured area.

The sample collector will complete a COC record to accompany each delivery container (cooler) and will be responsible for shipping samples to the laboratory. The sample collector will provide the project number and their signature in the designated fields at the top of the COC record. For each sample submitted to the project laboratory, the sample collector will indicate the date, time, number of containers, analytical parameters, and designated sample ID numbers. When shipping the samples, the sample collector will sign the bottom of the form and enter the date and time (24 hour) that samples were relinquished. Lines not used on the COC record will be crossed out. The sample collector will enter the carrier name on the form. Any required special handling of analyzed samples, such as hold or return, must be written on the COC record. A second member of the field crew will review the completed COC record to ensure that required information was not omitted and that unused lines are crossed out. The original signature copy of the COC record will be enclosed in a plastic bag and secured to the inside of the cooler lid. The COC record will be retained for project files. An example of the COC form, sample tag, and custody seals are included in Attachment 2 of SOP-15.

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

A designated sample custodian accepts the shipped samples, and verifies that the packing list sample numbers match those on the COC records. Pertinent information regarding shipment, pickup, and courier is entered in the section for remarks.

The laboratory sample custodian will reconcile the information on the COC records with the sample bottles received. The sample custodian will document any anomalies and report these to the laboratory project manager. Anomalies will be resolved with the project chemist. Photographs are recommended to document the condition of samples if significant out-of-control conditions are noted at the time the samples are received. The sample custodian must fax a copy of the cooler receipt form, the associated COC records, and the sample delivery group (SDG) assignment form to the project chemist within 24 hours of sample receipt. The information on the forms will then be entered into the laboratory information management system along with the analyses being requested.

The sample laboratory custodian is responsible for ensuring that all samples are transferred to the proper analyst or stored in the appropriate secure area. 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 using an internal COC record to track sample movement within the laboratory. When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample will be disposed of in compliance with all federal, state, and local regulatory requirements. All identifying stickers, data sheets, and laboratory records are retained as part of the documentation.

Worksheet #28—Laboratory QC Sample Summary

This worksheet provides additional discussions on the analytical QC requirements relevant to analysis of environmental samples that shall be followed by laboratories producing definitive data. The purpose of the laboratory QC activities is to produce data of known quality that satisfy the project-specific DQOs. Worksheet #24 (Analytical Instrument Calibration) and the methods included in Appendix D provide additional QA/QC requirements.

Laboratory QC samples shall be included in an analytical batch with the field samples. An analytical batch is a group of samples (not exceeding 20 environmental samples plus associated laboratory QC samples) similar in composition (matrix) that are extracted or digested at the same time and with the same lot of reagents and then analyzed together as a group. The analytical batch also extends to cover samples that do not need separate extraction or digestion (for example, VOCs analysis by purge and trap). The identity of each analytical batch shall be unambiguously reported with the analyses so that a reviewer can identify the laboratory QC samples and the associated environmental samples. MS/MSD samples are not treated as environmental samples. The type of laboratory QC samples and the frequency of use of these samples are discussed below and in method-specific analytical SOPs.

Matrix	**Soil, Sediment, Groundwater, Surface Water, Residue, Concrete**
Analytical Group	**Site Specific Metals and 250-micron sieve lead**
Concentration Level	**Low (mg/kg)(mg/L)**
Sampling SOP(s)	**SOP-03, SOP-08, SOP-09, SOP-10, and SOP-11**
Analytical Method/SOP Reference	**ILM05.4(sediment, groundwater, surface water) SW6010C/SW6020 (soil, residue, concrete)**
Sampler's Name	**TBD**
Field Sampling Organization	**CH2M HILL**
Analytical Organization	**USEPA CLP Laboratory or Subcontract Laboratory**
No. of Sample Locations	**Reference Worksheet 17, 18, and 20**

Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Preparation Blank, Continuing Calibration Blank, Initial Calibration Blank	1 per < 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	USEPA CLP Laboratory or Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per < 20 samples	75-125%R*	Flag outliers	USEPA CLP Laboratory or Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per < 20 samples	± 20% RPD**	Flag outliers	USEPA CLP Laboratory or Subcontract Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	After any analyte (except Ag and Hg) fails spike %R	85-115%R	Flag outliers	USEPA CLP Laboratory or Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	85-115%R
Interference Check Sample [ICP Analysis Only]	Beginning, end, and periodically during run (2 times every 8 hours)	± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	USEPA CLP Laboratory or Subcontract Laboratory ICP-AES/ICP-MS Technician	Sensitivity	± 2 times CRQL of true value or ± 20% of true value, whichever is greater

Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Laboratory Control Sample	1 per < 20 samples	80-120%R (except Ag and Sb)	Suspend analysis until source rectified; redigest and reanalyze affected samples	USEPA CLP Laboratory ICP-AES/ICP-MS Technician	Accuracy	80-120%R (except Ag and Sb)

*Except when the sample concentration is greater than 4 times the spike concentration.

**Except when the sample concentration is less than 5 times the CRQL, then ± CRQL.

Matrix	**Sediment**
Analytical Group	**AVS/SEM Metals**
Concentration Level	**Low (mg/kg)**
Sampling SOP(s)	**SOP-11**
Analytical Method/SOP Reference	**EPA 821 R91-100**
Sampler's Name	**TBD**
Field Sampling Organization	**CH2M HILL**
Analytical Organization	**Subcontract Laboratory**
No. of Sample Locations	**Reference Worksheet 17, 18, and 20**

Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per < 20 samples	No constituent > CRQL[1]	Suspend analysis until source rectified; redigest and reanalyze affected samples	Subcontract Laboratory Technician	Accuracy	No constituent > CRQL
Matrix Spike	1 per < 20 samples	40-160%R*	Flag outliers	Subcontract Laboratory Technician	Accuracy	40-160%R*
Matrix Spike Duplicate	1 per < 20 samples	± 40% RPD**	Flag outliers	Subcontract Laboratory Technician	Precision	± 40% RPD**
Laboratory Control Sample	1 per < 20 samples	70-130%R	Suspend analysis until source rectified; redigest and reanalyze affected samples	Subcontract Laboratory Technician	Accuracy	40-160%R

*Except when the sample concentration is greater than 4 times the spike concentration.

**Except when the sample concentration is less than 5 times the CRQL, then ± CRQL.

[1]CRQL for AVS/SEM Metals is as follows:

AVS = 0.05 uMol/g
SEM Cadmium = 0.09 uMol/g
SEM Copper = 0.001 uMol/g
SEM Lead = 0.0001 uMol/g
SEM Mercury = 0.01 uMol/g
SEM Nickel = 0.002 uMol/g
SEM Zinc = 0.005 uMol/g

Sum of SEM = 0.1 uMol/g

Matrix	**Sediment**
Analytical Group	**Total Organic Carbon**
Concentration Level	**Low (mg/kg)**
Sampling SOP(s)	**SOP-11**
Analytical Method/SOP Reference	**Lloyd-Kahn**
Sampler's Name	**TBD**
Field Sampling Organization	**CH2M HILL**
Analytical Organization	**Subcontract Laboratory**
No. of Sample Locations	**Reference Worksheet 17, 18, and 20**

Lab QC Sample:	**Frequency/Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
Preparation Blank	1 per < 20 samples	No constituent > CRQL of 1915 mg/kg	Suspend analysis until source rectified; reanalyze affected samples	Subcontract Laboratory Technician	Accuracy	No constituent > CRQL
Spike	1 per < 20 samples	75-125 %R	Flag outliers	Subcontract Laboratory Technician	Accuracy	75-125%R
Duplicate	1 per < 20 samples	± 30% RPD	Flag outliers	Subcontract Laboratory Technician	Precision	± 30% RPD
Laboratory Control Sample	1 per < 20 samples	80-120 %R	Suspend analysis until source rectified; reanalyze affected samples	Subcontract Laboratory Technician	Accuracy	80-120 %R

Matrix	**Residue, Concrete, Building Material**
Analytical Group	**SPLP Metals (Residue)/TCLP Metals (Concrete)**
Concentration Level	**Low (mg/L)**
Sampling SOP(s)	**SOP-03, SOP-09, SOP-10, and SOP-11**
Analytical Method/SOP Reference	**SW1312/6010C/SW6020 (SPLP)** **SW1311/6010C/SW6020 (TCLP)**
Sampler's Name	**TBD**
Field Sampling Organization	**CH2M HILL**
Analytical Organization	**Subcontract Laboratory**
No. of Sample Locations	**Reference Worksheet 17, 18, and 20**

Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Preparation Blank, Continuing Calibration Blank, Initial Calibration Blank	1 per < 20 samples	No constituent > CRQL	Suspend analysis until source rectified; redigest and reanalyze affected samples	Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	No constituent > CRQL
Spike	1 per < 20 samples	75-125%R*	Flag outliers	Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	75-125%R*
Duplicate	1 per < 20 samples	± 20% RPD**	Flag outliers	Subcontract Laboratory ICP-AES/ICP-MS Technician	Precision	± 20% RPD**
Post-Digestion Spike	After any analyte (except Ag and Hg) fails spike %R	85-115%R	Flag outliers	Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	85-115%R
Interference Check Sample [ICP Analysis Only]	Beginning, end, and periodically during run (2 times every 8 hours)	± 2 times CRQL of true value or ± 20% of true value, whichever is greater	Check calculations and instruments, reanalyze affected samples	Subcontract Laboratory ICP-AES/ICP-MS Technician	Sensitivity	± 2 times CRQL of true value or ± 20% of true value, whichever is greater
Laboratory Control Sample	1 per < 20 samples	80-120%R (except Ag and Sb)	Suspend analysis until source rectified; redigest and reanalyze affected samples	Subcontract Laboratory ICP-AES/ICP-MS Technician	Accuracy	80-120%R (except Ag and Sb)

*Except when the sample concentration is greater than 4 times the spike concentration.

**Except when the sample concentration is less than 5 times the CRQL, then ± CRQL.

Worksheet #29—Project Documents and Records

The required data package deliverables during every aspect of the project are identified in this worksheet. These include, but are not limited to, the following: (1) sample collection and field measurement records, (2) analytical records, and (3) data assessment records.

Sample Collection Documents and Records	Onsite Analysis Documents and Records	Offsite Analysis Documents and Records	Data Assessment Documents and Records	Other
Daily Field Notes/Observations Boring Logs Forms II Lite Database COC and Shipping Records Telephone Logs Corrective Action Forms GIS detail Waste profile information QA Review Records	Equipment Maintenance, Testing, and Inspection Logs Corrective Action Forms Checklists Telephone Logs QA Review Records Field Log Books Photographic Documentation Daily QC Summary Reports Field Change Request Audit records	Hard copy and electronic analytical data are defined below	Data Verification and Validation Reports Corrective Action Forms Telephone Logs QA review records Supplemental Remedial Investigation Reports	Project database for analytical and field data Health and Saftey Briefing information Staff health and Safety records

Hard-copy analytical data will meet USEPA CLP specifications or, in the case of non-CLP method approaches, the data will be CLP-like in format. The laboratory data package should be organized such that the analytical results are reported on a per-analytical-batch basis, unless otherwise specified. In addition to the summary data deliverable, a full supporting raw data deliverable package is required from the laboratory. All data will be provided in both hardcopy format as well as a portable document format (PDF) file. The USEPA will provide data copies to CH2M HILL and CH2M HILL will provide data copies to the USEPA for non-CLP analytical services.

An EDD is also required for all data. For services performed under the CLP, the EDD will use CLP-requirement formats. The USEPA will provide an EDD of validated data to CH2M HILL following current EQuIS format, and will also provide any available CADRE format exports. Laboratories performing work outside of the CLP will provide data to CH2M HILL electronically. These data will

undergo QA reviews before being loaded to the project database. Laboratory delivery time for data will vary based on project-specific data use.

Sample Tracking Program

The USEPA FORMS II Lite program will be used for field documentation and generation of COCs. Further guidance can be found in USEPA Office of Solid Waste and Emergency Response (OSWER) 9240.0-44, EPA 540-R-07-06, *Contract Laboratory Program Guidance for Field Samplers*, dated July 2007.

Analytical services tracking system (ANSETs) will be used as the sample tracking process and will be completed monthly.

Project-Specific Deliverables

Analytical data will be exported into a format consistent with the EDD format specified by USEPA Region 5. Data will be submitted to USEPA Region 5 in accordance with the requirements located online at http://www.epa.gov/region5superfund/edman/.

Documentation and reports specified in this QAPP will be retained in Adobe PDF format.

Worksheet #30—Analytical Services

The table below identifies the types of laboratories that will provide the analytical services for this project.

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address,)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Soil	Site Specific Metals	Low/Medium	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23	Turnaround time will be 21 days from date of receipt at the laboratory for final validated results.	USEPA CLP Laboratory/Location TBD	The CLP program will be responsible to manage the sample capacity issues at the lab.
Soil	AVS/SEM	Low	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23		Non-CLP	
Soil, Sediment, Groundwater, Surface Water	Site Specific Metals	Low/Medium	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23	Turnaround time will be 21 days from date of receipt at the laboratory for final validated results.	USEPA CLP Laboratory/Location TBD	The CLP program will be responsible to manage the sample capacity issues at the lab.
Soil	250-micron sieve for lead	Low	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23		Non-CLP	
Soil, Sediment, Surface Water	Grain size, pH, hardness, TOC	Low/Medium	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23	Turnaround time will be 21 days from date of receipt at the laboratory for final validated results.	USEPA Region 5 Central Regional Laboratory (CRL) 536 S Clark Chicago, IL 60604	The CRL program will be responsible to manage the sample capacity issues at the lab.
Residue	SPLP	Low/Medium	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23		Non-CLP	

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization (Name and Address,)	Backup Laboratory/Organization (Name and Address, Contact Person and Telephone Number)
Concrete and Building Cores	Site Specific Metals, TCLP	Low/Medium	Refer to Worksheet #18	Refer to SOPs defined in Worksheet #23			

Worksheet #31—Planned Project Assessments

Periodic assessments will be performed during the course of the project to ensure that the planned project activities are implemented in accordance with the site-specific plans. The type, frequency, and responsible parties of planned assessment activities to be performed for the project are summarized in the table below.

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)	Person(s) Responsible for Monitoring Effectiveness of CA
Specific Field Procedure Assessment and QAPP Compliance	Weekly	Internal	CH2M HILL Self Assessment	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/SM/ CH2M HILL or designee	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/SM/CH2M HILL or designee and Laura Crause/RI Leader/CH2M HILL
Data review and verification	As data becomes available from the laboratory	Internal and External	USEPA Region 5 CH2M HILL Project Chemist Laboratory Quality Assurance Officer	USEPA Region 5 Shannon Olson/ Chemist/ CH2M HILL CLP Laboratory/ Quality Assurance Officer CRL/Laboratory Quality Assurance Officer EnviroSystems/ Laboratory Quality Assurance Officer	CLP Lab/Laboratory Quality Assurance Officer CRL/Laboratory Quality Assurance Officer EnviroSystems/Laboratory Quality Assurance Officer	USEPA Region 5 Shannon Olson/Chemist/ CH2M HILL Ryan Loveridge/Ecological Risk Assessor/CH2M HILL CLP Lab/Laboratory Quality Assurance Officer CRL/Laboratory Quality Assurance Officer EnviroSystems/Laboratory Quality Assurance Officer	USEPA Region 5 Shannon Olson/Chemist/ CH2M HILL CLP Lab/Laboratory Quality Assurance Officer CRL/Laboratory Quality Assurance Officer EnviroSystems/ Laboratory Quality Assurance Officer

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)	Person(s) Responsible for Monitoring Effectiveness of CA
Field audit documentation	Weekly	Internal	CH2M HILL Self Assessment	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/SM/CH2M HILL or designee	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/ SM/CH2M HILL or designee and Laura Crause/RI Leader/CH2M HILL
Daily field documentation reviews	Daily	Internal	CH2M HILL Self Assessment	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/SM/CH2M HILL or designee	Laura Crause/RI Leader/CH2M HILL	Lisa Cundiff/Site Manager/CH2M HILL or designee and Laura Crause /RI Leader/CH2M HILL
Internal project reporting reviews	Once per report and/or report version generated	Internal	CH2M HILL Self Assessment	Varies dependent upon the expertise required by the CH2M HILL senior staff reviewers	Lisa Cundiff/SM/CH2M HILL or designee	Varies dependent upon the expertise required by the CH2M HILL senior staff reviewers	Lisa Cundiff/SM/CH2M HILL or designee
Health and Safety Audit	May occur once during sampling activities	Internal	CH2M HILL Field Audit	Mark Orman, Health and Safety Operations Manager, CH2M HILL	Lisa Cundiff/SM/CH2M HILL or designee	Laura Crause/RI Leader/CH2M HILL	Mark Orman, Health and Safety Manager, CH2M HILL

Worksheet #32—Assessment Findings and Corrective Action Responses

Based on the findings of the project assessments, corrective action may be required. For assessment findings that require corrective action, deficiencies will be documented and communicated to the appropriate project personnel. Corrective action will then be implemented and a follow-up assessment will be performed to verify the results of the corrective action. Procedures for handling deviations to the site-specific plans during each type of assessment are summarized in the table below.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Data review and verification	Laboratory resubmissions	Laboratory QA officer	After arrival of data from the lab and during data verification activities	Corrective action reports and/or updated case narratives and corrected data submissions	Shannon Olson/Project Chemist/CH2M HILL	7 business days
Daily field documentation reviews	Internal letter and any verification documentation	Lisa Cundiff/SM/ CH2M HILL	1 business day	Plan for correction and verification that correction is complete	Lisa Cundiff/SM/CH2M HILL	1 business day
Internal project reporting reviews	Internal report comments	Lisa Cundiff/SM/ CH2M HILL	7 business days	Response to comment and applicable report correction	Lisa Cundiff/SM/CH2M HILL	7 business days
Health and Safety Audit	Written Audit Report	Lisa Cundiff/SM/ CH2M HILL	3 to 5 business days	Letter and any verification documentation	Laura Crause/RI Leader/ CH2M HILL	24 hours after notification

Worksheet #33—QA Management Reports

In order to meet the project quality objectives, periodic QA management reports will be prepared to ensure that the project stakeholders are updated on project status and results of all QA assessments so that corrective actions can be implemented in a timely and effective manner. The frequency and type of planned QA management reports, the delivery date, the personnel responsible for report preparation, and the report recipients are identified in the table below.

Type of Report	Frequency	Projected Delivery Date	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Usability Assessment Report	Once after all data are generated and validated	Submitted with Final Reports	Shannon Olson/Project Chemist/CH2M HILL	USEPA and CH2M HILL
Health and Safety Audit	May occur once during the field activities	7 days after audit	Mark Orman/Health and Safety Manager/Health and Safety Officer/CH2M HILL	CH2M HILL
Daily Field Activity reports	Daily	Submitted with Final Reports	Lisa Cundiff/ SM/CH2M HILL	USEPA and CH2M HILL
Technical Status Reports	Monthly	As provided for in the Contract	Lisa Cundiff/SM/CH2M HILL	USEPA and CH2M HILL

Worksheet #34—Verification (Step I) Process

To ensure that scientifically sound data of known and documented quality are used in making environmental decisions, the following three-step data review will be performed: Step I (verification) will confirm that the sampling and analytical requirements have been met, Step II (validation) will assess whether the sampling and analytical processes comply with the contract-specific and the QAPP-specific requirements, and Step III (usability assessment) will determine whether the resulting data are suitable as a basis for the decision being made. Worksheets #34 (Validation [Step I] Process), #35 (Validation [Steps IIa and IIb] Process), and #36 (Validation [Steps IIa and IIb] Summary) describe the processes to be followed for the above three steps, respectively. Worksheet #34 establishes the procedures that will be followed to verify project data including, but are not limited to, sampling documents and analytical data package.

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
COC and Shipping Forms	COC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC will be initialed by the reviewer, a copy of the COC will be retained in the site file, and the original and remaining copies will be taped inside the cooler for shipment. See SOPs 14 and 15 for further details.	Internal	Shannon Olson or Designee (TBD)/CH2M HILL
Field Notebooks	Field notes will be reviewed internally at the end of each working day and placed in the site file.	Internal	Laura Crause or Designee (TBD)/CH2M HILL
Laboratory Data	Laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy before submittal. USEPA will perform data validation prior to submittal of data to CH2M HILL. Received data packages and data validation technical memorandum will undergo a "sanity-review" by the CH2M HILL project chemist or designee as specified in Worksheet #14.	Internal/ External	Laboratory QA Officer Shannon Olson/CH2M HILL
Project Reports	Project reporting activities will undergo a QA review by internal CH2M HILL senior staff with applicable expertise (that is, by SMEs) dependent upon the content of the report.	Internal	Varies/CH2M HILL

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

Step II (validation) will confirm whether the requirements for a specific intended use are fulfilled. The purpose of data validation is to assess the performance associated with the analysis in order to determine the quality of the data. Step IIa will verify whether the sampling and analytical data comply with the applicable methods, procedures, and contracts. Step IIb will compare the sampling and analytical data with the measurement performance criteria specified in Worksheet #12 (Measurement Performance Criteria).

Step IIa/IIb	Verification Input	Description	Responsible for Verification (Name, Organization)
IIb	Onsite Screening (Eh and pH, PID)	Verify that the field data meets QAPP requirements for completeness and accuracy based on the field calibration records.	Laura Crause/RI Lead/CH2M HILL
IIb	Field documentation	Verify accuracy and completeness of field notes and documentation daily and that sampling SOPs were followed.	Laura Crause/RI Lead/CH2M HILL
IIa	SOPs	Verify that the analytical SOPs were followed.	Shannon Olson/CH2M HILL ESAT Data Validation Personnel/USEPA Region 5 USEPA SST Project Leader Laboratory QA Officer/CLP Laboratory QA Officer/CRL
IIa	Method QC Results	Verify that the required QC samples were run and met required limits.	Shannon Olson/CH2M HILL ESAT Data Validation Personnel/USEPA Region 5 USEPA SST Project Leader Laboratory QA Officer/CLP Laboratory QA Officer/CRL

Step IIa/IIb	Verification Input	Description	Responsible for Verification (Name, Organization)
IIb	QAPP Field QC Sample Results	Verify that the required QAPP field QC samples were run and met required limits.	Shannon Olson/CH2M HILL ESAT Data Validation Personnel/USEPA Region 5 USEPA SST Project Leader Laboratory QA Officer/CLP Laboratory QA Officer/CRL
IIb	Quantification Limits	Verify that the sample results met the project quantification limit specified in the QAPP.	Shannon Olson/CH2M HILL ESAT Data Validation Personnel/USEPA Region 5 USEPA SST Project Leader Laboratory QA Officer/CLP Laboratory QA Officer/CRL
IIa IIb	Data review ad verification	Review validated data and the bioassay and toxicity results.	Shannon Olson/CH2M HILL
IIa IIb	Data usability evaluation	Evaluate data to precision, accuracy, representativeness, comparability and completeness for project objectives.	Shannon Olson/CH2M HILL Project Chemist Lisa Cundiff/CH2M HILL SM Barrie Selcoe/CH2M HILL Human Health Risk Assessor Ryan Loveridge/CH2M HILL Ecological Risk Assessor Sam Shannon/CH2M HILL Senior Reviewer Brian Schroth/CH2M HILL Senior Reviever Dan Moore/Critigen Data Management Advisor

Worksheet #36—Verification (Steps IIa and IIb) Summary

This worksheet identifies the matrices, analytical groups, and concentration levels that each entity performing verification will be responsible for, as well as criteria that will be used to validate those data.

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Verification Criteria	Data Validator (title and organizational affiliation)
IIa/IIb	Soil/Sediment/ Groundwater/ Surface Water	Site-Specific Metals	Low	Data Validation SOP for Inorganic Analysis of Low/Medium Concentration Metals under SOW ILM05.4	ESAT Data Validation Personnel/EPA Region 5 Data Validation Personnel
Ia/IIb	Sediment	AVS/SEM metals	Low	Professional Judgment	CH2M HILL
Ia/IIb	Surface Water	pH	Low	Data Validation SOP for pH under EPA 150.1	ESAT Data Validation Personnel/EPA Region 5 Data Validation Personnel
Ia/IIb	Surface Water	Hardness	Low	Data Validation SOP for Hardness under EPA 130.2	ESAT Data Validation Personnel/EPA Region 5 Data Validation Personnel

Data Verification/Validation Scope Overview

All CLP-performed analytical services will be validated in accordance with CLP program specifications, using the current versions of the National Functional Guidelines, and data will be made available to data users as defined by the QAPP. Samples collected for grain size will not be verified or validated.

Field Data Review

Field generated information may include field log books, PID calibrations and readings; waste management records and/or manifests, survey data, GIS data, sample COC forms, shipping documents, sampling observations, sample labels, and other miscellaneous field observations. All field measurements and or field log information will be entered into field log books and reviewed daily by the FTL or designee. The designee may be a qualified field geologist, engineer, environmental scientist, and/or technician.

Laboratory Data Review Requirements

All analytical data generated by the laboratory will be verified before submittal to the ESAT data validator. This multi-tiered internal data review process will include all aspects of data generation, reduction, and quality control assessment. In each laboratory analytical section, the analyst performing the tests will review 100 percent of the definitive data. After the analyst's review has been completed, 100 percent of the data will be reviewed independently by a senior analyst or by the supervisor of the respective analytical section using the same criteria.

Elements for review or verification at each level must include but not be restricted to the following:

- Sample receipt procedures and conditions
- Sample preparation
- Appropriate SOPs and analytical methodologies
- Accuracy and completeness of analytical results
- Correct interpretation of all raw data, including all manual integrations
- Appropriate application of QC samples and compliance with established control limits
- Verification of data transfers
- Documentation completeness (for example, all anomalies in the preparation and analysis have been identified, appropriate corrective actions have been taken and documented in the case narrative(s), associated data have been appropriately qualified, and anomaly forms are complete)
- Accuracy and completeness of data deliverables (hard copy and electronic)

Laboratory Data Evaluation

The calibration, QC, corrective actions, and flagging requirements for definitive data are shown in the Worksheets #12, #15, #24, and #28. The laboratory may apply data qualifiers based on their review or add a note in the laboratory case narrative. The definitions of any data qualifiers applied by the laboratory must be defined in the case narrative. The data qualifiers are reviewed by the supervisor of the respective analytical sections after the first and second level reviews of the laboratory data have been performed.

Data Review Guidelines

The laboratory assessment of the data quality will be reviewed for completeness and accuracy. Data review may be done electronically or manually, or by a combination of both. This will include, but is not limited to, the following:

- Sampling documentation (such as the COC form)
- Preservation summary and technical holding times
- Presence of all analyses and analytes requested
- Use of the required sample preparation and analysis procedures
- The method detection and RLs will be evaluated against the project requirements
- The correctness of the concentration units
- Case narrative

Data Verification/Validation Guidelines

The data verification process builds on data review. Project data will be reviewed and verified as part of the data assessment for this project. This review will be performed on an analytical batch basis by assessing QC samples and associated field sample results. Data verification guidelines have been developed in accordance with the method requirements, professional judgment and general USEPA national functional guidelines requirements.

Summary data review and verification will be performed as follows:

- COC documentation
- Holding time
- QC sample frequencies
- Method blanks
- Laboratory control samples (LCS)
- Surrogate spikes
- MS/MSD
- Initial and continuing calibration information
- Internal standards
- Tuning criteria
- Field duplicate (FD) precision
- Case narrative review and other method-specific criteria

A fully automated approach to verification from electronic data may be used to perform all of the comparisons against the limits for elements of QC that are available in the current form of

the laboratory electronic deliverables (if electronic data are unavailable, manual hard-copy review will be performed). The automated process includes data flagging for issues related to method blanks, equipment blanks, trip blanks, ambient blanks, LCSs, MS/MSD samples, field duplicates, surrogate recoveries, holding time, and reconciliation of dilutions and re-extractions. All of the elements of QC and their limits and logic for applying flags are incorporated in the computer application. Data flags, as well as the reason for each flag, are entered into an electronic database and made available to the data users. A final flag is applied to the data by the data validator/chemist after evaluating all flags entered into the database and selecting the most conservative of the verification flags.

If during the data review and verification process, a systematic problem or other major issue with the data is identified, the CH2M HILL project chemist will contact the laboratory's project manager or QA manager. Additional evaluation of the data may be performed including an in-depth review of the raw data to verify accuracy followed by analysis and interpretation of the data in the context of the project objectives and end-use as part of the usability assessment.

A data review and verification report will be prepared summarizing the findings and discussing their impact on the overall data usability. This may be incorporated into the final usability assessment.

Flagging Conventions

CH2M HILL specific final data qualifiers definitions of each data qualifier are summarized in Table 36-1.

TABLE 36-1
Verification/Validation Data Qualifiers

Qualifier	Description
R	The data are rejected because of deficiencies in meeting QC criteria and may not be used for decision making.
J	Estimated: The analyte was positively identified; the quantitation is an estimation because of discrepancies in meeting certain analyte-specific quality control criteria.
UJ	The analyte was not detected; however, the result is estimated because of discrepancies in meeting certain analyte-specific quality control criteria.
U	Undetected: The analyte was analyzed for, but not detected or is qualified as nondetect because of blank contamination.

Table 36-2 present the general data validation guidelines with consideration to the USEPA national functional guidelines to be used by CH2M HILL for applying these data usability qualifiers.

TABLE 36-2
Data Qualifying Conventions—General

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for extraction or analysis	J for positive results R or UJ for nondetects*	All analytes in the sample
Sample Preservation	Sample not preserved (If sample preservation was not done in the field but was performed at the laboratory upon sample receipt, no flagging is required)	J for positive results; R or UJ for nondetects*	Sample
	Temperature out of control	J for positive results; R or UJ for nondetects*	Sample
Sample Integrity (SW8260)	Bubbles in VOA vial >¼ inch used for analysis	J for positive results UJ for nondetects	Sample
Instrument Tuning	Ion abundance method-specific criteria not met	R for all results	All associated samples in analysis batch
Initial Calibration	All analytes must be within method specified criteria	J for positive results; R for nondetects	All associated samples in analysis batch
Second Source Check or Continuing Calibration	All analytes must be within method specified criteria	High Bias: J for positive results, no flag for nondetects Low Bias: J for positive results, UJ for nondetects R for all nondetects greater than twice the control criteria	All associated samples in analysis batch
Low Level Calibration Check or Interference Check Sample	All analytes must be within 20% of expected value	High Bias: J for positive results, no flag for nondetects Low Bias: J for positive results, UJ for nondetects R for all nondetects greater than twice the control criteria	All associated samples in analysis batch
LCS	% R > upper control limit (UCL)	J for positive results	The specific analyte(s) in all samples in the associated AAB
	%R < lower control limit (LCL)	J for positive results, R for nondetects	
Internal Standards	Area > UCL Area < LCL Sample is re-extracted AND reanalyzed AND recovery outside of criteria is confirmed as a matrix effect	J for positive results J for positive results, R for nondetects M for positive results, UM for nondetects	Sample

TABLE 36-2
Data Qualifying Conventions—General

QC Requirement	Criteria	Flag	Flag Applied To
Surrogate Spikes	%R > UCL %R < LCL and >10% %R <10% Excessive dilution*	J for positive results J for positive results, UJ for nondetects J for positive results, R for nondetects No flag required	Sample
Blanks (Method, Equipment or Trip)	Analyte(s) detected (use the blank of the highest concentration)	U for positive sample results ≤ 5x highest blank concentration (10x for common lab contaminants),	All samples in preparation, field or analytical batch, whichever one applies
Field duplicates	RPD > CL and field duplicates > RLs or one field duplicate > RL, one ND	J for positive results UJ for nondetects	The specific analyte(s) in all samples collected on the same sampling date. Note: No flagging is required for RPDs based on results less than the reporting limit
MS/MSD	MS or MSD % R > UCL or MS or MSD % R < LCL or MS/MSD RPD > CL Sample concentration > 4x spike concentration Excessive dilution*	J for all detected results J for all detected results and UJ for all nondetected results J for all detected results and UJ for all nondetected results No flag required No flag required	The specific analyte(s) in the parent sample
Post-Digestion Spike	All analytes must be within 25% of expected value	High Bias: J for positive results Low Bias: J for positive results; UJ for nondetects	The specific analyte(s) in the parent sample
Serial Dilutions	All analytes must be within 10% of expected value	If Post Spike not analyzed High Bias: J for positive results Low Bias: J for positive results; UJ for nondetects	The specific analyte(s) in the parent sample
Confirmation	RPD between primary and confirmation results > 40%	J for positive results	Sample
Retention Time Window	Analyte within established window	R for all results	Sample

* Based on analyte-specific review

Worksheet #37—Usability Assessment

The data usability assessment is an evaluation based on the results of data verification and validation in the context of the overall project decisions or objectives, and determines whether project execution and resulting data meet the project DQOs. Both the sampling and analytical activities must be considered, with the ultimate goal of assessing whether the final, qualified results support the decisions to be made with the data.

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

Summary of Usability Assessment Processes

It is the responsibility of the project chemist and the laboratory to ensure that the data meet the method detection limits, reporting limits, and laboratory QC limits listed in this QAPP. During the data verification assessment, non-conformances are documented and data are qualified for use in decision making. The data are determined to be usable by the project chemist based on the requirements of this QAPP. Data gaps will be present if a sample is not collected or not analyzed for the requested parameters, or if the data are determined to be unusable. The need for further investigation will be determined on a case-by-case basis, depending on whether data can be extrapolated from adjacent sampling locations, and whether or not the results are unnecessary based on the results from adjacent locations. All data are usable as qualified by the data validator, with the exception of rejected data. Estimated and/or biased results are usable. Outliers, if present, can be addressed on a case-by-case basis. There is no generic formula for determining whether a result is an outlier. Potential outliers will be referred to a statistician and senior consultant, who will determine which formulas are appropriate for classifying data points in a statistically appropriate and defendable manner.

Evaluation Procedures to Assess Project-Specific Overall Measurement Error

In-depth assessment occurs during the data verification process. The verification will assess conformance with the requirements of the methods, SOPs and objectives of this QAPP. The findings of the data verification process will generate qualifiers applied to the data considered in context to assess overall usability of the data.

Personnel Responsible for Performing Usability Assessment

- Shannon Olson/Project Chemist/CH2M HILL
- Dan Moore/Senior Project Chemist/Critigen
- Barrie Selcoe/Human Health Risk Assessor/CH2M HILL
- Ryan Loveridge/Ecological Risk Assessor/CH2M HILL
- Brian Schroth/Senior Reviewer/CH2M HILL

- Sam Shannon/Senior Reviewer/CH2M HILL
- Lisa Cundiff/Site Manager/CH2M HILL

Usability Assessment Documentation

The data verification report will identify precision and accuracy exceedances with respect to the laboratory performance for each batch of samples, as well as comparability of field and lab duplicates. All the results will be assembled and statistically reported for an overall quality assessment provided in the final project event report. Discussion will cover precision, accuracy, representativeness, comparability, and completeness defined as follows.

Precision

Laboratory precision is measured by the variability associated with duplicate (two) or replicate (more than two) analyses. One type of sample that can be used to assess laboratory precision is the LCS.

Multiple LCS analyses over the duration of the project can be used to evaluate the overall laboratory precision for the project. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch, but between LCSs analyzed in multiple batches.

Total precision is the measurement of the variability associated with the entire sampling and analytical process. The required level of precision for each method, matrix, and analyte are provided in Worksheet #15 (Reference Limits and Evaluation). It is determined by analysis of duplicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and MSD samples shall be analyzed to assess field and laboratory precision at a frequency described in Worksheet #20 (Field Quality Control Sample Summary). For duplicate sample results, the precision is evaluated using the RPD. For replicate results, the precision is measured using the relative standard deviation (RSD). The formula for the calculation of RPD is provided below.

If calculated from duplicate measurements:

$$RPD = \frac{(C_1 - C_2)\ x\ 100\%}{(C_1 + C_2)\ /\ 2} \qquad (1)$$

Where:

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values

If calculated from three or more replicates, use RSD rather than RPD:

$$RSD = (s\ /\ \bar{y})\ x\ 100\% \qquad (2)$$

Where:

RSD = relative standard deviation
s = standard deviation
$\bar{y}$ = mean of replicate analyses

Standard deviation, s, is defined as follows:

$$S = \sqrt{\sum_{i=1}^{n} \frac{(yi - \overline{y})^2}{n-1}} \tag{3}$$

Where:

S = standard deviation
yi = measured value of the ith replicate
$\overline{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

Accuracy reflects the total error associated with a measurement. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For many methods of organic compound analysis, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed.

Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements. The formula for calculation of accuracy is included in below as percent recovery (%R) from pure and sample matrices.

$$\%R = 100\%\ x \left[\frac{S - U}{C_{sa}} \right] \tag{4}$$

Where:

$\%R$ = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

For situations where a standard reference material (SRM) is used instead of or in addition to matrix spikes:

$$\%R = 100\%\ x \left[\frac{C_m}{C_{sm}} \right] \tag{5}$$

Where:

$\%R$ = percent recovery
C_m = measured concentration of SRM
C_{sm} = actual concentration of SRM

Representativeness

Representativeness is the degree to which sample data accurately reflect the characteristics of a population of samples. It is achieved through a well-designed sampling program and by using standardized sampling strategies and techniques and analytical procedures. Factors that can affect representativeness include site homogeneity, sample homogeneity at a single point, and available information around which the sampling program is designed.

Completeness (Statistical)

Completeness is a measure of the amount of valid data obtained compared with the amount expected under correct, normal conditions. It is calculated for the aggregation of data for each analyte measured as a compound of concern for the project objectives. Valid data are data that are usable in the context of the project goals. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an R-flag after a usability assessment has been performed. The goal for completeness, based on specific project goals, is 90 percent.

Defined as follows for all measurements:

$$\%C = 100\%\ x\left[\frac{V}{T}\right] \tag{6}$$

Where:

$\%C$	=	percent completeness
V	=	number of measurements judged valid
T	=	total number of measurements

Comparability

Comparability is the confidence with which one data set can be compared to another. It is achieved by maintaining standard techniques and procedures for collecting and analyzing samples and reporting the analytical results in standard units.

References

Environ International Corporation (Environ). April 2005. *Remedial Investigation Addendum Report.*

Environ International Corporation (Environ). March 2005. *Remedial Investigation Report.*

Environ International Corporation (Environ). November 2003. *Remedial Investigation Phase 2 Migration Pathway Assessment.*

Environ International Corporation (Environ). March 2003. *Remedial Investigation Phase 1 Source Characterization.*

Goodwin & Broms, Inc. (GBI). March 1999. *Monitoring Well Installation and Ground Water Sampling Interim Report*

Illinois Environmental Protection Agency (IEPA). September 1, 2005. *CERCLA Expanded Site Inspection Addendum Report*, Eagle Zinc Company, ILD 980606941.

Illinois Environmental Protection Agency (IEPA). January 17, 1996. *CERCLA Expanded Site Inspection Report*, Eagle Zinc Company, ILD 980606941.

U.S. Environmental Protection Agency (USEPA). n.d. Electronic Data Deliverable (EDD) Support, EPA Region 5 Superfund Division. Available online at http://www.epa.gov/region5superfund/edman/. Accessed on September 10, 2010.

U.S. Environmental Protection Agency (USEPA). May 2010. Regional Screening Levels Table.

U.S. Environmental Protection Agency (USEPA). 2009. National Recommended Water Quality Criteria.

U.S. Environmental Protection Agency (USEPA). July 2007. OSWER 9240.0-44, EPA 540-R-07-06, *Contract Laboratory Program Guidance for Field Samplers*

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

U.S. Environmental Protection Agency (USEPA). 2005-2007. Ecological Soil Screening Level. Interim Eco-SSL Documents. Available: http://www.epa.gov/ecotox/ecossl/.

U.S. Environmental Protection Agency (USEPA). March 2005. *Uniform Federal Policy for Quality Assurance Project Plans* (UFP QAPP) *Workbook*.

U.S. Environmental Protection Agency (USEPA). August 22, 2003. U.S. EPA, Region V, RCRA Ecological Screening Levels.

U.S. Environmental Protection Agency (USEPA). December 2001. *Risk Assessment Guidance for Superfund (RAGS): Volume I–Human Health Evaluation Manual* (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments). Final. Available online at http://www.epa.gov/oswer/riskassessment/ragsd/tara.htm.

U.S. Environmental Protection Agency (USEPA). December 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual.* Office of Solid Waste and Emergency Response, Washington, D.C.

Wisconsin Department of Natural Resourses (WDNR). 2003. Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application.

The following references are based on IEPA reports. CH2M HILL is working on obtaining these reports from IEPA.

Preliminary Assessment (PA) Report 1984 by the IEPA.

CERCLA Expanded SI Report; conducted by IEPA on October 26 and 27, 1993.

March 1999 report entitled *Interim Report of Residue Sampling and Analysis.*

Risk Science International (RSI) 1982 Risk Assessment Report.

March 2003 Phase I Source Characterization Technical Memorandum.

November 2003 Phase 2 Migration Pathway Assessment Technical Memorandum.

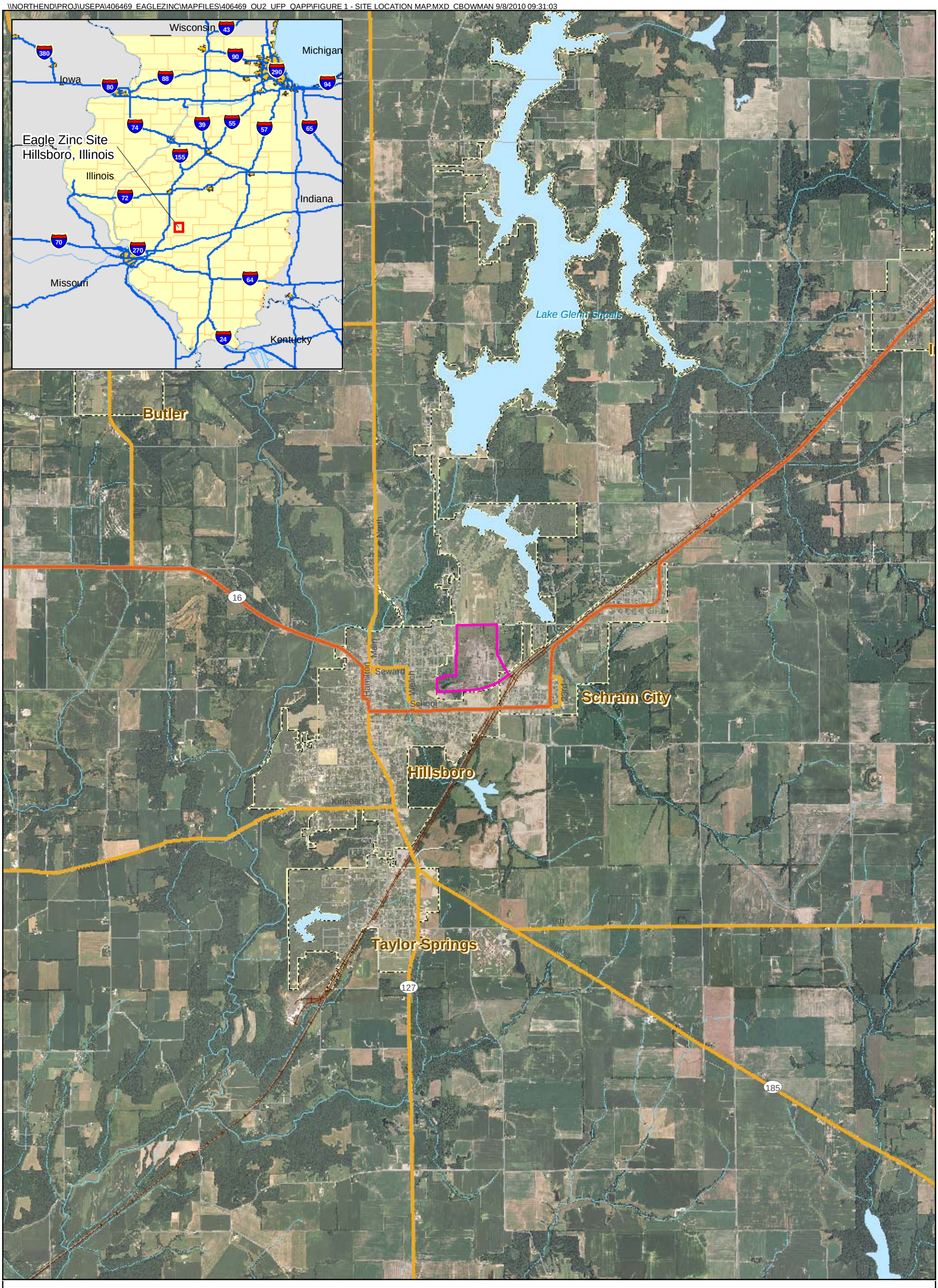
ENVIRON International Corporation, Deerfield, IL. Remedial Investigation Report. Eagle Zinc Company Site, Hillsboro, Illinois. February 2005. 286 pages.

April–May 2008. Illinois EPA Sampling Results Report for the Eagle Zinc NPL Site Buildings and Associated Structures.

September 2008. IEPA XRF Sampling.

Figures

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 1 - SITE LOCATION MAP.MXD CBOWMAN 9/8/2010 09:31:03



Legend
Site Boundary

N
W E
S

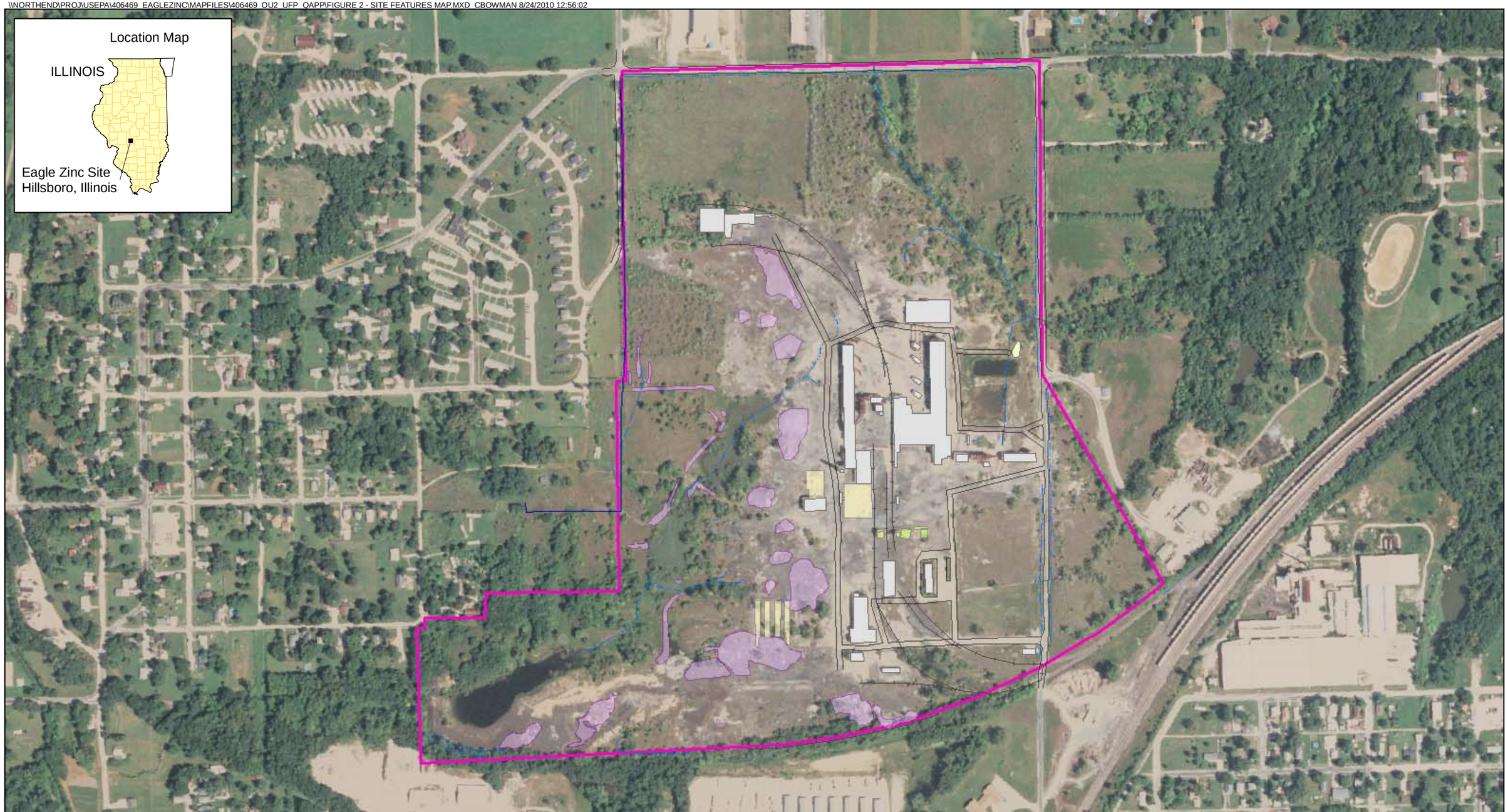
0 2,000 4,000 8,000 Feet

1 inch = 4,000 feet

Figure 1
Site Location Map
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 2 - SITE FEATURES MAP.MXD CBOWMAN 8/24/2010 12:56:02



Legend

- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

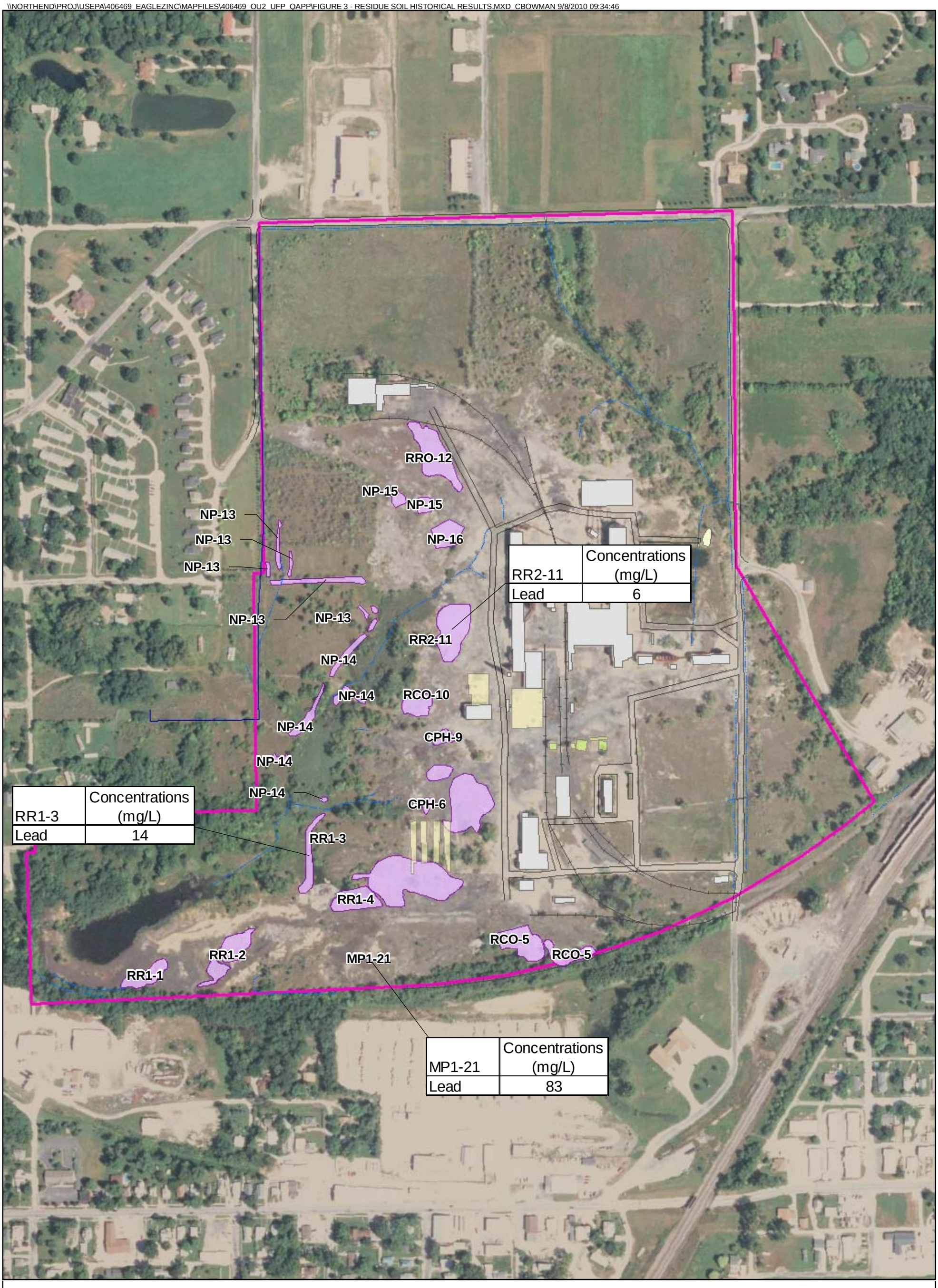
N
W E
S

0 200 400 800
Feet

Figure 2
Site Features Map
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 3 - RESIDUE SOIL HISTORICAL RESULTS.MXD CBOWMAN 9/8/2010 09:34:46



Legend

- Railroad
- Ditch
- Fence
- Site Boundary
- Residue Pile
- Building
- Foundation
- Tank
- Culvert
- Rip Rap

Notes:
Data is from the 2005 Remedial Investigation, ENVIRON 2005
RCRA Hazardous waste threshold for TCLP Lead = 5 mg/L
mg/L = milogram per liter
TCLP = Toxicity Characteristic Leaching Procedure

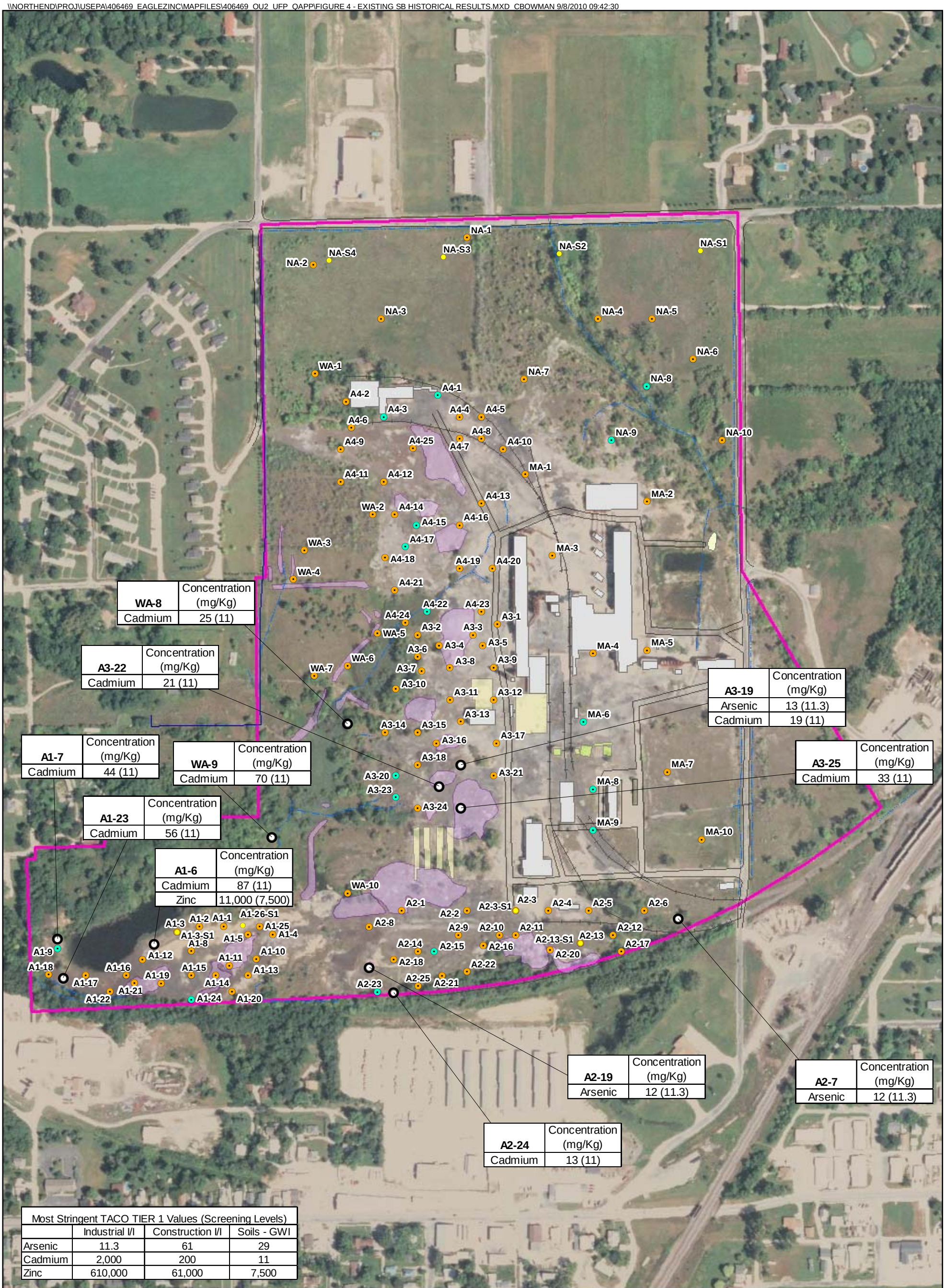
N
W E
S

0 170 340 680 Feet

Figure 3
Historical Residue Pile Samples Exceeding TCLP
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 4 - EXISTING SB HISTORICAL RESULTS.MXD CBOWMAN 9/8/2010 09:42:30



Legend

- Additional Soil Boring - March 2005
- Soil Boring - No Sample sent to Lab
- Soil Boring - Sample sent to Lab /Exceedances
- Soil Boring - Sample sent to Lab/No Exceedances
- Railroad
- Ditch
- Fence
- Site Boundary
- Residue Pile
- Building
- Foundation
- Tank
- Culvert
- Rip Rap

N W E S

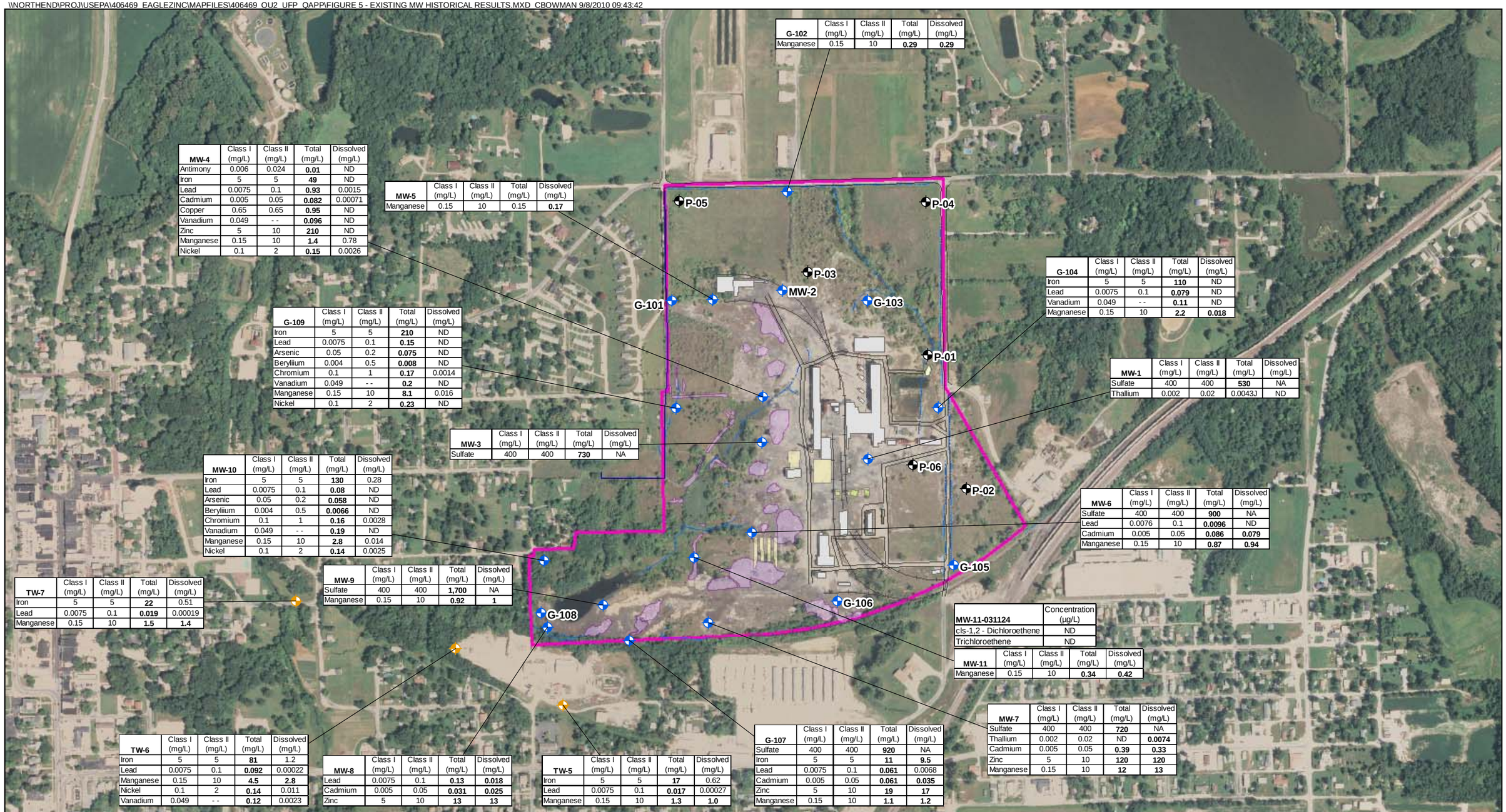
0 170 340 680 Feet

Notes:
Data is from the 2005 Remedial Investigation, ENVIRON 2005
Additional soil sample data is from the 2005 RI Addendum, ENVIRON 2005
( ) = Most Stringent TACO Tier I Value (Screening Levels)
mg/Kg = milogram per kilogram

Figure 4
Historical Soil Analytical Results
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 5 - EXISTING MW HISTORICAL RESULTS.MXD CBOWMAN 9/8/2010 09:43:42



G-102	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Manganese	0.15	10	**0.29**	**0.29**

MW-4	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Antimony	0.006	0.024	**0.01**	ND
Iron	5	5	**49**	ND
Lead	0.0075	0.1	**0.93**	0.0015
Cadmium	0.005	0.05	**0.082**	0.00071
Copper	0.65	0.65	**0.95**	ND
Vanadium	0.049	- -	**0.096**	ND
Zinc	5	10	**210**	ND
Manganese	0.15	10	**1.4**	0.78
Nickel	0.1	2	**0.15**	0.0026

MW-5	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Manganese	0.15	10	0.15	**0.17**

G-104	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**110**	ND
Lead	0.0075	0.1	**0.079**	ND
Vanadium	0.049	- -	**0.11**	ND
Magnanese	0.15	10	**2.2**	**0.018**

G-109	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**210**	ND
Lead	0.0075	0.1	**0.15**	ND
Arsenic	0.05	0.2	**0.075**	ND
Beryliium	0.004	0.5	**0.008**	ND
Chromium	0.1	1	**0.17**	0.0014
Vanadium	0.049	- -	**0.2**	ND
Manganese	0.15	10	**8.1**	0.016
Nickel	0.1	2	**0.23**	ND

MW-1	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**530**	NA
Thallium	0.002	0.02	0.0043J	ND

MW-3	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**730**	NA

MW-10	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**130**	0.28
Lead	0.0075	0.1	**0.08**	ND
Arsenic	0.05	0.2	**0.058**	ND
Beryliium	0.004	0.5	**0.0066**	ND
Chromium	0.1	1	**0.16**	0.0028
Vanadium	0.049	- -	**0.19**	ND
Manganese	0.15	10	**2.8**	0.014
Nickel	0.1	2	**0.14**	0.0025

MW-6	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**900**	NA
Lead	0.0076	0.1	**0.0096**	ND
Cadmium	0.005	0.05	**0.086**	**0.079**
Manganese	0.15	10	**0.87**	**0.94**

TW-7	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**22**	0.51
Lead	0.0075	0.1	**0.019**	0.00019
Manganese	0.15	10	**1.5**	**1.4**

MW-9	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**1,700**	NA
Manganese	0.15	10	**0.92**	**1**

MW-11-031124	Concentration (µg/L)
cis-1,2 - Dichloroethene	ND
Trichloroethene	ND

MW-11	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Manganese	0.15	10	**0.34**	**0.42**

MW-7	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**720**	NA
Thallium	0.002	0.02	ND	**0.0074**
Cadmium	0.005	0.05	**0.39**	**0.33**
Zinc	5	10	**120**	**120**
Manganese	0.15	10	**12**	**13**

TW-6	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**81**	1.2
Lead	0.0075	0.1	**0.092**	0.00022
Manganese	0.15	10	**4.5**	**2.8**
Nickel	0.1	2	**0.14**	0.011
Vanadium	0.049	- -	**0.12**	0.0023

MW-8	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Lead	0.0075	0.1	**0.13**	**0.018**
Cadmium	0.005	0.05	**0.031**	**0.025**
Zinc	5	10	**13**	**13**

TW-5	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Iron	5	5	**17**	0.62
Lead	0.0075	0.1	**0.017**	0.00027
Manganese	0.15	10	**1.3**	**1.0**

G-107	Class I (mg/L)	Class II (mg/L)	Total (mg/L)	Dissolved (mg/L)
Sulfate	400	400	**920**	NA
Iron	5	5	**11**	**9.5**
Lead	0.0075	0.1	**0.061**	0.0068
Cadmium	0.005	0.05	**0.061**	**0.035**
Zinc	5	10	**19**	**17**
Manganese	0.15	10	**1.1**	**1.2**

Legend

- Monitoring Well
- Piezometer
- Temporary Well
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

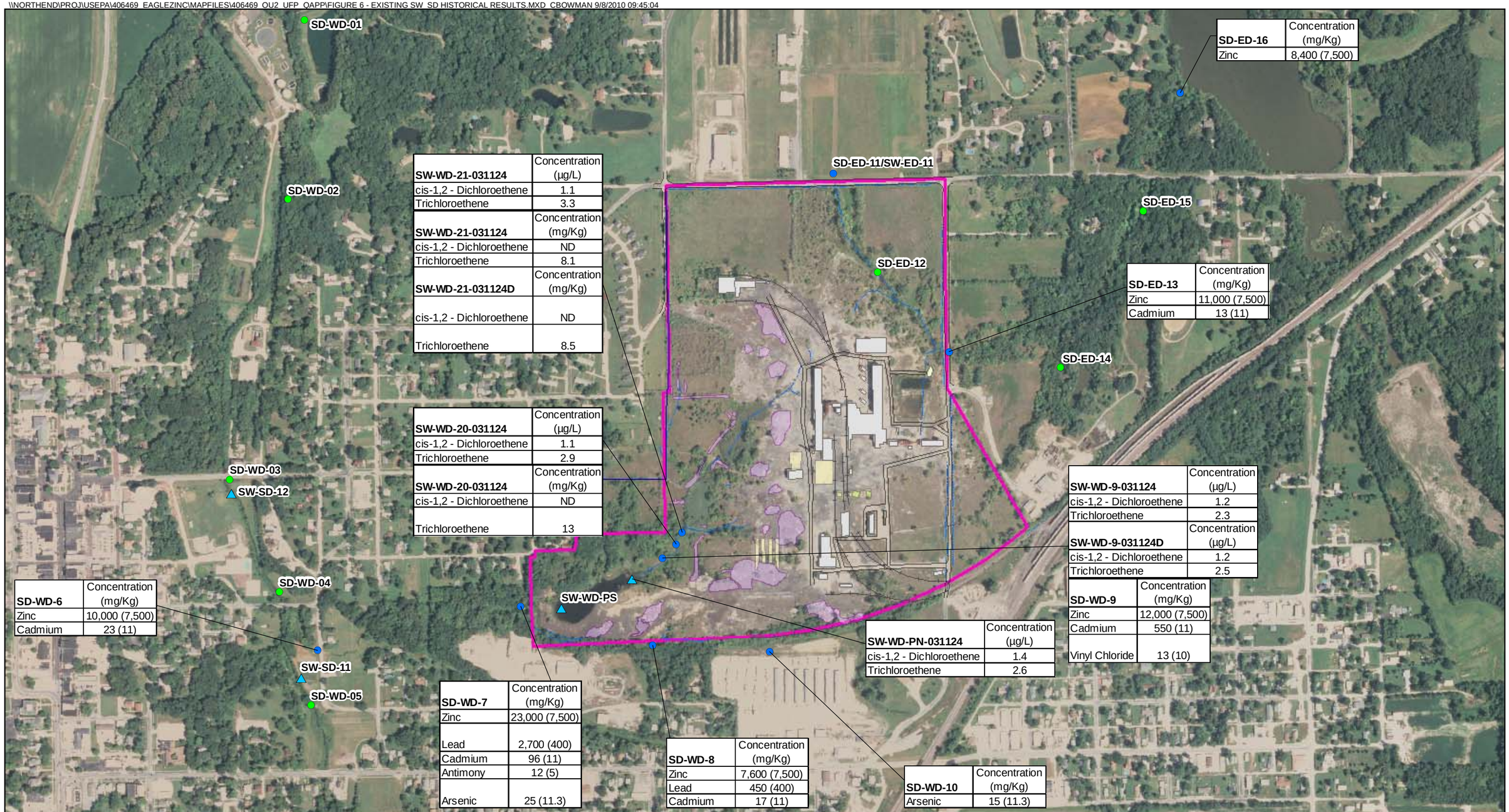
Notes:
Data is from the 2005 Remedial Investigation, ENVIRON 2005
BOLD - Concentrations above screening levels
-- = No Standard
NA - Not applicable
ND - Not detected
mg/L = milogram per liter
µg/L = microgram per liter

N
W E
S

0 300 600 1,200
Feet

Figure 5
Historical Groundwater Analytical Results
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL



Legend

- Sediment
- Sediment and Surfacewater
- Surface Water
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

Notes:
Data is from the 2005 Remedial Investigation, ENVIRON 2005
( ) = Most Stringent TACO Tier I Value (Screening Levels)
mg/Kg = milogram per kilogram
µg/L = microgram per liter

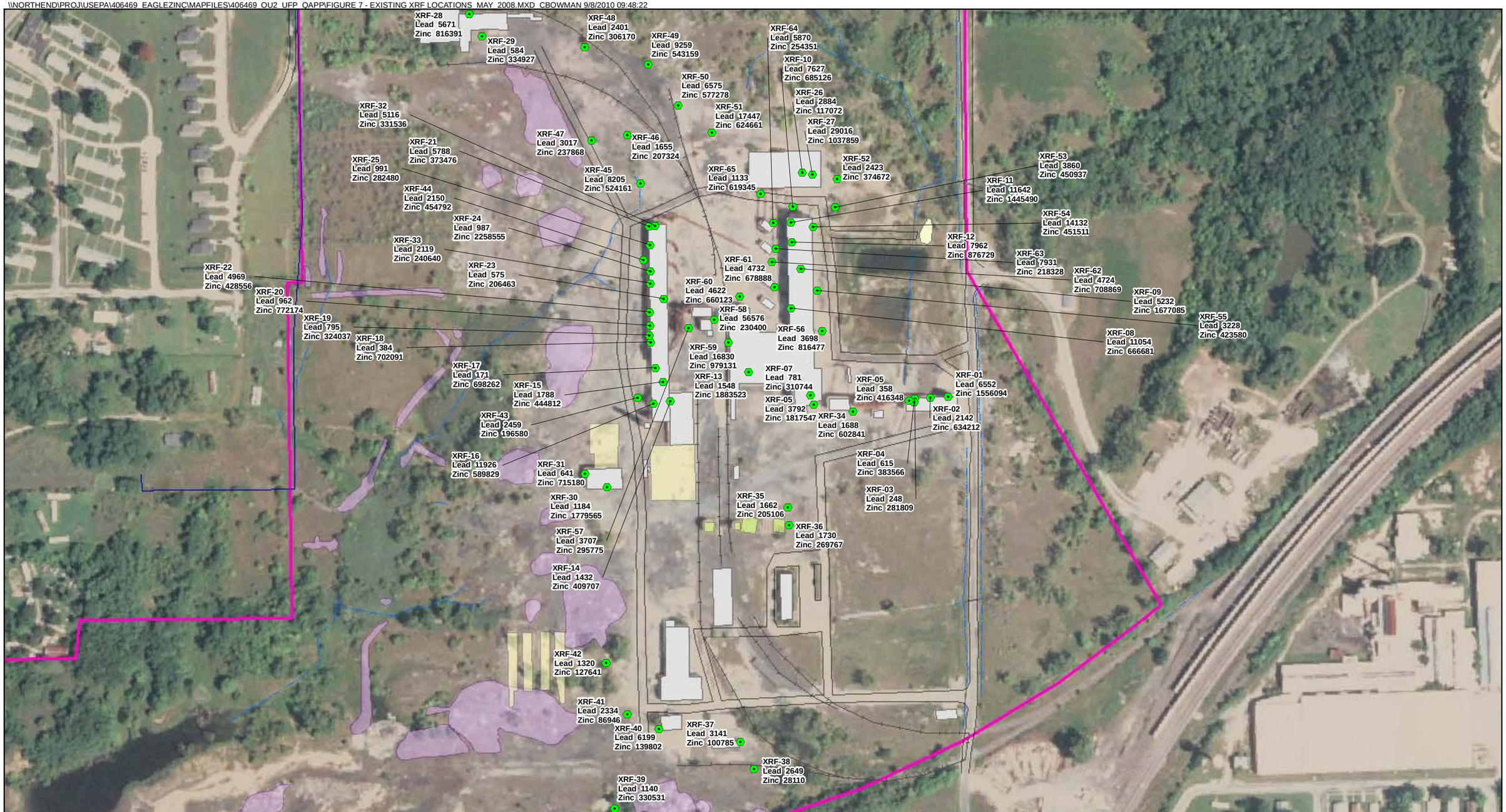
N
W E
S

0 300 600 1,200
Feet

Figure 6
Historical Surface Water and Sediment Analytical Results
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 7 - EXISTING XRF LOCATIONS_MAY_2008.MXD_CBOWMAN 9/8/2010 09:48:22



Legend

- XRF Locations
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

All units are ppm

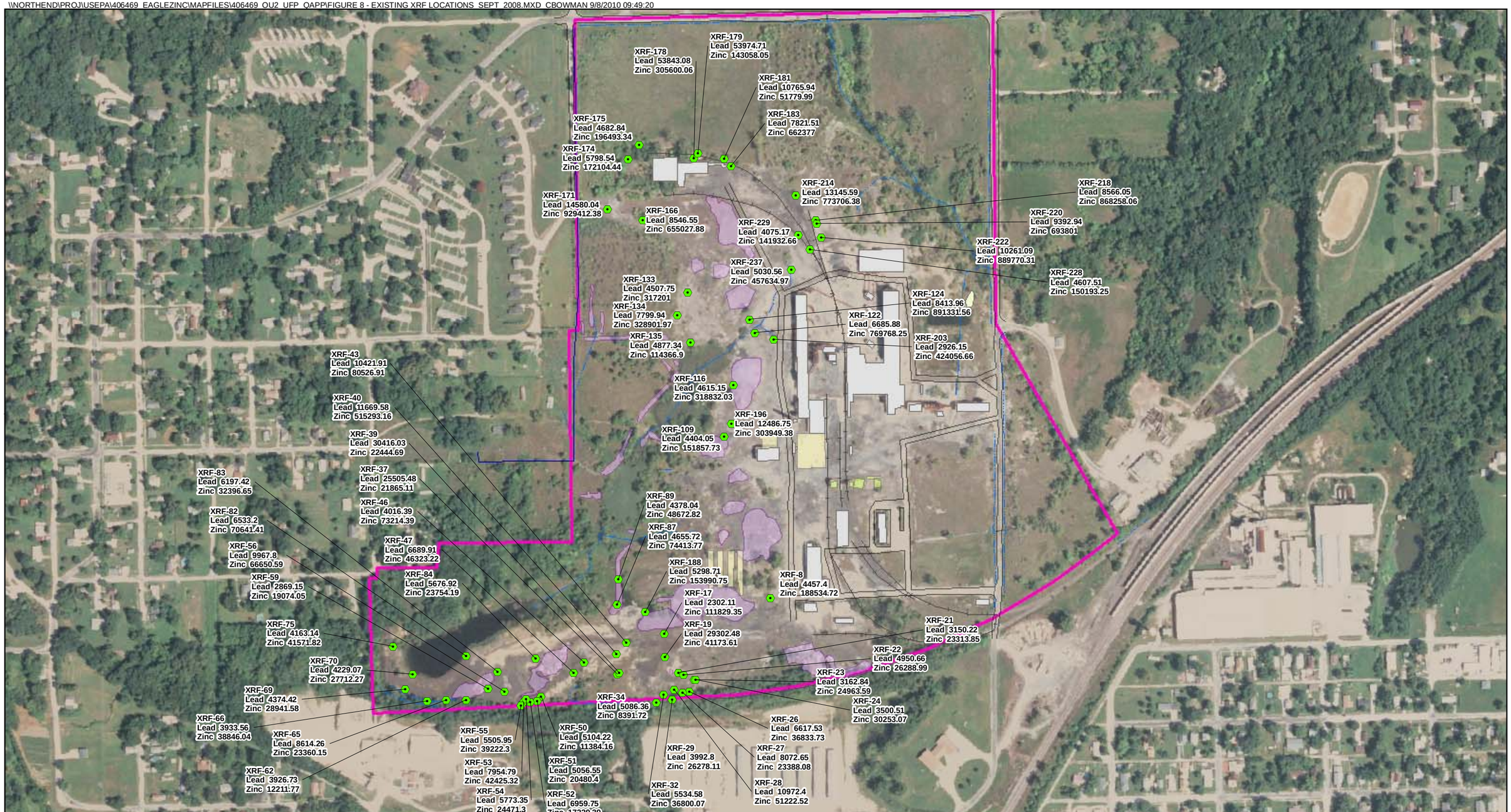
N
W E
S

0 125 250 500 Feet

Figure 7
Historical XRF Data
May 2008
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 8 - EXISTING XRF LOCATIONS_SEPT_2008.MXD CBOWMAN 9/8/2010 09:49:20



Legend

- XRF Locations
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

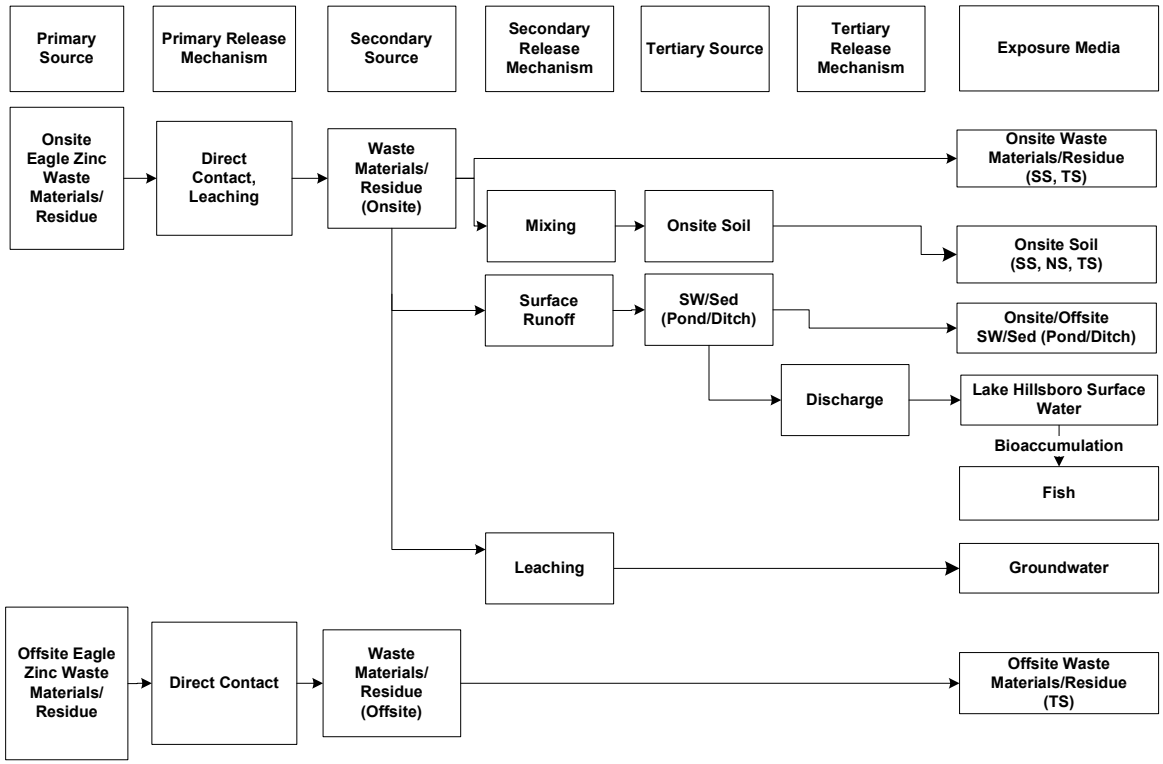
All units are ppm

N
W E
S

0 200 400 800 Feet

Figure 8
Historical XRF Data
September 2008
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL



		Potential Human Receptors			Potential Human Receptors		
		Onsite			Offsite		
		Current/Future	Future		Current/Future		Future
Exposure Route		Trespasser (Adolescent)	Industrial Worker	Construction Worker	Recreational Users (Adult/Child)	Residential (Adult/Child)	Construction Worker
Onsite Waste Materials/Residue (SS, TS)	Ingestion	X (SS)		X (TS)			
	Dermal Contact	X (SS)		X (TS)			
	Inhalation	X (SS)		X (TS)			
Onsite Soil (SS, NS, TS)	Ingestion	X (SS)	X (NS)	X (TS)			
	Dermal Contact	X (SS)	X (NS)	X (TS)			
	Inhalation	X (SS)		X (TS)			
Onsite/Offsite SW/Sed (Pond/Ditch)	Ingestion	X1			X2		
	Dermal Contact	X1			X2		
Lake Hillsboro Surface Water	Ingestion				X3	X3	
	Dermal Contact				X3	X3	
Fish	Ingestion				X4		
Groundwater	Ingestion		X			X5	
	Dermal Contact		X			X5	
	Inhalation		X			X5	
Offsite Waste Materials/Residue (TS)	Ingestion						X6 (TS)
	Dermal Contact						X6 (TS)
	Inhalation						X6 (TS)

Legend
X – Potentially complete exposure pathways identified
SS – Surface Soil (0-2 ft). NS – Native Soil. TS – Total Soil (0-10 ft).
SW – Surface Water. Sed – Sediment.

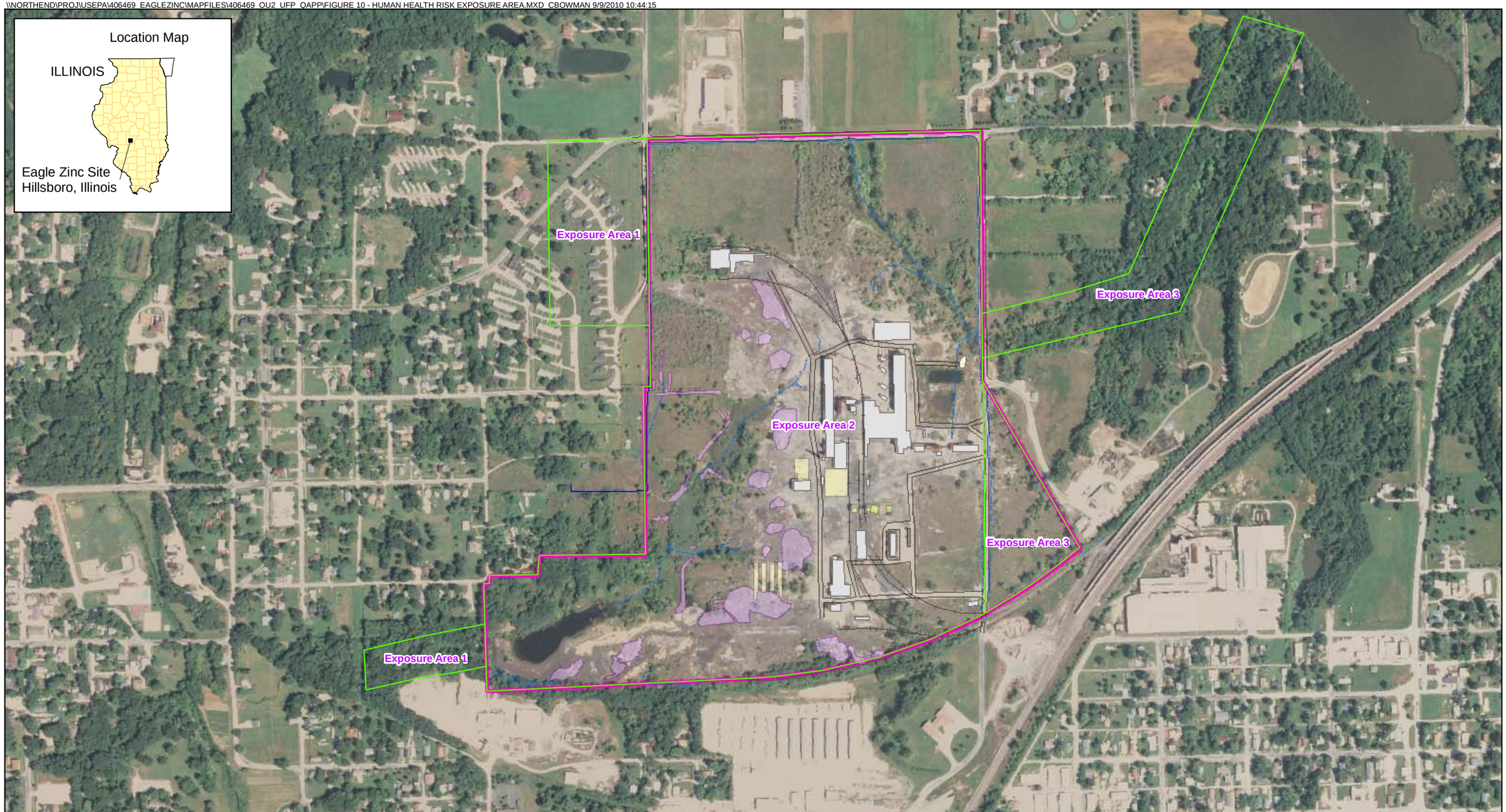
1 – Onsite sediment and surface water consists of the southwestern pond, western drainage ditch, eastern drainage ditch, small southern pond, and two retention basins.
2 – Offsite sediment and surface water consists of the western and eastern drainage ditches and Lake Hillsboro. Surface water discharges from the site via Stormwater Outfall 001 to the western drainage ditch and from Stormwater Outfall 002 to the eastern drainage ditch and Lake Hillsboro.
3 – Based on potential potable and recreational use of Lake Hillsboro surface water.
4 – Lake Hillsboro fish.
5 – Pathway potentially complete if offsite groundwater is impacted and private wells are present.
6 – Pathway potentially complete if waste material/residue is present offsite.

Note: Native Soil is soil situated immediately below waste material.

Figure 9
Preliminary Conceptual Exposure Model for the Human Health Risk Assessment
Eagle Zinc, Illinois

ES090210073328MKE

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 10 - HUMAN HEALTH RISK EXPOSURE AREA.MXD CBOWMAN 9/9/2010 10:44:15



Legend

- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert
- Exposure Areas

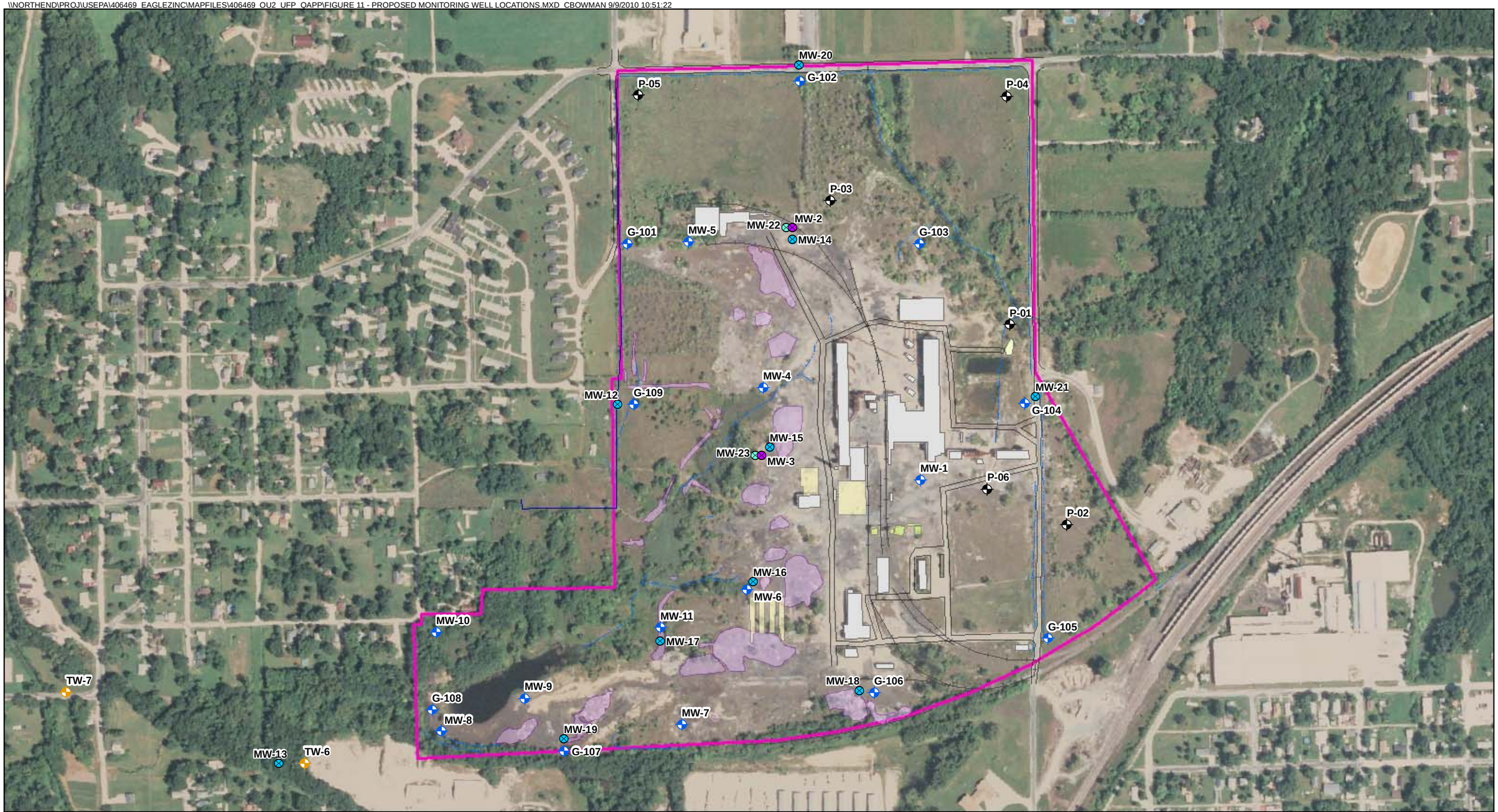
N
W E
S

0 250 500 1,000
Feet

Figure 10
Human Health Risk Exposure Areas
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 11 - PROPOSED MONITORING WELL LOCATIONS.MXD CBOWMAN 9/9/2010 10:51:22



Legend

- Proposed Replacement Monitoring Well
- Proposed Abandoned Monitoring Well
- Proposed Monitoring Well
- Existing Monitoring Well
- Existing Piezometer
- Existing Temporary Well
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

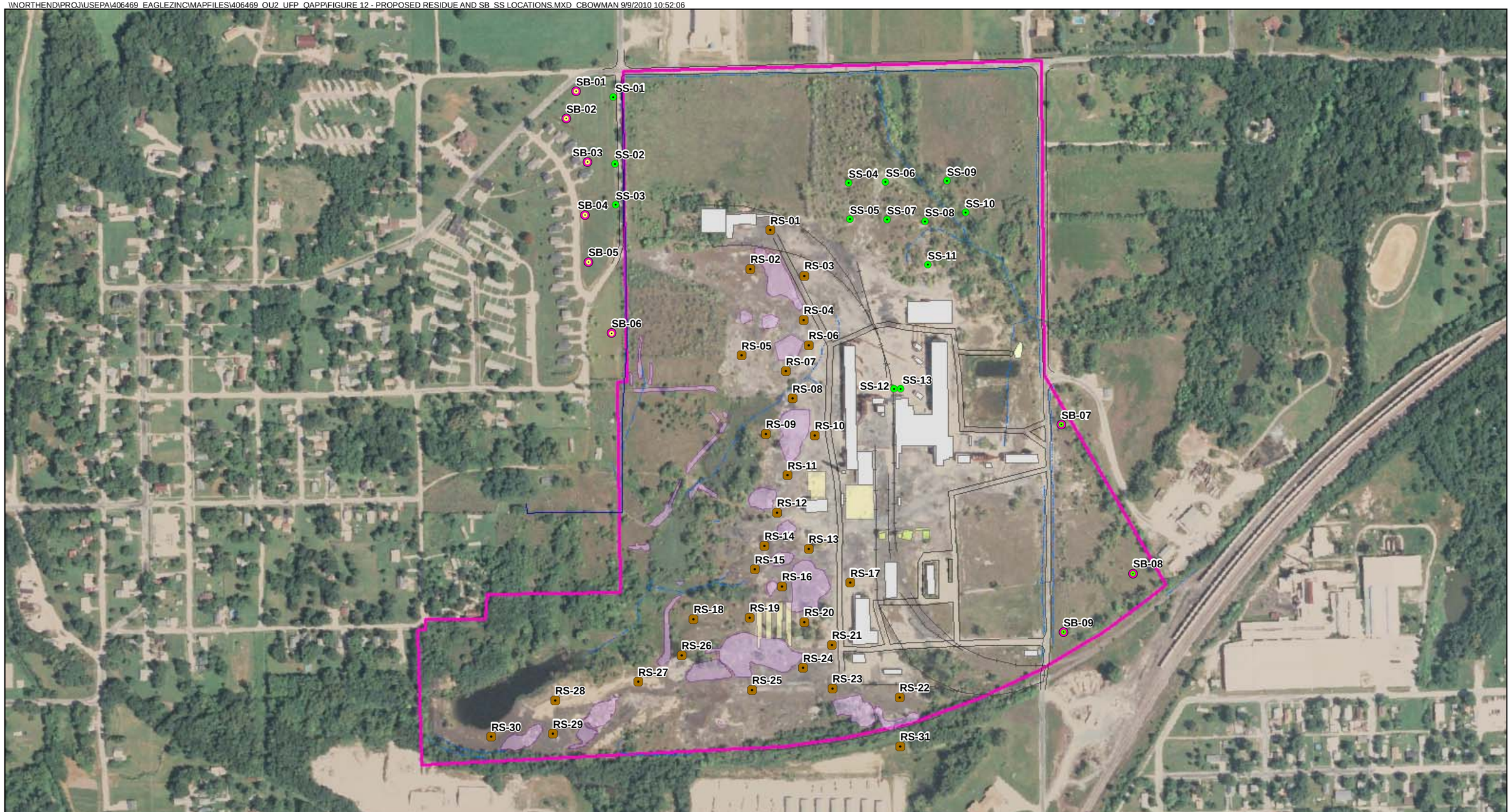
N
W E
S

0 200 400 800
Feet

Figure 11
Proposed Monitoring Well Locations
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 12 - PROPOSED RESIDUE AND SB_SS LOCATIONS.MXD CBOWMAN 9/9/2010 10:52:06



Legend

- Residential Soil Boring
- Residue/Soil Boring
- Soil Boring
- Surface Soil
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

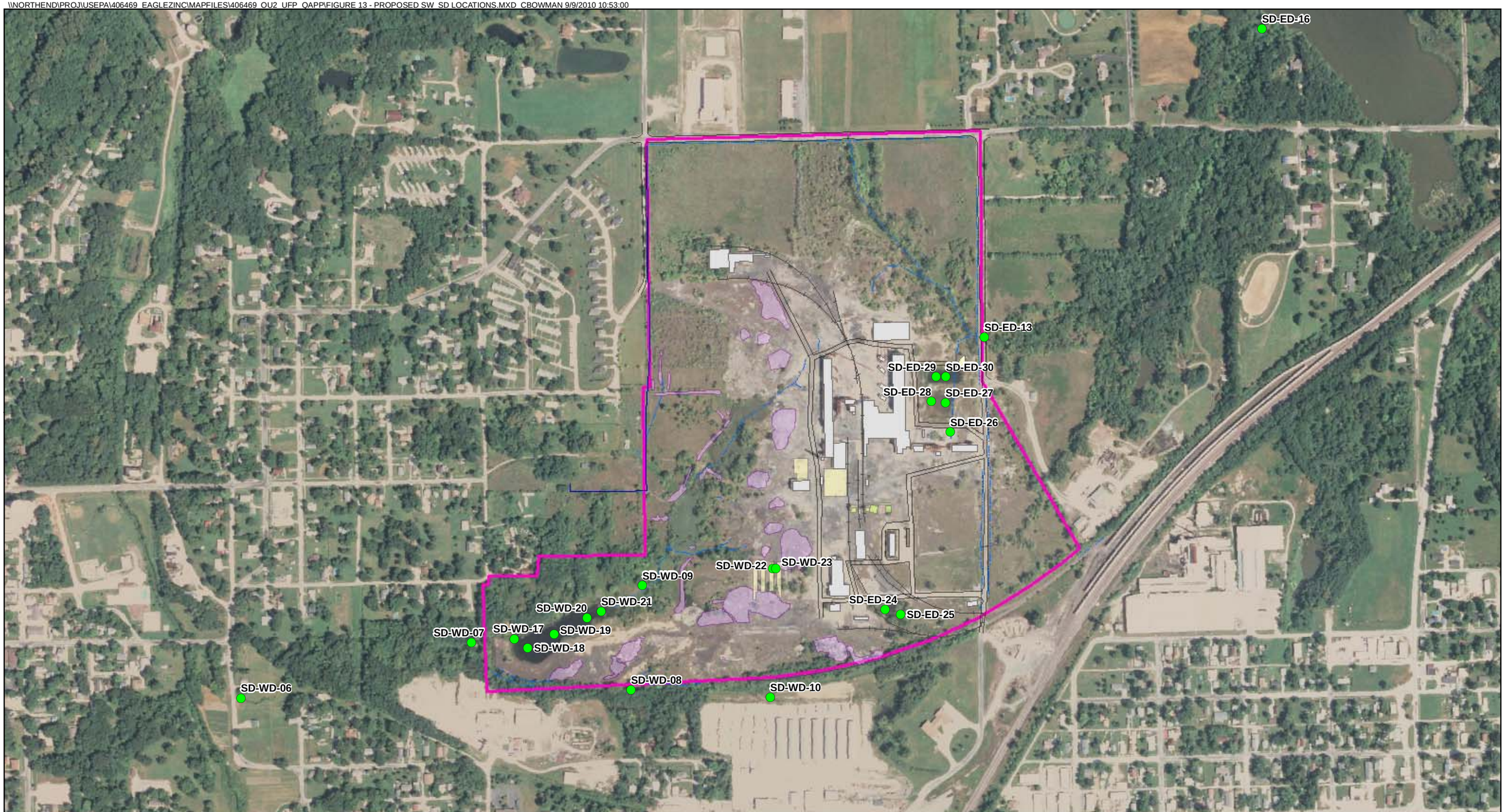
N
W E
S

0 200 400 800
Feet

Figure 12
Proposed Residue and Soil Sample Locations
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 13 - PROPOSED SW_SD LOCATIONS.MXD CBOWMAN 9/9/2010 10:53:00



Legend

- Surface Water and Sediment Location
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

N
W E
S

0 250 500 1,000
Feet

Figure 13
Proposed Surface Water and Sediment Sampling Locations
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 14 - PROPOSED CONCRETE CORE LOCATIONS.MXD CBOWMAN 9/9/2010 10:53:35

Legend

- Concrete Core
- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert

N
W E
S

0 125 250 500 Feet

Figure 14
Proposed Concrete Core Sample Locations
OU2 UFP-QAPP
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

Appendix A
Health and Safety Plan

Final Health and Safety Plan

OU2 Supplemental Remedial Investigation

Eagle Zinc Site, Hillsboro, Illinois
Revision #1

Prepared for

United States Environmental Protection Agency

November 2010

1034 South Brentwood Blvd
Suite 2300
Richmond Heights, MO 63117

Contents

1.0 INTRODUCTION 1-1

1.1 CH2M HILL POLICY AND COMMITMENT 1-2
1.1.1 Safe Work Policy 1-2
1.1.2 Health and Safety Commitment 1-2
1.1.3 Project-Specific Health, Safety, and the Environment Goals 1-2

2.0 APPLICABILITY 2-1

3.0 GENERAL PROJECT INFORMATION 3-1

3.1 PROJECT INFORMATION AND BACKGROUND 3-1
3.2 SITE BACKGROUND AND SETTING 3-1
3.3 DESCRIPTION OF TASKS 3-1
3.3.1 HAZWOPER-Regulated Tasks 3-1
3.3.2 Non-HAZWOPER Regulated Tasks 3-2

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 4-1

4.1 CLIENT 4-1
4.2 CH2M HILL 4-1
4.2.1 Project Manager 4-1
4.2.2 CH2M HILL Responsible Health and Safety Manager (RHSM) 4-2
4.2.3 CH2M HILL Safety Coordinator (SC) 4-2
4.3 CH2M HILL SUBCONTRACTORS 4-3
4.4 EMPLOYEE RESPONSIBILITIES 4-4
4.4.1 Employee Authority 4-5
4.5 CLIENT CONTRACTORS 4-5

5.0 STANDARDS OF CONDUCT 5-1

5.1 STANDARDS OF CONDUCT VIOLATIONS 5-1
5.2 DISCIPLINARY ACTIONS 5-1
5.3 SUBCONTRACTOR SAFETY PERFORMANCE 5-1
5.3.1 Observed Hazard Form 5-2
5.3.2 Stop Work Order 5-2
5.4 INCENTIVE PROGRAM 5-2
5.5 REPORTING UNSAFE CONDITIONS/PRACTICES 5-2

6.0 SAFETY PLANNING AND CHANGE MANAGEMENT 6-1

6.1 DAILY SAFETY MEETINGS AND PRE-TASK SAFETY PLANS 6-1
6.2 CHANGE MANAGEMENT 6-1

7.0 PROJECT HAZARD ANALYSIS 7-1

7.1 ACTIVITY HAZARD ANALYSIS (AHA) 7-1
7.2 SUBCONTRACTOR ACTIVITY HAZARD ANALYSIS 7-1

8.0 GENERAL HAZARDS AND CONTROLS 8-1

8.1 GENERAL PRACTICES AND HOUSEKEEPING 8-1
8.2 DRIVING SAFETY 8-2
8.3 PERSONAL HYGIENE 8-2
8.4 BLOODBORNE PATHOGENS 8-2
8.5 WORKPLACE HAZARD MATERIAL INFORMATION SYSTEM (WHMIS) 8-3
8.6 SUBSTANCE ABUSE 8-4
8.7 SHIPPING AND TRANSPORTATION OF CHEMICAL PRODUCTS 8-4

9.0 PROJECT-SPECIFIC HAZARD CONTROLS 9-1

9.1 ARSENIC 9-1
9.2 CADMIUM 9-1
9.3 DRILLING SAFETY 9-1
9.4 CONCRETE CORE DRILLING 9-2
9.5 DRUM HANDLING 9-3
9.6 DRUM SAMPLING SAFETY 9-3
9.7 ELECTRICAL SAFETY 9-4
9.7.1 General Electrical Safety 9-4
9.7.2 Portable Generator Hazards 9-5
9.8 FIELD VEHICLES 9-6
9.9 FIRE PREVENTION 9-6
9.9.1 Fire Extinguishers and General Fire Prevention Practices 9-7
9.10 GROUND SAMPLING/WATER LEVEL MEASUREMENTS 9-7
9.11 HAND AND POWER TOOLS 9-7
9.11.1 Machine Guarding 9-8
9.12 KNIFE USE 9-8
9.13 LEAD 9-10
9.14 MANUAL LIFTING 9-11
9.15 PRESSURE LINE/VESSEL SYSTEMS 9-11
9.16 PRESSURE WASHING OPERATIONS 9-12
9.17 TRAFFIC CONTROL 9-12
9.18 UTILITIES (UNDERGROUND) 9-13
9.18.1 Background and Records Assessment of Known Utilities 9-14
9.18.2 Designated Local Utility Locating Service 9-14
9.18.3 Independent Field Survey (Utility Locate) 9-14
9.18.4 Visual Assessment before and during Intrusive Activities 9-15
9.18.5 Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty 9-15
9.18.6 Intrusive Activities within 2 feet of an Underground Utility 9-15
9.18.7 Spotter 9-15
9.19 UTILITIES (OVERHEAD) 9-15
9.19.1 Proximity to Power Lines 9-15
9.20 VISIBLE LIGHTING 9-16
9.21 WORKING ADJACENT/OVER WATER 9-16
9.22 WORKING AROUND MATERIAL HANDLING EQUIPMENT 9-17

10.0 PHYSICAL HAZARDS AND CONTROLS 10-1

10.1 NOISE 10-1
10.2 ULTRAVIOLET RADIATION (SUN EXPOSURE) 10-1
10.2.1 Limit Exposure Time 10-1
10.2.2 Provide Shade 10-2
10.2.3 Clothing 10-2
10.2.4 Sunscreen 10-2
10.3 TEMPERATURE EXTREMES 10-2
10.3.1 Heat 10-2
10.3.2 Cold 10-5

11.0 BIOLOGICAL HAZARDS AND CONTROLS 11-1

11.1 BEES AND OTHER STINGING INSECTS 11-1
11.2 BIRD DROPPINGS 11-1
11.3 COYOTES 11-1
11.4 FERAL DOGS 11-1
11.5 MOSQUITO BITES 11-2
11.5.1 Symptoms of Exposure to the West Nile Virus 11-2
11.6 POISON IVY, POISON OAK, AND POISON SUMAC 11-2
11.7 SNAKES 11-4
11.8 SPIDERS - BROWN RECLUSE AND WIDOW 11-4
11.8.1 Hazard Controls 11-5
11.9 TICKS 11-5

12.0 CONTAMINANTS OF CONCERN (COC) 12-1

13.0 SITE MONITORING 13-1

13.1 DIRECT READING MONITORING SPECIFICATIONS 13-1
13.2 CALIBRATION SPECIFICATIONS 13-1
13.3 RESERVED INTEGRATED PERSONAL AIR SAMPLING 13-2
13.3.1 Method Description 13-2
13.3.2 Personnel and Areas 13-2

14.0 PERSONAL PROTECTIVE EQUIPMENT (PPE) 14-1

14.1 REQUIRED PPE 14-1
14.2 RESPIRATORY PROTECTION 14-2
14.2.1 Respirator Change-Out Schedule 14-3

15.0 WORKER TRAINING AND QUALIFICATION 15-1

15.1 CH2M HILL WORKER TRAINING 15-1
15.1.1 Hazardous Waste Operations Training 15-1
15.1.2 First Aid/Cardiopulmonary Resuscitation 15-2
15.1.3 Safety Coordinator Training 15-2
15.1.4 Site-Specific Training 15-2
15.1.5 Project-Specific Training Requirements 15-2

16.0 MEDICAL SURVEILLANCE AND QUALIFICATION 16-1

16.1 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE 16-1
16.2 RESPIRATOR USER QUALIFICATION 16-1
16.3 HEARING CONSERVATION 16-1

17.0 SITE-CONTROL PLAN 17-1

17.1 SITE-CONTROL PROCEDURES 17-1
17.2 REMEDIATION WORK AREA ZONES 17-1
17.2.1 Support Zone 17-1
17.2.2 Contamination Reduction Zone 17-1
17.2.3 Exclusion Zone 17-2
17.2.4 Other Controlled Areas 17-2

18.0 DECONTAMINATION 18-1

18.1 CONTAMINATION PREVENTION 18-1
18.2 PERSONNEL AND EQUIPMENT DECONTAMINATION 18-1
18.3 DECONTAMINATION DURING MEDICAL EMERGENCIES 18-2
18.4 WASTE COLLECTION AND DISPOSAL 18-2
18.5 DIAGRAM OF PERSONNEL-DECONTAMINATION LINE 18-2

19.0 EMERGENCY RESPONSE PLAN 19-1

19.1 PRE-EMERGENCY PLANNING 19-1
19.2 EMERGENCY EQUIPMENT AND SUPPLIES 19-1
19.3 INCIDENT RESPONSE 19-2
19.4 EMERGENCY MEDICAL TREATMENT 19-2
19.5 EVACUATION 19-2
19.6 EVACUATION SIGNALS 19-3
19.7 INCLEMENT WEATHER 19-3

20.0 SPILL CONTAINMENT PROCEDURES 20-1

21.0 INSPECTIONS 21-1

21.1 PROJECT ACTIVITY SELF-ASSESSMENT CHECKLISTS 21-1
21.2 SAFE BEHAVIOR OBSERVATIONS 21-1

22.0 INCIDENT NOTIFICATION, REPORTING, AND INVESTIGATION 22-1

22.1 GENERAL INFORMATION 22-1
22.2 SECTION DEFINITIONS 22-1
22.3 REPORTING REQUIREMENTS 22-1

22.4 HITS SYSTEM AND INCIDENT REPORT FORM (IRF) 22-2
22.5 SERIOUS INCIDENT REPORTING REQUIREMENTS 22-2
22.5.1 Serious Incident Determination 22-2
22.5.2 Serious Incident Reporting 22-3
22.6 INCIDENT ROOT CAUSE ANALYSIS 22-5
22.6.1 Personal Factors 22-5
22.6.2 Job Factors 22-5
22.6.3 Corrective Actions 22-6

23.0 RECORDS AND REPORTS 23-1

ATTACHMENTS

Attachment 1 Employee Signoff Form – Health and Safety Plan
Attachment 2 Chemical Inventory/Register Form
Attachment 3 Chemical-Specific Training Form
Attachment 4 Project Activity Self-Assessment Checklists/Forms/Permits
Attachment 5 Behavior Based Loss Prevention Forms
Attachment 6 Material Safety Data Sheets
Attachment 7 Working Alone Standard
Attachment 8 Tick Fact Sheet
Attachment 9 Observed Hazard Form
Attachment 10 Stop Work Order Form
Attachment 11 Vehicle Accident Guidance

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: Mark Orman **Date**: 11 November 2010

Field Operations Manager Approval: **Date:**

Project Manager Approval: Lisa Cundiff **Date:** 5 November 2010

Revisions

Revisions Made By: **Date:**

Description of Revisions to Plan:

Revisions Approved By: **Date:**

1.0 Introduction

CH2MHILL

HSSE Target Zero World-Class Performance

Health, Safety, Security, and Environment Policy

Protection of people and the environment is a CH2M HILL core value. It is our vision to create a culture within CH2M HILL that empowers employees to drive this value into all global operations and achieve excellence in health, safety, security, and environment (HSSE) performance. CH2M HILL deploys an integrated, enterprise-wide behavior-based HSSE management system to fulfill our mission and the expectations of our clients, staff, and communities based on the following principles:

- We require all management and supervisory personnel to provide the leadership and resources to inspire and empower our employees to take responsibility for their actions and for the actions of their fellow employees to create a safe, healthy, secure, and environmentally-responsible workplace.
- We provide value to clients by tailoring HSSE processes to customer needs and requiring all CH2M HILL employees and subcontractors to deliver projects with agility, personal service, and responsiveness and in compliance with HSSE requirements and company standards to achieve health, safety, security, and pollution prevention excellence. Our performance will aspire to influence others and continually redefine world-class HSSE excellence.
- We systematically evaluate our design engineering and physical work environment to verify safe and secure work conditions and practices are established, consistently followed, and timely corrected.
- We continually assess and improve our HSSE program to achieve and maintain world-class performance by setting and reviewing objectives and targets, reporting performance metrics, and routinely reviewing our progress.
- We care about the safety and security of every CH2M HILL employee and expect all employees to embrace our culture, share our core value for the protection of people and the environment, understand their obligations, actively participate, take responsibility, and "walk the talk" on and off the job.

The undersigned pledge our leadership, commitment, and accountability for making this policy a reality at CH2M HILL.

Dated the 2nd day of September 2008.

Ralph R. Peterson, Chairman of the Board & Chief Executive Officer

Robert C. Allen, Senior Vice President & Chief Human Resources Officer

Garry M. Higdem, President, Energy & Chemicals

Mark A. Lasswell, President & Chief Executive, Civil Infrastructure

Thomas G. Searle, President & Chief Executive, International

Bob C. Card, Chairman, CH2M HILL International

Lee A. McIntire, President & Chief Operating Officer; President & Chief Executive, Energy

Don S. Evans, Vice Chair, Board of Directors; Chief Marketing Officer

Catherine Santee, Senior Vice President & Chief Financial Officer

Michael E. McKelvy, President & Chief Executive, Industrial

Nancy R. Tuor, President & Chief Executive, Federal

Jacqueline Rast, President & Chief Executive, CPE

Keith Christopher, Senior Vice President, Health, Safety, Security, and Environment

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
- 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
- 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
- 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 Number: 406469

Client: USEPA

Project/Site Name: Eagle Zinc Site Operable Unit 2 (OU2)

Site Address: Industrial Park Drive, Hillsboro, IL

CH2M HILL Lisa Cundiff

CH2M HILL Office: STL

DATE HSP Prepared: 8/31/10

Date(s) of Site Work: 9/01/10 through 8/31/11

3.2 Site Background and Setting

The site is located in a mixed industrial/commercial/residential area in Hillsboro, Montgomery County, Illinois. The site is approximately 132 acres with about 30 acres of buildings and associated structures. There are about 23 buildings onsite that were previously used for facility operations; the types of buildings include offices laboratories, manufacturing/processing, equipment/raw material/finished product storage, bag houses and maintenance facilities. Also located onsite are railroad spurs, residual material, two stormwater retention ponds, a small pond and several roads. Active industrial operations ceased in 2003. The area has been zoned commercial/industrial and there are no plans to rezone the area for other uses.

Previous investigations have taken place since the early 1980s. The initial remedial investigation (RI) started in 2001 and a draft RI Report was produced in 2005. The previous investigations show multiple residue piles throughout the site that exceed screening levels. The contaminants of concern (COC) onsite include lead and cadmium. Other contaminants onsite include copper, zinc, and manganese. In 2008, the buildings and associated structures onsite were sampled via XRF and revealed significantly high levels of lead concentrations in, on, and around the building structures. This sampling event led the USEPA decision to complete an interim action to address the immediate threat posed by the buildings. A removal action was conducted in January 2009 to quickly mitigate site access and exposure; the action consisted of fence installation around the most accessible areas of the site.

The USEPA has divided the site into two operable units (OUs) to effectively deal with the short-term risks, lead in buildings, and the long-term risks, contaminated soil and groundwater onsite. OU-2 residue, soil, groundwater, surface water, and sediment are the focus of this Supplemental Remedial Investigation..

3.3 Description of Tasks

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

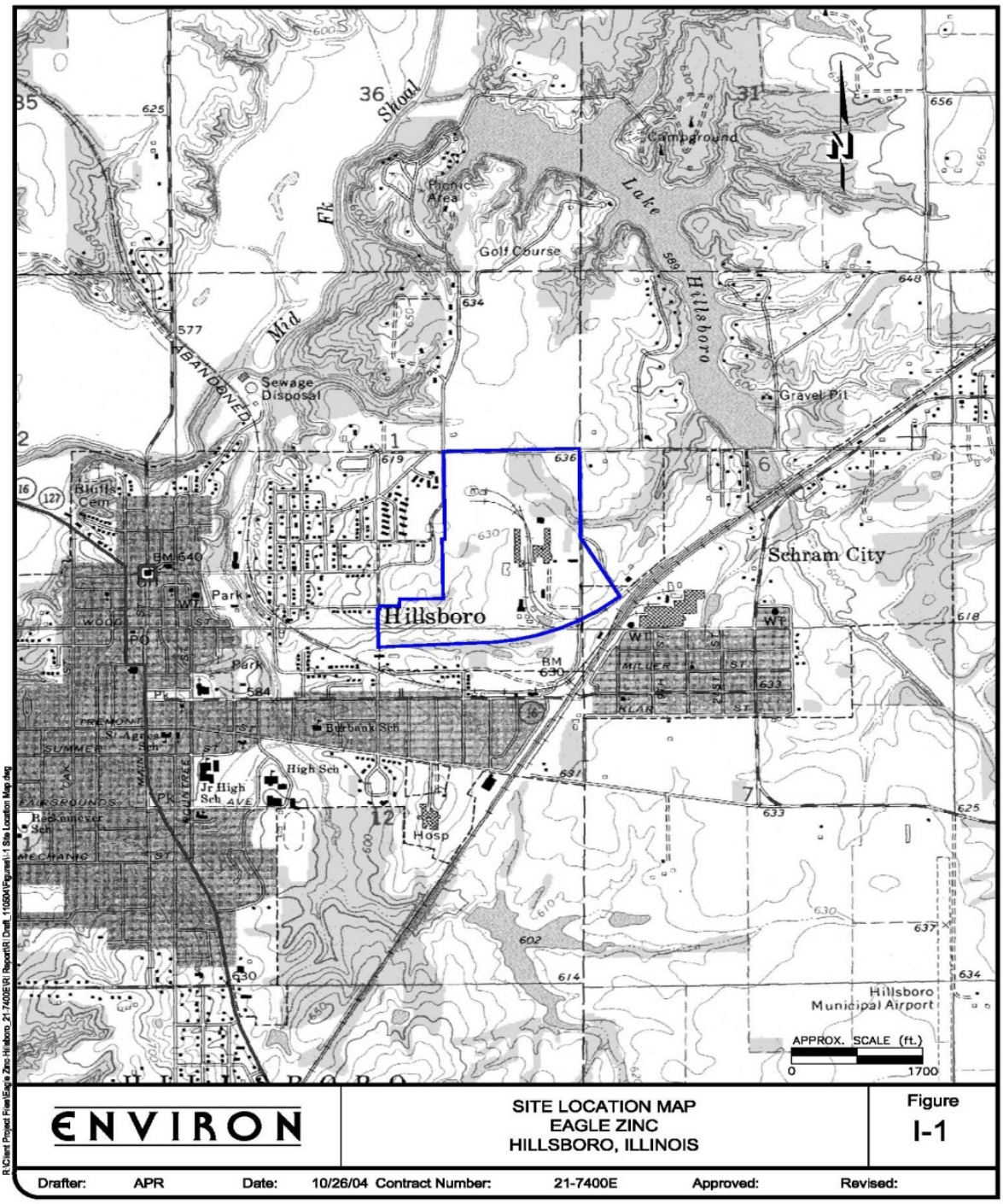
- Monitoring Well Installation
- Groundwater Sampling
- Residue Sampling
- Surface Water and Sediment Sampling
- Soil Boring Completion and Subsurface Sampling
- Survey of Monitoring Wells

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
• Site walk • Concrete coring, testing	• Brief on hazards, limits of access, and emergency procedures • Post areas of contamination as appropriate • Perform air sampling/monitoring as specified in this HSP

Site Map


Hillsboro
Schram City
Lake Hillsboro
Mid Fk Shoal
Campground
Picnic Area
Golf Course
Sewage Disposal
Gravel Pit
ABANDONED
Bluff Cem
Park
Burbank Sch
High Sch
Jr High Sch
Hosp
Hillsboro Municipal Airport
APPROX. SCALE (ft.)
0
1700
ENVIRON
SITE LOCATION MAP
EAGLE ZINC
HILLSBORO, ILLINOIS
Figure
I-1
Drafter: APR
Date: 10/26/04
Contract Number: 21-7400E
Approved:
Revised:

4.0 Project Organization and Responsibilities

4.1 Client

Contact Name: Nefertiti Simmons
Phone: 312-886-6148
Facility Contact Name: Use USEPA Contact Name (facility is vacant)
Phone: 312-886-6148

4.2 CH2M HILL

4.2.1 Project Manager

Project Manager Name: Lisa Cundiff
Job Title: Project manager
CH2M HILL Office: STL
Telephone Number: 314-335-3010
Cellular Number: 618-610-6120

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
  - 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/or procedures
- Manage the site and interfacing with third 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
- Support and implement use of stop-work orders when subcontractor safety performance is not adequate

4.2.2 CH2M HILL Responsible Health and Safety Manager (RHSM)

RHSM Name: Mark Orman
Job Title: ESBG Federal Sector HSM
CH2M HILL Office: MKE
Telephone Number: 414-847-0597
Cellular Number: 414-712-4138

The RHSM is responsible for the following:

- Review and evaluate subcontractor HSE performance using the prequalification 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/downgrades in respiratory protection after reviewing analytical data
- Conduct audits as determined by project schedule and coordination with PM
- Participate in incident investigations, lessons learned, loss/near loss reporting

4.2.3 CH2M HILL Safety Coordinator (SC)

SC Name: Laura Crause
Job Title: Staff Geologist
CH2M HILL Office: STL
Telephone Number: 314-335-3008
Cellular Number: 217-899-5498

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 available to site personnel include copies of executed subcontracts and subcontractor certificates of insurance (including CH2M HILL as named additional insured), bond, contractor's license, 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
- Post the Occupational Safety and Health Administration (OSHA) job-site poster; the poster is required at sites where project field offices, trailers, or equipment-storage boxes are established

- 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 third-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
- 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
- Document all verbal 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: EDI
Subcontractor Contact Name: Patricia Feely
Telephone: 312-345-1400 x 136

Subcontractor: Drilling
Subcontractor Contact Name: TBD
Telephone: TBD Subcontractor: Utility Clearance
Subcontractor Contact Name: TBD
Telephone: TBD

Subcontractor: Surveyors
Subcontractor Contact Name: TBD
Telephone: TBD

Subcontractor: IDW
Subcontractor Contact Name: TBD
Telephone: TBD

Subcontractor: Concrete Coring, materials testing
Subcontractor Contact Name: TBD
Telephone: TBD

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 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
- 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 field sampling plan. 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:

- Perform work in a safe manner and produce quality results
- Perform work in accordance with company policies, and report injuries, illnesses, and unsafe conditions
- Complete work without injury, illness, or property damage
- Report all incidents immediately to supervisor, and file proper forms with a human resources representative
- Report all hazardous conditions and/or hazardous activities immediately to supervisor for corrective action
- Complete an HSE orientation prior to being authorized to enter the project work areas

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: NA
Contact Name:
Telephone:
Contractor Task(s):

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 noncompliance 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
  - Notify the client, PM, and RHSM as appropriate

If apparent contractor noncompliance 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
- 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 noncompliance 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. 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 and RHSM.

When repeated noncompliance 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 Contract Administrator to determine what the contract dictates for actions to pursue in event of subcontractor noncompliance 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 proactive 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.
- 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 COCs or change in concentrations of COCs
- New hazards or hazards not previously identified that are not addressed in this HSP

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
- COCs

7.1 Activity Hazard Analysis (AHA)

An AHA defines the activity being performed, the hazards posed and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited 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. In addition, a listing of the equipment to be used to perform the activity as well as inspection requirements and training requirements for the safe operation of the equipment listed must be identified. The following hazard controls and applicable CH2M HILL core standards and SOPs should be used as a basis for preparing AHAs.

AHAs must be prepared for CH2M HILL activities and 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/or 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

Potential Hazard / Project Activity		Monitoring Well Installation	Groundwater Sampling	Soil Boring Completion and Subsurface Sampling	Residue Sampling	Surface Water and Sediment Sampling	Survey Monitoring Wells	Site Visit
Arsenic		X	X	X	X	X		
Biological Hazards		X	X	X	X	X	X	X
Cadmium		X	X	X	X	X		
Chemical Hazard		X	X	X	X	X		
Drilling		X		X				
Drum Handling		X	X	X	X	X		
Electrical Safety		X	X	X	X	X		
Field Vehicles		X	X	X	X	X	X	X
Fire Prevention		X	X	X	X	X	X	
Groundwater Sampling			X			X		
Hand and Power Tools		X	X	X	X	X	X	
IDW Drum Sampling		X	X	X	X	X		
Knife Use		X	X	X	X	X		
Lead		X	X	X	X	X		
Manual Lifting		X	X	X	X	X	X	
Noise		X	X	X				
Pressure Washing Equipment/ Decontamination		X	X	X	X	X		
Pressurized Lines/Equipment		X		X				
Temperature Extremes		X	X	X	X	X	X	X
Traffic Control		X	X	X	X	X	X	
Ultraviolet Light Exposure (sunburn)		X	X	X	X	X	X	X
Utilities (underground/overhead)		X	X	X	X	X		
Visible Lighting		X	X	X	X	X	X	X
Work Adjacent/Over Water/Boating safety						X		
Working Around Material Handling Equipment		X	X	X	X	X		
Work Alone								X

8.0 General Hazards and Controls

8.1 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.
- Structurally unsound buildings will not be entered.
- 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 the workplace and dispose of 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.
- Check the work area to determine what problems or hazards may exist.

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 and 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. 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 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
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics

8.4 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.
- 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)
- Administering post-exposure prophylaxis

8.5 Workplace Hazard Material Information System (WHMIS)

(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 onsite by CH2M HILL using the chemical inventory form included as an attachment to this HSP.
- Confirm that an inventory of chemicals brought onsite 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 onsite, obtain a material safety and date sheet (MSDS) for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific training using the chemical-specific training form included as an attachment to this HSP.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

The following are general guidelines for storing chemicals and other hazardous materials:

- Keep acids away from bases.
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals).
- Keep flammables and corrosives in appropriate storage cabinets.
- Do not store paper or other combustibles near flammables.
- Use secondary containment and lipped shelving that is secured.

- Have a fire suppression system available.

8.6 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
- 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).

8.7 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's Procedures for Shipping and Transporting Dangerous Goods)

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

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. 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 Arsenic

(Reference CH2M HILL, SOP HSE-501, *Arsenic*)

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride.
- Arsenic is considered a "Confirmed Human Carcinogen."
- Arsenic particulates (inorganic metal dust) are odorless. Vapor and gaseous odor varies depending upon specific organic arsenic compound.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

9.2 Cadmium

(Reference CH2M HILL SOP HSE-504, *Cadmium*)

- Do not enter regulated work areas unless training, medical monitoring, and personal protective equipment (PPE) requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Cadmium is considered a "Suspected Human Carcinogen."
- Cadmium particulates (fumes and dust) are odorless.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

9.3 Drilling Safety

- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. A minimum distance of 15 feet between mast and overhead lines (<50 killivolts [kV]) is recommended. Increased separation may be required for lines greater than 50 kV.

- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately

9.4 Concrete Core Drilling

Below are the hazard controls and safe work practices to follow when working around or performing concrete core drilling.

- Operators must read and understand the Operators Manual(s) for the equipment that will be used.
- Follow all manufacturers' operating instructions and comply with all warning labels on the equipment.
- Inspect equipment to ensure it is in proper operating condition prior to use. Equipment damage or missing parts must be corrected prior to operation.
- Follow all requirements for use of PPE. Minimum PPE includes hearing protection, safety glasses with side shields, safety toed boots. A face shield over safety glasses or liquid splash goggles may be required for wet coring.
- Inspect areas to be cored to ensure there are no obstructions, for example utilities on the opposite side of a wall to be cored through. Follow utility locate procedures for when coring slab on grade.
- Provide dust control (wet coring or local exhaust for dry coring) to avoid potential silica exposure.
- Make sure that all electrical wiring is grounded.
- The power supply line (electric cord, pneumatic or hydraulic line) must be protected from damage and routed to prevent it becoming a tripping hazard.
- When hydraulic coring equipment is uses, all workers must be aware of hydraulic lines running to the coring equipment. Preparations must be made for containment/ clean up in the event of a ruptured hydraulic line.
- All workers must keep their hands and body away from the cutting saw/ cable.

- The power supply must be disconnected when changing bits or conducting other maintenance on the equipment.
- Slippery conditions may exist in wet coring operations. Water needs to be controlled during cutting and proper safety toed footwear used to minimize slip potential.
- Use the Drilling Self-Assessment checklist to evaluate coring operations.

9.5 Drum Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums.

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries.
- Ensure drum bungs/lids are secured and drums are labeled prior to moving.
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; roller conveyor equipped with solid rollers; and drum carts designed specifically for drum handling.
- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface.
- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials.
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency.
- Supply operators with appropriate respiratory protective equipment when needed.
- Ensure that drums are secure and are not in the operator's view of the roadway.
- Prior to handling, all personnel should be warned about hazards of handling.
- Before moving anything, determine the most appropriate sequence in which the various drums and other containers should be moved (e.g. small containers may have to be removed first to permit heavy equipment to enter and move the drums).
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur.

9.6 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums.
- Sample only labeled drums or drums from a known waste stream.
- Do not sample bulging or swollen drums. Contact the RHSM.
- If drums contain, or potentially contain, flammable materials, use nonsparking tools to open.

- Use the proper tools to open and seal drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer/sample the content of drums using a method that minimizes contact with material.
- Use the PPE and perform air monitoring as specified in the PPE and site monitoring sections of this HSP.
- Have a spill kit accessible during sampling activities.
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

9.7 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.

9.7.1 General Electrical Safety

- 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 (LO/TO) 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 that 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
  - 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 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 ½ inch (1.27 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.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

9.7.2 Portable Generator Hazards

- Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire.
- NEVER use a generator indoors or in similar enclosed or partially-enclosed spaces. Generators can produce high levels of CO very quickly. When you use a portable generator, remember that you cannot smell or see CO. Even if you can’t smell exhaust fumes, you may still be exposed to CO.
- If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY. DO NOT DELAY. The CO from generators can rapidly lead to full incapacitation and death.
- If you experience serious symptoms, get medical attention immediately. Inform project staff that CO poisoning is suspected. If you experienced symptoms while indoors have someone call the fire department to determine when it is safe to re-enter the building.
- Follow the instructions that come with your generator. Locate the unit outdoors and away from doors, windows, and vents that could allow CO to come indoors.
- Keep the generator dry and do not use in rain or wet conditions. To protect from moisture, operate it on a dry surface under an open, canopy-like structure. Dry your hands if wet before touching the generator.
- Plug appliances directly into the generator. Or, use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads. Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.
- Most generators come with GFCI. Test the GFCIs daily to determine whether they are working.
- If the generator is not equipped with GFCI protected circuits plug a portable GFCI into the generator and plug appliances, tools, and lights into the portable GFCI.
- Never store fuel near the generator or near any sources of ignition.

- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.
- The frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator unless specified by the manufacturer.

9.8 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.
- Car rental must meet the following requirements:
  - Dual air bags
  - Antilock brakes
  - Be midsize or larger
- 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, 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 where it can be accessed easily 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 backup 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.

9.9 Fire Prevention

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

Follow the fire prevention and control procedures listed below.

9.9.1 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
  - Undergo a maintenance check each year
- The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- 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.

9.10 Ground Sampling/Water Level Measurements

- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel-toe boots (refer to Section 4).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to Section 5 on air monitoring).
- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M HILL SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- Wash exposed skin thoroughly with soap and water if dermal contact occurs with the groundwater and acid used in sample preservation.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.

9.11 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 Laboratory 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.).
- 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.

9.11.1 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.

9.12 Knife Use

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multipurpose 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 AHA or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training)

  Knife users have been trained and follow the AHA

Responsibilities	• Supervisors, with assistance from the FTL/SC, are responsible for funding, ensuring the correct tool is being used and employees are wearing the proper PPE when using knives, and reviewing this policy. • Employees are responsible for having and utilizing the proper PPE while performing an activity requiring the use of a knife. Employees are also responsible for understanding the proper use of a knife.
Glove Requirements	• In general, Kevlar cut resistant gloves are to be worn when using a knife in an occupational setting. • Other types of gloves may be required and will be identified within the AHA / written procedure. Example: Leather gloves may be worn when using the acetate sleeve cutter.
Training (Ref. VO for additional hand safety topics)	• All employees that will use a knife must be trained in the proper use. • When using a knife, always cut away from the body. • Many tasks using a utility knife require a knife edge, but not a sharp point. For these tasks, protection against puncture wounds can be added by using a rounded-tip blade. • If a folding knife is used, it must be a locking blade type. • Never use a knife that will fold under pressure. • If a fixed blade knife is used, make sure there is a handle guard to keep the hand from slipping forward. Also, make sure the handle is dry and non- greasy/slippery to ensure a better grip. • When cutting, make the force of the cut carry the blade away from any part of the body. For a peculiar situation where this is not possible, protect yourself with a leather apron, or other material placed between you and the blade. Consider placing the material to be cut in a vise, or other holding device. • If a fixed blade knife is carried, use a sheath or holder. • Store utility knives safely, retract the blade, or sheath an open blade before storing. Never leave a knife with the blade exposed on the floor, on a pallet, on a work surface, or in a drawer or cabinet. • Keep your knife sharp. A dull blade requires more force to cut and consequently, increases the risk of slip or mistake. • Knives used on the job, but not carried with you, must be properly stored when not in use. • Never use a defective knife. • Utility knife blades are brittle and can snap easily. Do not bend or apply side loads to them by using them to open cans or pry loose objects. Use the knife only to cut. It was not designed to work as a prybar, screw driver, hole punch, and other assorted things that make it seem so easy. • If you do get cut, seek medical attention to treat the injury by notifying your supervisor and contacting WorkCare at 1-866-893-2514.

- Examples of preferred tools and Kevlar cut resistant gloves:

- A safety spring provides for automatic blade "shoot-back" into the handle when contact w/cutting surface is lost
- **Stay focused on the cutting job.** It only takes a second of inattention with a sharp blade to produce a serious cut. Letting the mind wander or talking with others while using a knife greatly increases the risk of an accident and injury. If interrupted while working with a knife, stop cutting, retract the blade, and place the knife down on a secure surface before dealing with the interruption. Never continue cutting while distracted!
- As always, utilize the hierarchy of controls and first attempt to engineer out the hazard and then frequently question whether the right tool is being used for the job.

9.13 Lead

(Reference CH2M HILL SOP HSE-508, *Lead*)

CH2M HILL is required to control employee exposure to lead when exposures are at or above 30 $\mu g/m^3$ by implementing a program that meets the requirements of the OSHA Lead standard, 29 CFR 1910.1025 and 29 CFR 1926.62. The elements of the CH2M HILL lead program include the following:

- Exposure monitoring
- Methods of control, including PPE and respirators
- Medical surveillance
- Training on hazards of lead and control measures (includes project-specific training and the computer-based training on CH2M HILL's VO, *Lead Exposure Training)*

- Record keeping requirements

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

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

9.14 Manual Lifting

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

Back injuries are the leading cause of disabling work and most back injuries are the result of improper lifting techniques or overexertion. Use the following to mitigate the hazards associated with lifting:

- When possible, the task should be modified to minimize manual lifting hazards.
- Lifting of loads weighing more than 40 pounds (18 kilograms) shall be evaluated by the SC using the lifting evaluation form contained in SOP HSE-112.
- Using mechanical lifting devices is the preferred means of lifting heavy objects such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys.
- Personnel shall seek assistance when performing manual lifting tasks that appear beyond their physical capabilities.
- In general, the following steps must be practiced when planning and performing manual lifts:
- Assess the situation before you lift
- Ensure good lifting and body positioning practices
- Ensure good carrying and setting down practices
- All CH2M HILL workers must have training in proper manual lifting training either through the new employee orientation or through manual lifting module located on the VO.

9.15 Pressure Line/Vessel Systems

- Pressure vessels, pumps and hosing must be operated and maintained in accordance with the manufacturer's recommendations.
- The rated pressure of the vessels and hosing of the system must not be exceeded.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent of the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.

9.16 Pressure Washing Operations

- Only trained, authorized personnel may operate the high pressure washer.
- The manufacturer's safety and operating instructions must be followed.
- The pressure washer must be inspected before use and the deadman switch confirmed as fully operational.
- The wand must always be pointed at the work area.
- The trigger should never be tied down.
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches from the trigger to the tip.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum.

9.17 Traffic Control

(Reference CH2M HILL SOP HSE-216, *Traffic Control*)

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:

- Caution should be used when exiting a traveled way or parking along street. Avoid sudden stops, use flashers, etc.
- Vehicles must be parked in a manner that will allow for safe exit, and where practicable, in manner 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 (e.g., behind an established barrier, parked vehicle, guardrail, etc).
- Always pay attention to moving traffic—never assume drivers are looking out for you.

- Work as far from a 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 depend 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 with a flashing arrow sign and truck-mounted crash cushion (TMCC). 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.
- 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 your back faces oncoming traffic.

9.18 Utilities (underground)

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 <u>before any intrusive subsurface activity</u> and must include at least the following elements:

1. Background and records assessment of known utilities or other subsurface obstructions
2. Contact and use the designated local utility locating service
3. 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.*
4. Visual survey of the area to validate the chosen location

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then nonaggressive 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 RHSM and the PM.

9.18.1 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.

9.18.2 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.

9.18.3 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 resurvey the area. Obtain documentation of the survey and clearances in writing that are 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.

9.18.4 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, including 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.

9.18.5 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 nonaggressive means such as air or water knifing, hand digging, or human powered hand augering. Nonconductive 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 nonaggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

9.18.6 Intrusive Activities within 2 feet of an Underground Utility

Use nonaggressive 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.

9.18.7 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).

9.19 Utilities (overhead)

9.19.1 Proximity to Power Lines

No work is to be conducted within 50 feet (15.2 meters) of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet (15.2 meters) of overhead power lines without first making this determination.

Operations adjacent to overhead power lines are PROHIBITED unless one of the following conditions is satisfied:

- Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.
- The minimum clearance from energized overhead lines is as shown in the table below, or the equipment will be repositioned and blocked to ensure that no part, including cables, can come within the minimum clearances shown in the table.

MINIMUM DISTANCES FROM POWERLINES

Powerlines Nominal System Kv	Minimum Required Distance, Feet (Meters)
0-50	10 (3.0)
51-100	12 (3.7)
101-200	15 (4.6)
201-300	20 (6.1)
301-500	25 (7.6)
501-750	35 (10.7)
751-1000	45 (13.7)

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

- The power line(s) has been isolated through the use of insulating blankets that have been properly placed by the utility. If insulating blankets are used, the utility will determine the minimum safe operating distance; get this determination in writing with the utility representative's signature.
- All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the PM prior to the start of work.

9.20 Visible 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.
- Construction work conducted inside buildings should be provided with at least 55 lux light.
- The means of egress shall be illuminated with emergency and nonemergency lighting to provide a minimum 11 lux 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.

9.21 Working Adjacent/Over Water

During stream gauge installation, the SSC will assess site conditions and determine the need for the following. If any activities pose a risk to drowning, the following should be done during the activity:

- Fall protection should be provided to prevent personnel from falling into water. Where fall protection systems are not provided and the danger of drowning exists, U.S. Coast Guard (USCG)-approved personal flotation devices (PFDs), or a life jacket, shall be worn.
- Provide employees with an approved (USCG for U.S. operations) life jacket or buoyant work vest.
  - Employees should inspect life jackets or work vests daily before use for defects. Do not use defective jackets or vests.
- Post ring buoys with at least 90 feet of 3/8-inch solid-braid polypropylene (or equal) line next to the work area. If the work area is large, post extra buoys 200 feet or less from each other.
- Provide at least one life saving skiff, immediately available at locations where employees are working over or adjacent to water.

- Ensure the skiff is in the water and capable of being launched by one person and is equipped with both motor and oars.

- Designate at least one employee onsite to respond to water emergencies and operate the skiff at times when there are employees above water.
  - If the designated skiff operator is not within visual range of the water, provide him or her with a radio or provide some form of communication to inform them of an emergency.
  - Designated employee should be able to reach a victim in the water within 3 to 4 minutes.
- Ensure at least one employee trained in CPR and first aid is on site during work activities.
- No smoking is permitted on board vessels or during refueling operations.
- The boat skipper has the final authority with regard to boat safety and navigational safety.
- Use the checklist below to evaluate vessel integrity.

Marine Vessel Checklist		
	Yes	**N/A**
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		

9.22 Working Around Material Handling Equipment

When CH2M HILL personnel are exposed to material handling equipment, the following safe work practices/hazard controls shall be implemented:

- Never approach operating equipment from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment.

- Never turn your back on any operating equipment.
- Never climb onto operating equipment or operate contractor/subcontractor equipment.
- Never ride contractor/subcontractor equipment unless it is designed to accommodate passengers and equipped with firmly attached passenger seat.
- Never work or walk under a suspended load.
- Never use equipment as a personnel lift; do not ride excavator buckets or crane hooks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment on cross slopes and unstable terrain.

10.0 Physical Hazards and Controls

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 90 dBA 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.
- In areas or around equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 84 dBA or a noise dose of 50 percent 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 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 VO.
- 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.

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.

10.2.1 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.

10.2.2 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.

10.2.3 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.

10.2.4 Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Reapply 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 nonwaterproof 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

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)
- 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 the degree to which a worker's body has physiologically adjusted or acclimatized to working under hot conditions. Acclimatization affects their ability to do work. Acclimatized individuals sweat sooner and more profusely than unacclimatized individuals. Acclimatization occurs gradually over 1 to 2 weeks of continuous exposure, but it can be lost in as little as 3 days in a cooler environment.

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 degree Fahrenheit (ºF) (10 degrees Celsius [ºC]) to 60 ºF (15.6 º 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

The following procedures should be implemented when the ambient air temperature exceeds 70° F (21 ºC), the relative humidity is high (greater than 50 percent), or when the workers exhibit symptoms of heat stress.

- The heart rate should be measured by the radial pulse for 30 seconds, as early as possible in the resting period.
- The heart rate at the beginning of the rest period should not exceed 110 beats per minute or 20 beats per minute above resting pulse.
- If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same.
- If the pulse rate still exceeds 110 beats per minute 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 110 beats per minute, or 20 beats per minute above resting pulse.
- Alternately, the oral temperature can be measured before the workers have something to drink.
- If the oral temperature exceeds 99.6 ºF (37.6 ºC) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral temperature is maintained below 99.6 ºF (37.6 ºC). While an accurate indication of heat stress, oral temperature is difficult to measure in the field.

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 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.
- Follow the Incident Notification, Reporting, and Investigation section 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.

Noninsulating 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.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-chill index (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.
- NSC guidelines for work and warm-up schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor or 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. Rewarm 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.

T_{air} (°C) / V10 (km/h)	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	**-58**
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	**-57**	**-63**
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	**-60**	**-66**
20	1	-5	-12	-18	-24	-30	-37	-43	-49	**-56**	**-62**	**-68**
25	1	-6	-12	-19	-25	-32	-38	-44	-51	**-57**	**-64**	**-70**
30	0	-6	-13	-20	-26	-33	-39	-46	-52	**-59**	**-65**	**-72**
35	0	-7	-14	-20	-27	-33	-40	-47	-53	**-60**	**-66**	**-73**
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	**-61**	**-68**	**-74**
45	-1	-8	-15	-21	-28	-35	-42	-48	**-55**	**-62**	**-69**	**-75**
50	-1	-8	-15	-22	-29	-35	-42	-49	**-56**	**-63**	**-69**	**-76**
55	-2	-8	-15	-22	-29	-36	-43	-50	**-57**	**-63**	**-70**	**-77**
60	-2	-9	-16	-23	-30	-36	-43	-50	**-57**	**-64**	**-71**	**-78**
65	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-79**
70	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-80**
75	-3	-10	-17	-24	-31	-38	-45	-52	**-59**	**-66**	**-73**	**-80**
80	-3	-10	-17	-24	-31	-38	-45	-52	**-60**	**-67**	**-74**	**-81**

Notes

T_{air} = Actual Air Temperature in °C

V_{10} = Wind Speed at 10 meters in km/h (as reported in weather observations)

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 immediate supervisor.

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 worker's immediate supervisor. If a stinger is present, remove it carefully with tweezers. 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 Coyotes

While far from domesticated, coyotes show little fear of humans and have become comfortable living in close proximity to our communities. Although they tend to do most of their hunting after dusk, coyotes can be active at any time. Under normal circumstances, a coyote is not a danger to humans. They are, however, territorial and will respond aggressively if they or their family are threatened.

If you encounter a coyote that behaves aggressively, you have probably gotten too close to its prey or its family. Try to scare the coyote by yelling and waving your arms. Throw rocks, sticks or other objects. Do not turn away and run.

11.4 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, contact the worker's immediate supervisor. Report the incident to the local authorities.

11.5 Mosquito Bites

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

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing permethrin or N,N-diethyl-meta-toluamide (DEET) since mosquitoes may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35 percent DEET. Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

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

11.5.1 Symptoms of Exposure to the West Nile Virus

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

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

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the worker's immediate supervisor.

11.6 Poison Ivy, Poison Oak, and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in spring and summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in fall, but plants lose its (yellowed, then brown) leaves in winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons. These plants contain urushiol, a colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems, and leaves and causes allergic skin reactions when contacted. The oil is active year round.

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

Poison Ivy *Poison Sumac* *Poison Oak*

Contamination with poison ivy, sumac, or oak can happen through several pathways, including:

- Direct skin contact with any part of the plant (even roots once above ground foliage has been removed)
- Contact with clothing that has been contaminated with the oil
- Contact from removing shoes that have been contaminated (shoes are coated with urushiol oil)
- Sitting in a vehicle that has become contaminated
- Contact with any objects or tools that have become contaminated
- Inhalation of particles generated by weed whacking, chipping, vegetation clearing

If you must work on a site with poison ivy, sumac, or oak the following precautions are necessary:

- Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac, or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
- All tools used in the poison ivy, sumac, or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If onsite decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.
- PPE, including Tyvek® coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with Zanfel, Tecnu or other product designed for removing urushiol. If you do not have Zanfel or Tecnu wash with cold water. Do not take a bath, as the oils can form an invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Tecnu may also be used to decontaminate equipment.
- Use IvyBlock or similar products to prevent poison oak, ivy, and sumac contamination. Check with the closest CH2M HILL warehouse to see if these products are available. Follow all directions for application.

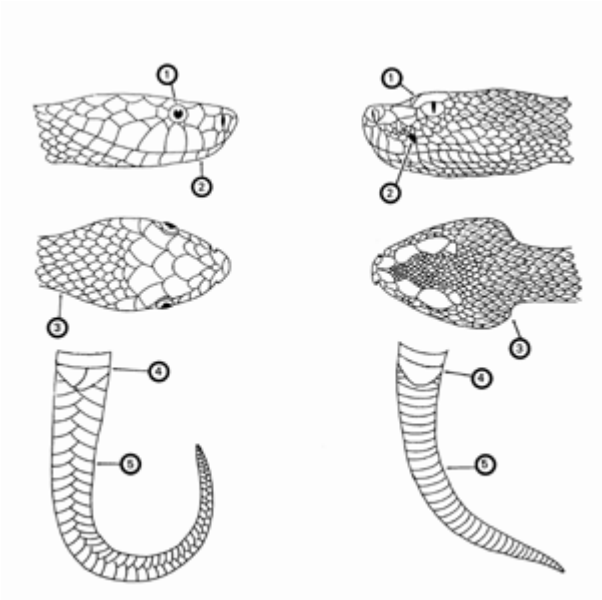
If you do come into contact with one of these poisonous plants and a reaction develops, contact your supervisor.

11.7 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 worker's immediate supervisor 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 nonpoisonous snakes.

Identification of Poisonous Snakes

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



11.8 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 nonaggressive. Keep an eye out for irregular, patternless 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.

11.8.1 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 your immediate supervisor 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.
- 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

11.9 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 millimeters) 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 (e.g., 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 preplanning 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 the tick fact sheet attached to this HSP 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.

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 bullseye 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 your medical provider, human resources representative, supervisor, and health and safety manager.

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

12.0 Contaminants of Concern (COC)

The table below summarizes the potential contaminants of concern (COC) and their occupational exposure limit and signs and symptoms of exposure. The table also includes the maximum concentration of each COC and the associated location and media that was sampled (groundwater, soil boring, surface soil). These concentrations were used to determine engineering and administrative controls described in the "Project-Specific Hazard Controls" section of this HSP, as well as PPE and site monitoring requirements.

Contaminants of Concern					
Contaminant	**Location and Maximum[a] Concentration (ppm)**	**Exposure Limit[b]**	**IDLH[c]**	**Symptoms and Effects of Exposure**	**PIP[d] (eV)**
Arsenic	Unknown	0.01 mg/m^3	5 Ca	Ulceration of nasal septum, respiratory irritation, dermatitis, gastrointestinal disturbances, peripheral neuropathy, hyperpigmentation	NA
Cadmium	Unknown	0.005 mg/m^3	9 mg/m^3 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
Chromium (as Cr(II) & Cr(III))	Unknown	0.5 mg/m^3	25 mg/m^3	Irritated eyes, sensitization dermatitis, histologic fibrosis of lungs	NA
Lead	Unknown	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
PCBs (Limits as Aroclor 1254)	Unknown	0.5 mg/m^3	5 CA	Eye and skin irritation, acne-form dermatitis, liver damage, reproductive effects	UK
Zinc oxide	Unknown	2 mg/m^3	500 mg/m^3	Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough	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
ug/m^3 = micrograms 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 30 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 Direct Reading Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency [b]	Calibration
Noise-Level Monitor[e]:	Drilling	<85 dB(A) 85-120 dB(A) 120 dB(A)	No action required Hearing protection required Stop; re-evaluate	Initially and periodically during task	Daily
Dust Monitor: Visual/DataRAM	All	No visual dust or <.01mg/m^3 visual dust or >.01mg/m^3	Level D Level C/engineering controls	Continuous	NA

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d]Noise monitoring and audiometric testing also required.

13.2 Calibration Specifications

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

Instrument	Gas	Span	Reading	Method
5 Gas Meter (MultiRAE) PID: OVM, 10.6 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
LEL/O_2/H_2S/CO Sensors	Methane	NA	2.5% (50% LEL)	1.5 lpm reg T-tubing
	Oxygen	NA	20.9%	1.5 lpm reg T-tubing
	Hydrogen Sulfide	NA	25 ppm	1.5 lpm reg T-tubing
	Carbon Monoxide	NA	50	1.5 lpm reg T-tubing
Noise Monitor	NA	NA	114 dBA	Modulator

Dust Monitor: DataRAM	Dust-free air	Not applicable	0.00 mg/m^3 in "Measure" mode	Dust-free area OR Z-bag with HEPA filter

Calibrate air monitoring equipment daily (or prior to use) in accordance with the instrument's instructions. Document the calibration in the field logbook (or equivalent) and include the following information:

- Instrument name
- Serial Number
- Owner of instrument (for example, CH2M HILL, HAZCO)
- Calibration gas (including type and lot number)
- Type of regulator (for example, 1.5 lpm)
- Type of tubing (for example, direct or T-tubing)
- Ambient weather condition (for example, temperature and wind direction)
- Calibration/instrument readings
- Operator's name and signature
- Date and time

13.3 Reserved Integrated Personal Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the RHSM immediately if these contaminants are encountered.

13.3.1 Method Description

NA during this initial SOW

13.3.2 Personnel and Areas

Results must be sent immediately to the RHSM. Regulations may require reporting to monitored personnel. Results reported to:

RHSM:
Other:

14.0 Personal Protective Equipment (PPE)

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

14.1 Required PPE

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 and maintain 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.
- Areas requiring PPE should be posted, or employees must be informed of the requirements in an equivalent manner.
- 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.
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

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

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
Monitoring Well Installation	Mod D	Cotton coveralls or Tyvek **Boots:** Safety-toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required
Equipment decontamination if using pressure washer	Modified D with splash protection	**Boots:** 16-inch-high steel-toed rubber boots **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] over safety glasses with side shields or splash goggles Ear protection [d]	None required.
Ground Water Sampling	D	Work clothes; safety toed leather work boots and surgical-style nitrile gloves	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required.
Soil Boring Completion of Subsurface Sampling	Mod D	Cotton coveralls or Tyvek **Boots:** Safety-toe, chemical-resistant boots OR Safety -toe, leather work boots with outer	Hardhat [c] Safety glasses with side shields	None required.

Project-Specific Personal Protective Equipment Requirements[a]				
Task	**Level**	**Body**	**Head**	**Respirator [b]**
		rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Ear protection [d]	
Residue Sampling	D	Work clothes; safety toed leather work boots and surgical-style nitrile gloves	Hardhat [c] safety glasses with side shields Ear protection [d]	None required.
Surface Water and Sediment Sampling	D	Work Clothes; safety toed leather work boots USCG Flotation vest, and surgical-style nitrile gloves	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required.
Survey of Monitoring Wells	D	Work clothes; safety toed leather work boots and gloves	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required.

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

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

14.2 Respiratory Protection

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

Implement the following when using respiratory protection:

- Respirator users must have completed appropriate respirator training within the past 12 months. Level C training is required for APR use and Level B training is required for supplied-air respirators, and self-contained breathing apparatus (SCBA) use. Specific training is required for the use of powered air-purifying respirators (PAPR).
- Respirator users must complete the respirator medical monitoring protocol and been approved for the specific type of respirator to be used.
- Tight-fitting facepiece respirator (negative or positive pressure) users must have passed an appropriate fit test within past 12 months.

- Respirator use shall be limited to those activities identified in this plan. If a change in site conditions change alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan.
- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use.
- Canisters/cartridges shall be replaced according to the change-out schedule specified in this plan. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade.
- Respirators in regular use shall be inspected before each use and during cleaning.
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition.
- Respirators shall be properly stored to protect against contamination and deformation.
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service.
- When breathing air is supplied by cylinder or compressor, the SC or RHSM shall verify the air meets Grade D air specifications.
- The SC or designee shall complete the health and safety self-assessment checklist – respiratory protection included in as attachment to this plan to verify compliance with CH2M HILL's respiratory protection program.

14.2.1 Respirator Change-Out Schedule

Contaminant	Change-Out Schedule
Arsenic, Cadmium, Chromium, Lead, PCB	End of shift

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.

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 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.

Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received 3 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.

Refresher Training

General site workers and treatment, storage, and disposal 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.

Eight-Hour Supervisory Training

Onsite 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 VO 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:

- HSPs/AHAs
- Lead/Asbestos awareness (CH2M HILL staff)
- ACM state certification – sample collection
- HAZWOPER
- Lead Risk Assessor license and training
- XRF training

16.0 Medical Surveillance and Qualification

All site workers participating in hazardous waste operations or emergency response 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 onsite hazardous waste operations or emergency response 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 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.

16.3 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
  - Two-way radio or cellular telephone, if available
- Establish offsite communication.
- Establish and maintain the "buddy system" unless approval is obtained from PM/HSM for use of lone worker program.

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. No eating, smoking or drinking is permitted while in the EZ.

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.
- 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 and 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.

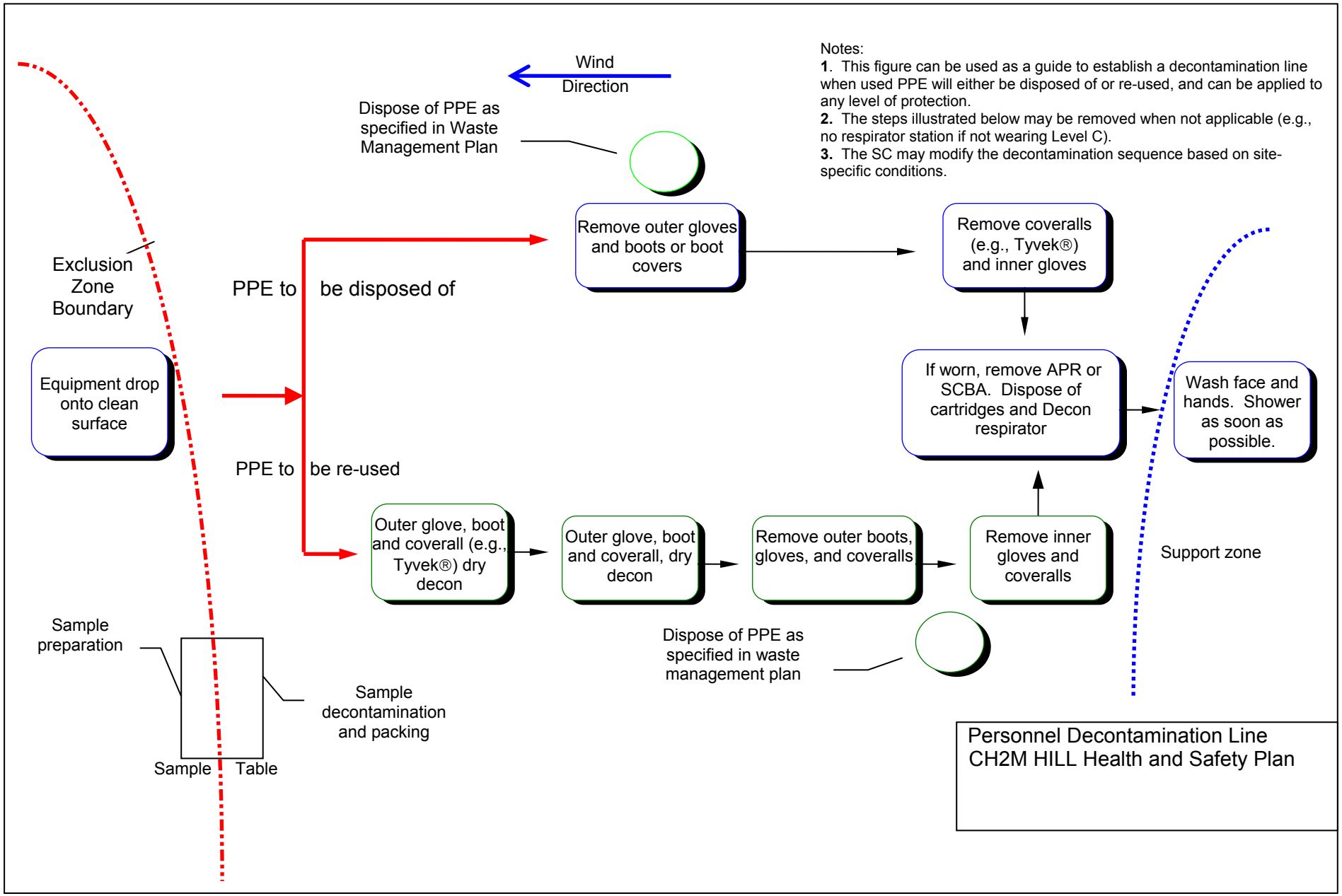
Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating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


Notes:
1. This figure can be used as a guide to establish a decontamination line when used PPE will either be disposed of or re-used, and can be applied to any level of protection.
2. The steps illustrated below may be removed when not applicable (e.g., no respirator station if not wearing Level C).
3. The SC may modify the decontamination sequence based on site-specific conditions.
Wind Direction
Dispose of PPE as specified in Waste Management Plan
Exclusion Zone Boundary
PPE to be disposed of
Remove outer gloves and boots or boot covers
Remove coveralls (e.g., Tyvek®) and inner gloves
Equipment drop onto clean surface
If worn, remove APR or SCBA. Dispose of cartridges and Decon respirator
Wash face and hands. Shower as soon as possible.
PPE to be re-used
Outer glove, boot and coverall (e.g., Tyvek®) dry decon
Outer glove, boot and coverall, dry decon
Remove outer boots, gloves, and coveralls
Remove inner gloves and coveralls
Support zone
Sample preparation
Dispose of PPE as specified in waste management plan
Sample decontamination and packing
Sample Table
Personnel Decontamination Line
CH2M HILL Health and Safety Plan

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 (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., 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.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital. Drills should take place periodically but no less than once a year.
- Brief new workers on the emergency response plan.
- The ERC will evaluate emergency response actions and initiate appropriate follow-up actions.

19.2 Emergency Equipment and Supplies

The ERC should mark the locations of emergency equipment on the site map and post the map.

Emergency Equipment and Supplies	Location
20 (or two 10) class A,B,C fire extinguisher	Field Vehicle
First-aid kit	Field Vehicle
Eye Wash	Field Vehicle
Potable water	Field Vehicle
Bloodborne-pathogen kit	Field Vehicle
Additional equipment (specify):Cell Phone	FTL/SSC

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.
- 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/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 worker's immediate supervisor 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.

19.7 Inclement Weather

Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Field crew members performing work outdoors should carry clothing appropriate for inclement weather. 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--seek low areas); staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Some other general precautions include:

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

Remember that lightning may strike several miles from the parent cloud, so work should be stopped/restarted accordingly. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap.

High winds can cause unsafe conditions, and activities should be halted until wind dies down. High winds can also knock over trees, so walking through forested areas during high-wind situations should

be avoided. If winds increase, seek shelter or evacuate the area. Proper body protection should be worn in case the winds hit suddenly, because body temperature can decrease rapidly.

Emergency Contacts

24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911

Medical Emergency – 911 **Facility Medical Response #:911** **Local Ambulance #:911**	**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
Fire/Spill Emergency – 911 **Facility Fire Response #:** 911 **Local Fire Dept #:** 911	**CH2M HILL Director – Health, Safety, Security & Environment** Andy Strickland/DEN (720) 480-0685 (cell) or (720) 286-2393 (office)
Security & Police – 911 **Facility Security #:** 911 **Local Police #:** 911	**CH2M HILL Responsible Health and Safety Manager (RHSM)** Name: Mark Orman Phone: 414-712-4138
Utilities Emergency Phone Numbers Water: 1811 Gas: 1811 Electric: 1811	Env. Compliance Mgr. Name: Terri Gerrish Phone: **973-632-0238**
CH2M HILL Project Manager Name: Lisa Cundiff Phone: 618-610-6120	**CH2M HILL Worker's Compensation:** Contact Business Group HR dept. to have form completed or contact Jennifer Rindahl after hours: (720) 891-5382
CH2M HILL Safety Coordinator (SC) Name: Laura Crause Phone: 217-899-5498	**Media Inquiries Corporate Strategic Communications** Name: John Corsi Phone: (720) 286-2087
CH2M HILL Project Environmental Manager Name: Phone:	**Automobile Accidents** Rental: Jennifer Rindahl/DEN: 720-286-2449 CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057
Federal Express Dangerous Goods Shipping Phone: 800/238-5355	**CHEMTEL (hazardous material spills)** **Phone: 800/255-3924**

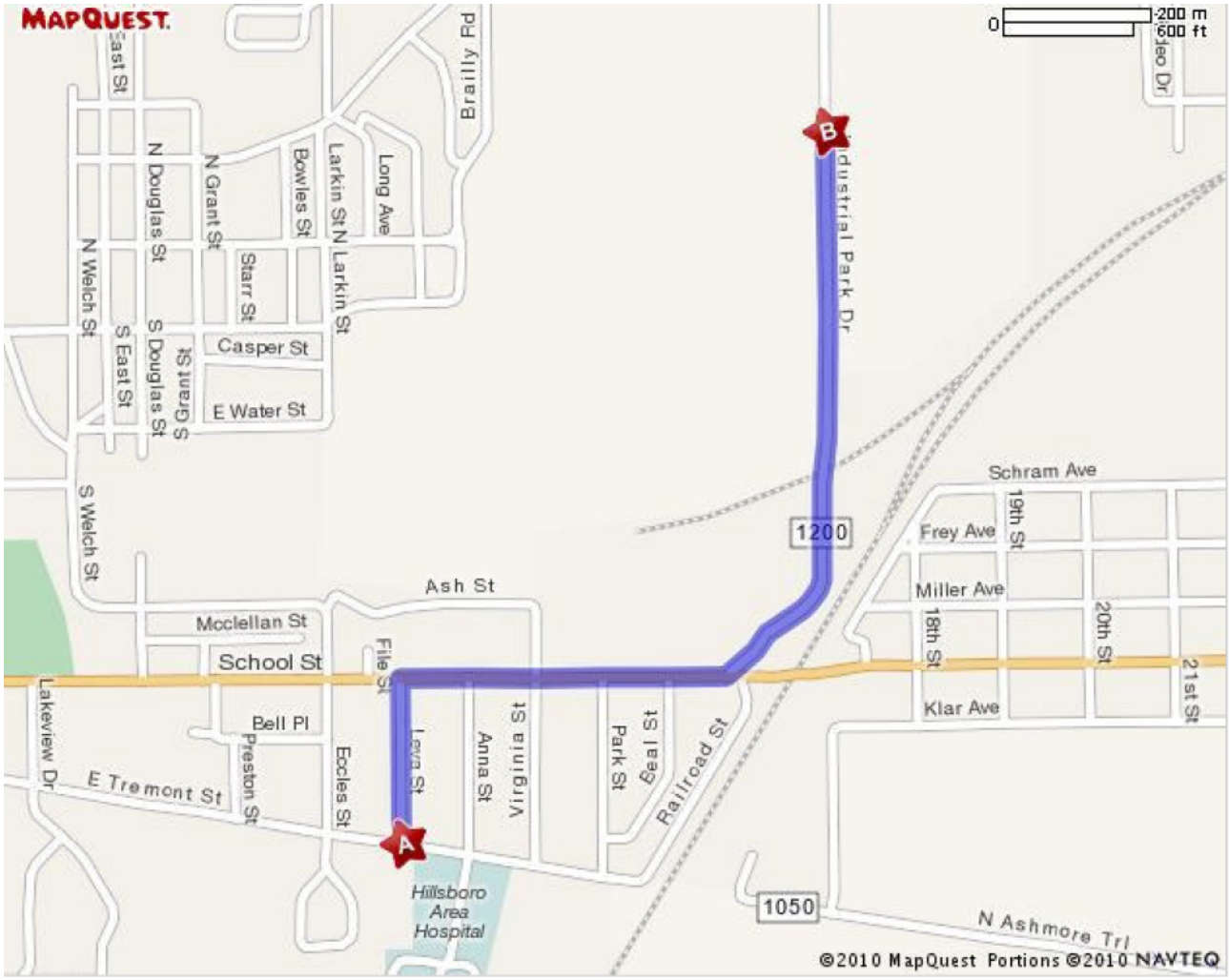
Facility Alarms: None	Evacuation Assembly Area(s):
Facility/Site Evacuation Route(s):	

Directions to Local Hospital

Local Hospital:

Hillsboro Area Hospital
1200 East Tremont Street
Hillsboro, IL 62046
(217) 532- 6111

1. Depart CR-1200 E / Industrial Park Dr toward SR-16 / School St - 0.7 miles
2. Bear right onto SR-16 / School St - 0.3 miles
3. Turn left onto Anna St - 0.2 miles
4. Turn right onto E Tremont St - 0.1 miles
5. Arrive



20.0 Spill Containment Procedures

CH2M HILL and subcontractor personnel working at the project site shall be knowledgeable of the potential HSE 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
- Follow the incident notification, reporting, and investigation section of this plan.

21.0 Inspections

21.1 Project Activity Self-Assessment Checklists

In addition to the hazard controls specified in this document, project activity self-assessment checklists are contained as an attachment to this HSP. The project-activity self–assessment checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SC.

The self-assessment checklists will also be used by the SC in evaluating the subcontractors and any client contractors' compliance onsite.

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

- Drilling
- Lead
- Manual Lifting

21.2 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 complete the SBO form (attached to this HSP) weekly. They shall be electrically submitted weekly by e-mailing them to the address CH2M HILL ES FED Safe Behavior Observation.

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 (e.g., hitting a utility)
- Incidents which attract negative media coverage
- Near misses
- Spills, leaks, or regulatory violations
- 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 undesired event that results or could have resulted in loss through injury, damage to assets, or environmental harm. This includes all of the definitions below.

Accident: An incident involving actual loss through injury, damage to assets, or environmental harm.

Near Miss: An unsafe act or incident that, in other circumstances, could have resulted in loss through injury, damage to assets, or environmental harm.

Serious Incident:

- All fatalities including contractors, subcontractors, third parties, or members of the public
- Kidnap/missing person
- 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
- Acts or threats of terrorism
- 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/site manager
- Date and time of incident
- Description of incident
- Extent of knowledge injuries/damage
- Level of medical attention
- Preliminary root cause/corrective actions

The SC shall complete an entry into the HITS database system located on CH2M HILL's VO (or if VO not available, use the hard copy IRF and root cause analysis form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

The CH2M HILL team shall comply with all applicable statutory incident reporting requirements such as those to OSHA and the police.

22.4 HITS System and Incident Report Form (IRF)

It is the policy of CH2M HILL to maintain a HITS entry and/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.

22.5 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 (HSSE) and Firm Wide Security Operations (FWSO) requirements for the consistent reporting of and managing of serious events throughout our operations.

22.5.1 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/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

22.5.2 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.

ESBG US Operations
Incident Reporting Flow Diagram

Direct Reporting Responsibility

Informational Reporting

Incident
- Injury or illness
- Hazardous substance exposure
- Damage to property
- Fire or explosion
- Spill, release, potential violation, or permit exceedance
- A "near-miss"

If incident is an **injury** to US or Puerto Rico based CH2M HILL personnel contact the Occupational Health Nurse at 866/893-2514. Outside the US, the supervisor must notify the HR

The Ops Leader is responsible for completing the IRF in **HITS** when there is an injury to a CH2M HILL employee. The PM, CM or SC is responsible for completing the IRF for all other incidents. ***The IRF/HITS must be completed within 24 hours of the incident and does not replace the required immediate PM and RHSM notifications.***

Incident
Ensure that Emergency Responders have been notified as necessary

Employee or Subcontractor
Provide immediate notification.

Supervisor – Construction Manager - Safety Coordinator
Provide immediate notification by phone and email to PM and RHSM. In addition, for spills, NOVs, and permit issues you may also call the EM.

CRISIS MANAGER:
If the incident meets the "**Serious Incident**" criteria, contact the Crisis Manager
(720.286.4911)

Third Party – Incidents outside of our contractual obligations do not need to be communicated, unless they are serious and/or may affect CH2M HILL. The RHSM will determine the level of communication necessary for third party incidents.

Serious Incident:
- 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 US 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.

Responsible HSM (RHSM)
Immediately notify the Sector OR Client Program HSE Manager, immediately notify the Responsible Environmental Manager (EM) for spills, NOVs, and permit issues, and direct the incident investigation.

Client Program HSE Manager
Notify Sector HSM, and coordinate communication and incident investigations.

Immediate notification to the Sector HSM is not required for some minor incidents. Follow the program or sector protocol.

Sector HSE Manager
Coordinate communication, direct significant incident investigations, notify Sector EM for spills, NOVs, & permit issues.

HSSE Director
Provide decision-making assistance or direction for incident resolution.

Project Manager
Provide notification to the Sector OR Program Project Delivery (PD) or Operations (Ops) Manager or designee. Notification is based on program or sector specific criteria.

Immediate notification to the PD/Ops Manager is not required for some minor incidents. Follow the program or sector protocol.

Sector or Program PD/Ops Manager
Notify Client Program Manager OR Sector Director, provide guidance and follow the incident through to resolution.

Client Program Manager
Notify Sector Director; provide decision-making assistance or direction for incident resolution.

Keep unnecessary communication of serious incidents to a minimum.

Sector Director
Provide decision-making assistance or direction for incident resolution.

ES US Operations Director/ Executive Leadership Team
Provide decision-making assistance, direction for incident resolution, and make higher level notifications as necessary

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.

22.6 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. The investigation team will consist of the SC (with support from RHSM), appropriate subcontractor personnel as necessary, the PM, and the responsible supervisor. More participants may be involved as needed to complete the investigation.

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 reinterview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must use the root cause analysis flow chart to assist in identifying the root cause(s) of a loss. Any loss may have one or more root causes and contributing factors. The root cause is the primary or immediate cause of the incident, while a contributing factor is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the person involved in the loss, his or her peers, or the supervisor should be referred to as "personal factors." Causes that pertain to the system within which the loss or injury occurred should be referred to as "job factors."

22.6.1 Personal Factors

- Lack of skill or knowledge
- Correct way takes more time and/or requires more effort
- Short-cutting standard procedures is positively reinforced or tolerated
- Person thinks there is no personal benefit to always doing the job according to standards

22.6.2 Job Factors

- Lack of or inadequate operational procedures or work standards
- Inadequate communication of expectations regarding procedures or standards
- 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.

22.6.3 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.

- The RHSM will inform the Responsible Environmental Manager (REM) of any environmental incidents.
- Evaluation and follow-up of the IRF will be completed by the type of incident by the RHSM, REM, or FWSO. The business group HSE Lead will review all business group incidents and modify as required.
- 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.
- 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, nonionizing radiation, vibration, and lasers exposure assessments, and measurements.
- Respiratory fit test records
- Training records
- Injury/illness reports and investigations
- Federal or state agency inspection records
- Other Records
  - Ergonomic evaluations
  - HSE audits and assessments
  - Project-Specific HSE Plans
  - Confined Space Entry Permits
  - Equipment inspections
  - Equipment maintenance
  - SBOs
  - Self-assessment checklists

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: Eagle Zinc **Project Number:** 406469

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: Eagle Zinc, Hillsboro, Illinois

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☒ Project:

Project No.: 406469

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: Eagle Zinc	Project # : 406469
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

Project Activity Self-Assessment Checklists/Permits/Forms

- Drilling
- Lead
- Manual Lifting

CH2MHILL

HS&E Self-Assessment Checklist - DRILLING

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

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

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

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

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

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

SECTION 1 - SAFE WORK PRACTICES (4.1)

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

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

8. Driller license/certification obtained	☐	☐	☐	☐
9. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
10. Water withdrawal permit obtained, where required	☐	☐	☐	☐
11. Dig permit obtained, where required	☐	☐	☐	☐

UTILITY LOCATING (4.2.2)

12. Location of underground utilities and structures identified	☐	☐	☐	☐

SECTION 2 (Continued)

	Yes	No	N/A	N/O
WASTE MANAGEMENT (4.2.3)				
13. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (4.2.4)				
14. Waste disposed of according to project's written safety plan	☐	☐	☐	☐
15. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT MUNITIONS RESPONSE (4.2.5)				
16. MEC plan prepared and approved	☐	☐	☐	☐
17. MEC avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
18. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
19. Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS (4.3)				
GENERAL (4.3.1)				
20. Only authorized personnel operating drill rigs	☐	☐	☐	☐
21. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
22. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (4.3.2)				
23. Location of underground utilities and structures identified	☐	☐	☐	☐
24. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
25. Drilling pad established, when necessary	☐	☐	☐	☐
26. Drill rig leveled and stabilized	☐	☐	☐	☐
27. Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (4.3.3)				
28. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
32. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (4.3.4)				
33. Kill switch clearly identified and operational	☐	☐	☐	☐
34. All machine guards are in place	☐	☐	☐	☐
35. Rig ropes not wrapped around body parts	☐	☐	☐	☐
36. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
37. Drill operation stopped during inclement weather	☐	☐	☐	☐
38. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
39. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG SITE CLOSURE (4.3.5)				
40. Ground openings/holes filled or barricaded	☐	☐	☐	☐
41. Equipment and tools properly stored	☐	☐	☐	☐
42. All vehicles locked and keys removed	☐	☐	☐	☐
DRILL RIG MAINTENANCE (4.3.6)				
28. Defective components repaired immediately	☐	☐	☐	☐
29. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
30. Cathead in clean, sound condition	☐	☐	☐	☐
31. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
32. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater	☐	☐	☐	☐
33. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
34. Good housekeeping maintained on and around rig	☐	☐	☐	☐

SECTION 4

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

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

CH2MHILL

HS&E Self-Assessment Checklist—Lead

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

This checklist is to be used at locations where: (1) CH2M HILL employees are exposed to lead operations and/or (2) CH2M HILL provides oversight of subcontractor personnel who are exposed to lead operations.

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

Completed checklists shall be sent to the HS&E Staff for review.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to lead hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with the lead standard and its requirements
Subcontractors Name: _____

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

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-508.

SECTION 1

PERSONNEL SAFE WORK PRACTICES (3.1)	Yes	No	N/A	N/O
1. Work activities identified where there is a potential for lead exposure.	☐	☐	☐	☐
2. Surfaces tested where lead may be present.	☐	☐	☐	☐
3. Regulated areas have been identified and marked.	☐	☐	☐	☐
4. Personnel entering into regulated areas have been trained and medically qualified.	☐	☐	☐	☐
5. No eating, drinking, smoking, chewing, or applying cosmetics in regulated areas.	☐	☐	☐	☐
6. Respiratory protection and other controls selected as per direction of competent person.	☐	☐	☐	☐
7. Work progresses from areas of less contamination to areas of higher contamination	☐	☐	☐	☐
8. Water is added to soil prior to and during ground intrusive work to minimize dust generation	☐	☐	☐	☐
9. Personnel in vicinity of ground intrusive activities are wearing disposable coveralls or equal	☐	☐	☐	☐
10. Personnel exercising enhanced personal hygiene near contaminated soil operations	☐	☐	☐	☐

SECTION 2

	Yes	No	N/A	N/O
EXPOSURE ASSESSMENTS (3.2.2)				
11. The exposure assessment has been completed.	☐	☐	☐	☐
12. Air monitoring data supporting the exposure data is available.	☐	☐	☐	☐
13. PPE is appropriate for the type of activity and concentration.	☐	☐	☐	☐
14. Personnel have been provided PPE, hygiene facilities, biological monitoring, and training during initial exposure determination.	☐	☐	☐	☐
15. An assessment has been conducted for each process, personnel, or control.	☐	☐	☐	☐
16. New assessment conducted when a change occurs in process, personnel, or controls.	☐	☐	☐	☐
17. Air monitoring results above the AL but below the PEL have been sampled in the last 6 months.	☐	☐	☐	☐
18. Air monitoring results above the PEL have been sampled in the last 3 months.	☐	☐	☐	☐
19. The exposure assessment based on theoretical calculations, historical data, or other information has been verified.	☐	☐	☐	☐
COMMUNICATION OF HAZARDS (3.2.3)				
20. Training on the lead standard and Appendix A and B of the lead standard has been met.	☐	☐	☐	☐
21. The Written Compliance Program is available.	☐	☐	☐	☐
22. Warning Signs have been posted in areas above the PEL	☐	☐	☐	☐
23. Notification of owners, tenants, and contractors has been made.	☐	☐	☐	☐
CONTROL METHODS (3.2.4)				
24. Engineering and work practices are implemented in areas at or above the PEL.	☐	☐	☐	☐
25. The mechanical ventilation has been assessed to control lead exposures.	☐	☐	☐	☐
26. Where administrative controls are used, a job rotation schedule has been implemented.	☐	☐	☐	☐
27. A written compliance program is established and implemented.	☐	☐	☐	☐
28. All surfaces are clean of lead dust accumulation.	☐	☐	☐	☐
29. Vacuums are equipped with HEPA filters.	☐	☐	☐	☐
30 Compressed air is not used to remove lead or control lead dust.	☐	☐	☐	☐
31. Employees not allowed to eat, drink, or smoke in regulated areas.	☐	☐	☐	☐
32. Change areas are available when regulated areas are in use.	☐	☐	☐	☐
33. PPE used in lead operations not worn by employees off the worksite.	☐	☐	☐	☐
34. Personal hygiene facilities (showers and wash facilities) are available in areas above the PEL.	☐	☐	☐	☐
35. Employees required to wash hands and face at end of shift and prior to eating, smoking, etc.	☐	☐	☐	☐
36. Eating facilities, free of lead contamination, provided and readily accessible.	☐	☐	☐	☐
PERSONAL PROTECTIVE EQUIPMENT (3.2.5)				
37. Respirators are used in areas at or above the PEL.	☐	☐	☐	☐
38. The selection of the appropriate respirator is based on the airborne lead concentration.	☐	☐	☐	☐
39. All other required PPE (coveralls, gloves, goggles, etc) and equipment provided to employees.	☐	☐	☐	☐
40. PAPRs have been made available to employees who request them.	☐	☐	☐	☐
41. Clean & dry protective clothing provided weekly; daily to employees exposed over 200 $\mu g/m^3$	☐	☐	☐	☐
42. Clothing to be laundered is labeled with “Caution” signs.	☐	☐	☐	☐
43. Businesses and personnel laundering contaminated clothing have been informed of lead hazard.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: ____________________________

CH2MHILL

HSE Self-Assessment Checklist—Lifting

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

This checklist is to be used at locations where: (1) CH2M HILL employees perform manual lifting activities (office or projects), and/or (2) CH2M HILL provides oversight of a subcontractor performing manual lifting activities.
SC or Office Safety Coordinators/Committee members may consult with subcontractors (if applicable) when completing this checklist but shall not direct the means and methods of activities nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and we must carefully rely on their expertise. Conditions considered imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazardous area until corrected.
Complete the appropriate project or office information:

Project Information
Project Name: _____ Project No.: _____
Location: _____ PM: _____
Auditor: _____ Title: _____ Date: _____

Office Information
Office Location: _____
Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:
☐ Evaluate CH2M HILL employee manual lifting activities.
☐ Evaluate a CH2M HILL subcontractor's manual lifting activities.
Subcontractor Name: _____

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

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-112.

Planning Activities	**Yes**	**No**	**N/A**	**N/O**
1. Efforts have been made to inquire about receiving equipment or supplies in containers weighting less than 50 pounds (23 kilograms).	o	o	o	o
2. Equipment or supplies are being delivered as close as possible to their use point.	o	o	o	o
3. Heavy equipment or supplies are being stored off the ground and no lower than knee height.	o	o	o	o
4. Adequate space has been provided to access and lift equipment or supplies without reaching or twisting.	o	o	o	o
Safe Work Practices (5.1)	**Yes**	**No**	**N/A**	**N/O**
5. Tasks or activities have been modified to reduce or minimize manual lifting.	o	o	o	o

6. All employees performing manual lifting have received training on how to lift safely.	o	o	o	o
7. Manual lifting control measures are evaluated during assessments.	o	o	o	o
8. Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
9. Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
Office Environments (5.1.1)	**Yes**	**No**	**N/A**	**N/O**
10. Employees have received lifting training.	o	o	o	o
11. Mechanical devices are readily available to employees handling equipment or supplies weighing more than 40 pounds (18 kilograms).	o	o	o	o
Field Projects (5.1.2)	**Yes**	**No**	**N/A**	**N/O**
12. All manual lifting tasks or activities have been addressed in the written site safety plan.	o	o	o	o
13. Employees have received safe lifting training as required by the written site safety plan.	o	o	o	o
Mechanical Lifting (5.2)	**Yes**	**No**	**N/A**	**N/O**
14. Hand trucks and trolleys are visually inspected before use.	o	o	o	o
15. Hand trucks and trolleys do not have any broken or damaged parts.	o	o	o	o
16. Hand truck and trolley paths are free of uneven surfaces, water, oil, or cracks and holes.	o	o	o	o
17. Loads carried by hand trucks are balanced and sturdy.	o	o	o	o
18. Hand trucks or dollies are being pushed when on level ground.	o	o	o	o
19. When going up or down a slope using a hand truck or trolley, the load is downslope of the person.	o	o	o	o
20. Employees using hand trucks or dollies are moving slowly and cautiously.	o	o	o	o
21. Employees using hand trucks or trolleys are able to see over the load.	o	o	o	o
Assisted Lifting (5.3)	**Yes**	**No**	**N/A**	**N/O**
22. Personnel are not performing manual lifting beyond their physical capabilities.	o	o	o	o
23. Loads are evenly distributed when being handled by multiple people.	o	o	o	o
Manual Lifting (5.4)	**Yes**	**No**	**N/A**	**N/O**
24. Before the lift, the load and path was assessed.	o	o	o	o
25. Loads being lifted are free of sharp edges, slivers, or wet or greasy spots.	o	o	o	o
26. Gloves are used for manual lifts of loads with sharp or splintered edges.	o	o	o	o
27. Employees performing manual lifts use the proper lifting techniques.	o	o	o	o
28. Special tools fabricated for lifting grates or manhole covers are used.	o	o	o	o

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

CH2M HILL Health and Safety Plan

Attachment 5

Behavior Based Loss Prevention System Forms

Activity Hazard Analysis

Pre-Task Safety Plans

Safe Behavior Observation

Incident Report and Investigation

(use electronic form when possible)

HITS

CH2M HILL Health and Safety Plan

Attachment 6

Material Safety Data Sheets

(Included as material is obtained)

CH2M HILL Health and Safety Plan

Attachment 7

Working Alone Standard

CALL – IN CONTACT FORM

Date of site work:_____ Expected start time:_____

Name of CH2M HILL employee in the field:_____

Name of CH2M HILL employee responsible to receive contact:

Client Emergency Contact (if any):

CH2M HILL employee's contact numbers:

Radio #_____

Cell Phone #_____

Address and Location of work:_____

Directions/Map:

Planned Activity: _____

Specified Frequency and time for call in:_____

Time	Verified	Location

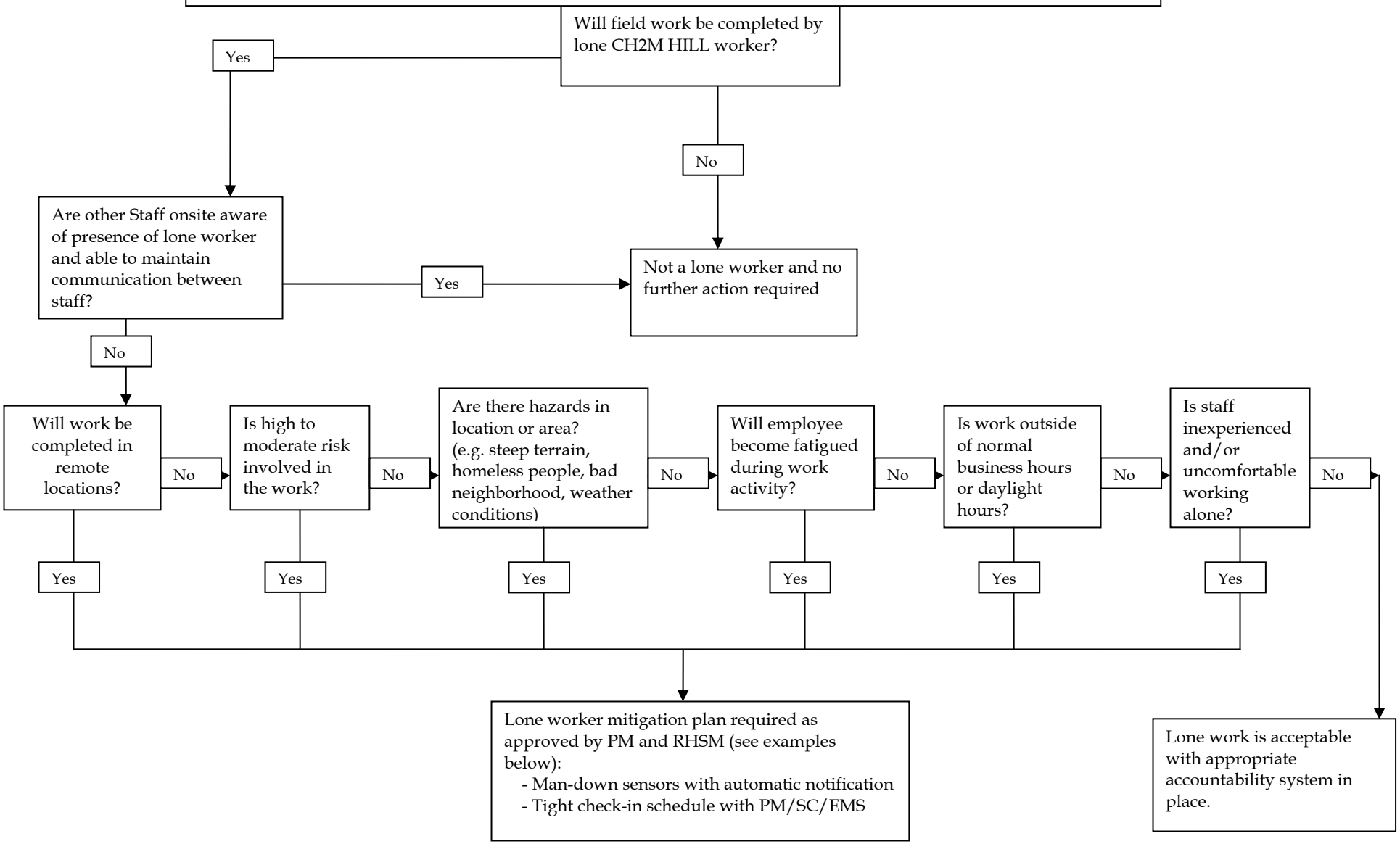
If lone worker fails to call in at specified frequency/time:

1) Call worker's radio and cell to determine if an emergency exists.
2) If no reply, immediately call Client security/emergency service if there is one at the site.

3) If there is no client security, call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency onsite. Provide the lone worker's name, their last known location, and your contact information.

4) After Emergency Services have been contacted, call the other emergency contacts, Project Manager, and Responsible Health and Safety Manager.

Lone Worker Protocol



MKE/102600001

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 8

Tick Fact Sheet

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 and 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 and 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

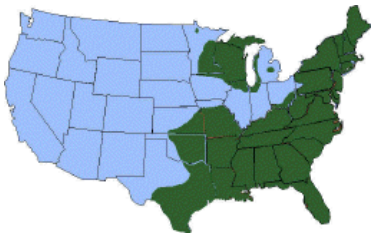
sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

Deer Tick

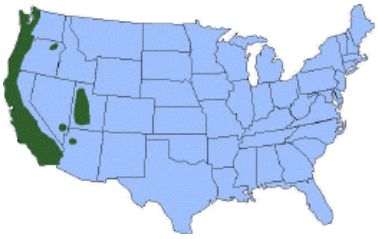
From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)

Dog Tick

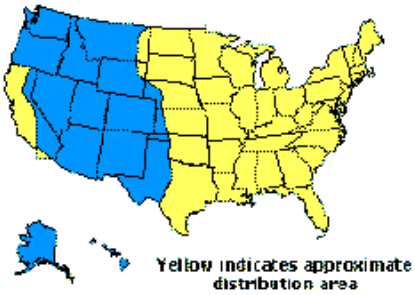
Rocky Mountain Wood Tick

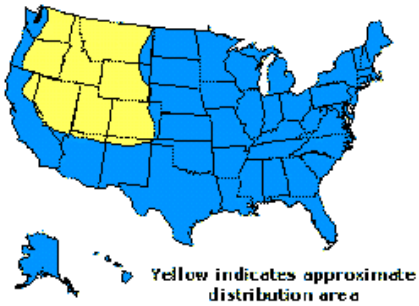


Distribution of Deer Tick (dark green)



Distribution of Pacific Deer Tick (dark 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

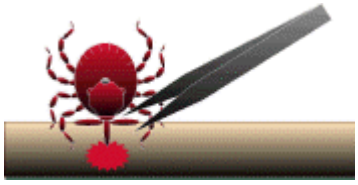
A tick check should be performed after field survey before entering the field vehicle (you do not want to infest your field vehicle with ticks). Have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thoroughly as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self check.

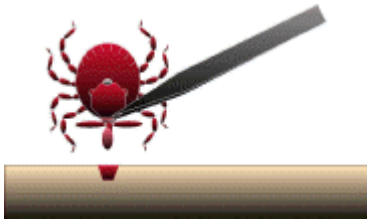
If a tick has embedded itself into the skin, remove the tick as described below.

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.

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—reinfection from future tick bites can occur even after a person has contracted a tick-borne disease.

CH2M Hill has a protocol in place for employees who have experienced a tick bite due to work-related activities, to test all ticks that have been removed from them for the presence of Borrelia burgdorferi.

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 9

Observed Hazard Form

CH2MHILL

OBSERVED HAZARD FORM

Name/Company of Observer (*optional*):

Date reported:_____

Time reported:_____

Contractor(s) performing unsafe act or creating unsafe condition:

1. _____

2. _____

3. _____

Unsafe Act or Condition:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Location of Unsafe Act or Condition:

Name of CH2M HILL Representative:

_____

Corrective Actions Taken: Date: _____

_____

_____

_____

_____

_____

Project Safety Committee Evaluation: Date: _____

_____

_____

_____

_____

_____

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 10

Stop Work Order Form

CH2MHILL

Stop Work Order

REPORT PREPARED BY:

Name:	**Title:**	**Signature:**	**Date:**

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:
	_____

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	**Title:**	**Signature:**	**Date:**

**** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by CH2M HILL Constructors, Inc. Representative,***

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:
	_____

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	**Title:**	**Signature:**	**Date:**

CH2M HILL HEALTH AND SAFETY PLAN
Attachment 11

Vehicle Accident Guidance

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.

Please see link below to print out an insurance card (for **CH2M HILL employees** only). The page shows state-specific restrictions and the definitions of hired, owned, etc., vehicles.

https://communities.int.ch2m.com/legal/insurance/Shared%20Documents/AutoID_Cards.aspx?PageView=Shared

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)

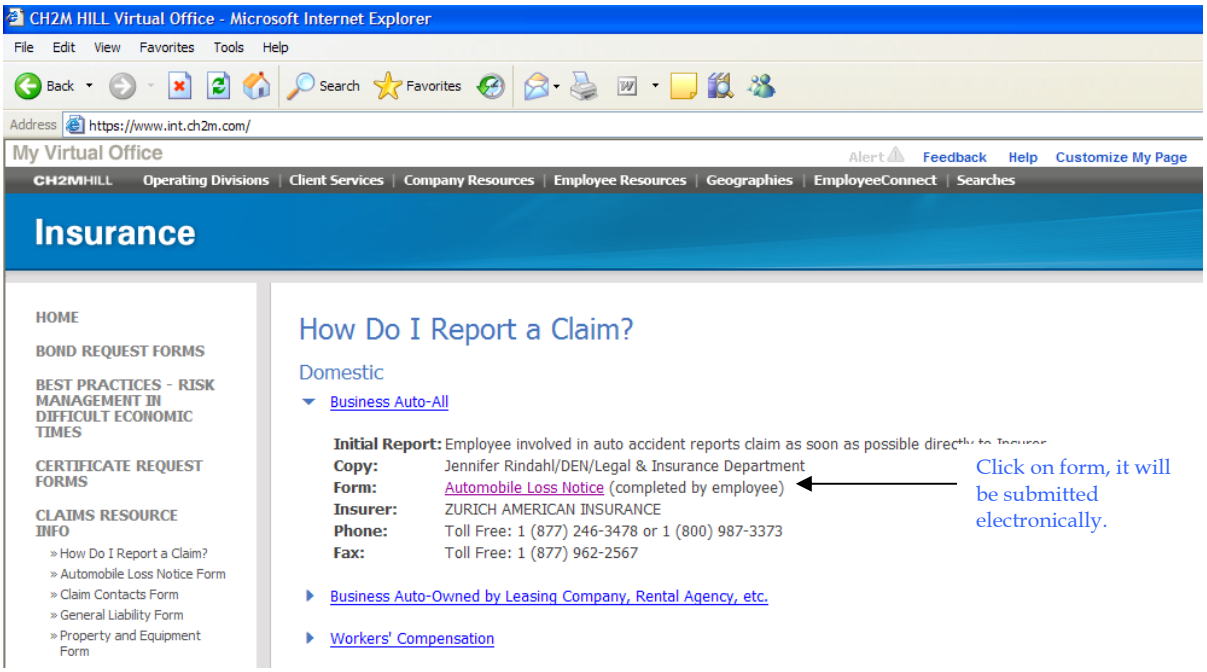
4. Complete a HITS report on the VO.

Additional Steps for FLEET VEHICLES:

Definition: These are vehicles **rented for greater than 90 days** or rentals that are **leased** (either through ARI [Automotive Rental, Inc.] or leases from other companies [older fleet vehicles]).

Report the accident to the following:

1. Fill out and Auto Loss Notice on the Virtual Office (click "Company Resources," then "Corporate Groups," then "Insurance"). See screen shot below.



2. Contact Zurich (1-877-246-3478 or 1-800-987-3373).

3. Contact Linda George/DEN at 720-286-2057.

Note: If you are an ES employee that happens to use an **OMI vehicle** on a project and get into an accident, you must also contact Michelle Garlington/DEN (720-286-4273).

Additional Steps for RENTALS:

1. Fill out and Auto Loss Notice on the Virtual Office (click "Company Resources," then "Corporate Groups," then "Insurance"). See screen shot above.

2. Call 1-800-VISA-911 (**only** if the car has been **rented for less than 31 days**—they provide some additional physical damage coverage in this time period).

3. Call Zurich (1-877-246-3478 or 1-800-987-3373).

4. Call the rental company (Budget, National, Enterprise, etc.).

5. Call Jennifer Rindahl/DEN at 720-286-2449.

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. Refer to the Employee Handbook/Policies, assistance for meeting personal insurance deductibles (up to $500) is available 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:

Business Auto Insurance Manual
https://www.int.ch2m.com/webuploads/newsgenerator/travel/news/business_auto_manual[1].pdf

Claims Resource Manual
https://communities.int.ch2m.com/legal/insurance/Shared Documents/Claims_Resource_Manual.doc

Appendix B
Site Management Plan

SITE MANAGEMENT PLAN
Revision #1

EAGLE ZINC SITE OU2
Hillsboro, Illinois

Supplemental Remedial Investigation

WA No. 067-RDRD-B5Y7 / Contract No. EP-S5-06-01

November 2010

Contents

Contents iii
Acronyms and Abbreviations v
Introduction 1
Site Investigation Activities 1
Site Access 1
Site Security 2
Identification and Management of Investigation-Derived Waste 2
Waste Characterization 2
Waste Profile 3
General Waste Management Requirements 3
Drums/Small Containers 3
Waste Storage Time Limit 4
Labels 4
Inspections 5
Employee Training 5
Transporter Requirements 6
Spill Reporting 6
Spill Response 7
Soil 7
Water 7
Trash 7
Recordkeeping 7

Figure

1 Site Layout

Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DQO	data quality objective
IDW	Investigation-derived waste
LDR	land disposal restrictions
NRC	National Response Center
OU	Operable Unit
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RQ	reportable quantity
SMP	Site Management Plan
T&D	transport and disposal
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency

Introduction

This Site Management Plan (SMP) was developed to address the remedial investigation (RI) activities at the Eagle Zinc Site. The SMP describes the management responsibilities during field activities regarding access, security, contingency procedures, connection of utilities, storage and disposal of investigation-derived waste, and other procedures to be followed in the field.

These plans were prepared in conjunction with the following site-specific plans prepared by CH2M HILL:

- The Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) describes the project objectives and organization, functional activities, sampling objectives, sampling locations and analysis, sampling procedures, handling, equipment, and a breakdown of samples to be analyzed. The QAPP will also include quality assurance/quality control (QA/QC) protocols that will be used to achieve the data quality objectives (DQOs).
- The Health and Safety Plan discusses the task-specific health and safety requirements and contingency procedures, including emergency procedures and spill reporting.

Site Investigation Activities

Tasks to be conducted during the site investigation are specified in the UFP-QAPP and include the following:

- Site reconnaissance
- Mobilization
- Monitoring well installation
- Sampling of surface and subsurface soil, groundwater, surface water, sediment, residue and concrete slabs
- Survey of monitoring wells
- Demobilization

It is estimated that the fieldwork will be completed over a 6-week period in 10-day shifts beginning in early November 2010. It will be the responsibility of the field team leader to conduct the tasks according to the specified procedures. The UFP-QAPP describes the project organization structure and management responsibilities.

Site Access

The Eagle Zinc Site is located in Hillsboro, Illinois. The Site can be reached by the following directions:

- Take I-55 north from St. Louis to Exit 52 for SR-16, Litchfield.
- Turn right on SR-16.

- Keep straight onto SR-16 / SR-127 / CR-1200 north for 2.6 miles.
- Turn left onto SR-16 / School Street. There is a MOTO MART on the corner.
- Bear left on Industrial Park Drive.
- The Eagle Zinc site is on the left, and there is a locked gate at the entrance on the west site of the road.
- This gate is the entrance to the site.

Right of entry was gained by the United States Environmental Protection Agency (USEPA) for all investigation areas in Operable Unit 2 (OU2).

Site Security

The gate surrounding part of the site should remain locked and secured each night. The field trailer and the gate should be secured each night. A minimum of two people will be onsite during field activities for safety reasons. The area has an established 911 emergency call number that may be used for emergency assistance.

Field Support Facilities

CH2M HILL plans to rent a trailer to be used as the field office and sample preparation area. Portable restroom facilities will be rented and maintained onsite during field activities. It is assumed that electrical power and water can be made available by contacting the appropriate utility companies. The trailer will be located off the entrance adjacent to the former office building.

Identification and Management of Investigation-Derived Waste

Investigation-derived waste (IDW) including soil cuttings, monitoring well development water, purge water, personal protective equipment (PPE), and decontamination water will be generated during the field sampling event. All IDW except for aqueous IDW will be containerized in 55-gallon drums that will be temporarily stored and kept secure at the site. The drums will be located inside the locked gated area used as the site entrance on the east side of the site as shown on Figure 1. Aqueous IDW will be stored in a frac tank onsite. Management of hazardous wastes during the SRI is not expected; however, hazardous waste management is discussed below in the event the IDW is classified as hazardous waste.

Waste Characterization

Environmental media will be characterized through sampling and laboratory analysis. Wastes will be sampled and analyzed according to the site-specific plans and characterized in accordance with Title 40 Code of Federal Regulations (40 CFR) Part 261 Subpart C.

IDW will be disposed of in accordance with all requirements of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Offsite Rule (40 CFR 300.440).

The disposal facility must provide written evidence of valid USEPA CERCLA Offsite Rule approval, written evidence of valid USEPA or state Permit-to-Operate, and a summary of violations within the last 5 years and their resolutions. Prior to entering into a transport and disposal (T&D) subcontract agreement, this information must be reviewed and approved by a CH2M HILL T&D specialist.

Waste Profile

Waste characterization information will be documented on a waste profile form provided by the designated offsite treatment, disposal, or recycling facility as part of the waste acceptance process. The profile will be reviewed, approved, and signed by USEPA. Signed profile(s) will then be submitted to the offsite facility for acceptance.

The profile typically requires the following information including, but not limited to:

- Generator information including name, address, contact, and phone number
- Site name including street/mailing address
- Process generating waste
- Source of contamination/historical use
- Waste composition (for example, 95 percent soil, 5 percent debris)
- Physical state of waste (for example, solid, liquid, and others)
- Applicable hazardous waste codes

A copy of the approved waste profile will be received prior to scheduling offsite transportation of the waste.

General Waste Management Requirements

Hazardous wastes will be segregated from nonhazardous wastes. Additionally, incompatible wastes (for example, flammable and corrosive wastes) will be segregated. Wastes of the same matrix, contamination, and source may be aggregated to facilitate accumulation and disposal.

Wastes will be accumulated in containers (including drums, tanks, or roll-off boxes). Good housekeeping practices will be maintained at all waste accumulation areas.

- Soil cuttings will be accumulated in drums.
- Aqueous wastes will be contained in a frac tank.
- PPE will be contained in drums.

All containers will be inspected upon arrival at the site for signs of disrepair and any contamination or contents. If any of these containers are in disrepair, are contaminated, or already contain waste, they will be immediately rejected and documented.

Drums/Small Containers

The following guidelines relate to drums and small containers:

- Each drum will be provided with its own label, and labels will be visible.

- Adequate aisle space will be provided for containers, such as 55-gallon drums, to allow the unobstructed movement of personnel and equipment. For hazardous waste, required minimum aisle space is 30 inches and no more than two drums wide.
- Drums will remain closed except when removing or adding waste to the drum. Covers will be properly secured at the end of each workday. Closed means that the lid and/or bung must be on and securely tightened (except when adding or removing waste).
- Drums will be disposed of with the contents. If the contents are removed from the drums for offsite transportation and treatment for disposal, the drums will be decontaminated prior to reuse or before leaving the site.
- The frac tank containing liquids or hazardous waste will be provided with secondary containment and will not be located near a stormwater inlet or conveyance.

Waste Storage Time Limit

In the event that dangerous or hazardous wastes are generated, they will be removed from the site within 90 days from date of generation. Other wastes will be removed from the site as soon as possible. The date of generation is the day that waste is first placed in a container (drum, roll-off box, or tank) or stockpile.

Labels

Waste containers will be labeled in accordance with 49 CFR 172, 173, and 178. Labels will include the type of waste, location from which the waste was generated, and accumulation start date. Containers, roll-off boxes, and tanks used to store or accumulate waste (including soil and aqueous wastes) will include one of the following labels:

- "Analysis Pending" or "Waste Material"—Temporary or handwritten label until analytical results are received and reviewed. This label will include the accumulation start date.
- "Hazardous Waste"—Preprinted hazardous waste labels with the following information:
  - Accumulation start date
  - Generator name
  - USEPA ID number
  - Waste codes
    Prior to transport, the manifest number must be added (for containers of less than 110-gallon capacity).
- "Nonhazardous Waste"—Preprinted labels with the following information:
  - Accumulation start date
  - Generator name
  - USEPA ID number
  - Waste-specific information (for example, contaminated soil)

Where applicable, the major hazards (for example, flammable, oxidizer, and carcinogen) also will be included on the label.

Inspections

Waste accumulation and equipment storage areas will be inspected at least weekly for malfunctions, deterioration, discharges, and leaks that could result in a release.

- Containers (drums) will be inspected for leaks, signs of corrosion, or signs of general deterioration.
- All areas will be inspected to ensure that good housekeeping practices are maintained.

Any deficiencies observed or noted during inspection will be corrected immediately, and corrective measures will be documented. Appropriate measures may include transfer of waste from leaking container to new container, replacement of liner or cover, or repair of containment berm. Copies of inspection reports and corrective measures will be maintained onsite and available for review.

A barrier, such as barricade tape or temporary fencing, will be provided for hazardous/dangerous waste accumulation areas and for other waste storage areas that are accessible to the general public. Hazardous waste storage areas also will have signs that provide 24-hour emergency contacts and telephone numbers.

Waste accumulation areas will contain emergency response equipment appropriate to the wastes' hazards. **The Health and Safety Plan identifies the project emergency response procedures and equipment, including emergency response contacts and phone numbers.**

In addition to the Health and Safety Plan procedures, hazardous waste accumulation areas will be provided with fire extinguishers (for wastes known or suspected to be flammable or ignitable), decontamination equipment, and an alarm system (if radio equipment is not available to all staff working in accumulation area). Spill control equipment (for example, sorbent pads) will be available in the waste accumulation areas, and where liquids are transferred from one vessel to another.

Employee Training

Field staff that will manage hazardous waste will meet the training requirements of Washington Administrative Code 173-303-330 through the following:

- OSHA 1910.120 HAZWOPER training
- On-the-job training including:
  - Site-specific health and safety plan review; requires each site worker and guests to review and sign the plan
  - Activity hazard analysis and daily "tailgate" meetings
  - Project-specific Work Plan review (for example, this Site Management Plan)

Waste profile forms, manifests, labels, and land disposal restriction (LDR) notification/certification forms (for hazardous waste only) will be reviewed and approved by a CH2M HILL T&D specialist prior to scheduling of waste disposal offsite. The generator will sign all transportation and disposal documentation.

Transporter Requirements

Each transportation vehicle and load of waste will be inspected and documented before leaving the site. The quantities of waste leaving the site will be recorded on a transportation and disposal log. A contractor licensed for commercial transportation will transport nonhazardous wastes. In the event that wastes are hazardous/dangerous, the transporter will have a USEPA Identification number, and will comply with transportation requirements outlined in 49 CFR 171-179 (DOT), 40 CFR 263.11 and 263.31 (Hazardous Waste Transportation), and Washington Administrative Code 173-303-240 to 173-303-270.

The transporter will be responsible for weighing loads at a certified scale. For each load of material, weight measurements will be obtained for each full and empty container, dump truck, or tanker truck. Disposal quantities will be based on the difference of weight measurements between the full and empty container or dump truck. Weights will be recorded on the waste manifest and weight ticket.

The transporter will observe the following practices when hauling and transporting wastes offsite:

- Minimize impacts to general public traffic.
- Repair road damage caused by construction and/or hauling traffic.
- Line and cover trucks/trailers used for hauling hazardous or regulated waste to prevent spills or releases.
- Decontaminate vehicles prior to re-use, other than hauling contaminated waste.
- Ensure seals on trucks transporting liquids are in good condition.
- Wastes or materials from other sites may not be combined with wastes generated during this project.

All personnel involved in offsite disposal activities will follow safety and spill response procedures outlined in the Health and Safety Plan.

Spill Reporting

In the event of a spill or release of waste, the transporter will immediately notify Ecology and CH2M HILL**.** The following information about the spill will be reported and recorded:

- Type of material (for example, soil, sludge, or water) and contaminant
- Location
- Estimated volume
- Media affected (for example, spilled on concrete pad or soil)
- Time of spill/release
- Final disposal of spilled material

The transporter will also report a spill or release of hazardous waste, hazardous material above and reportable quantity (RQ), and oil, as required, to:

- National Response Center (NRC): 800-424-8802 or 202-426-2675

- Washington Emergency Management Division: 1-800-258-5990 OR 1-800-OILS-911

The transporter will also report in writing, as required by 49 CFR 171.16, to the Director, Office of Hazardous Materials Regulations, Materials Transportation Bureau, Department of Transportation, Washington, DC 20590.

Spill Response

The transporter will clean up any spill or release of waste (including soil or water) that occurs during transportation, or take such action as may be required or approved by federal, state, or local officials. Spilled waste will be immediately cleaned up, including soils on the outside of the trucks, the truck and/or container, or road surface. Where appropriate, the spilled material will be returned to the original waste container. In any case, the spilled material will be properly contained and disposed.

Fully executed manifests (generator, transporter, facility signatures) and Certificates of Disposal/Destruction will be submitted to USEPA. Copies of this paperwork will be retained in the CH2M HILL project file.

Soil

Soil from drill cuttings will be containerized in 55-gallon drums and temporarily stored onsite while the soil IDW is characterized as specified in the site-specific plans for offsite disposal. Boreholes will be backfilled with bentonite chips to near surface and topsoil will be placed in the upper 1 foot of the hole to ground surface.

Water

Monitoring well development water, purge water, and decontamination water will be generated during the installation and sampling event. Equipment will be washed with distilled water and a 10 percent Liquinox or Alconox mixture. The water will be containerized in 55-gallon drums and temporarily stored onsite while the aqueous IDW is characterized as specified in the site-specific plans for offsite disposal.

PPE

PPE consisting of nitrile gloves, paper towels that have come in contact with soil or water, tubing, etc. will be temporarily stored onsite.

Trash

Trash consisting of regular household-type waste (such as, paper towels, office trash, and others) will be disposed in a solid waste receptacle rented for field investigations and temporarily stored onsite.

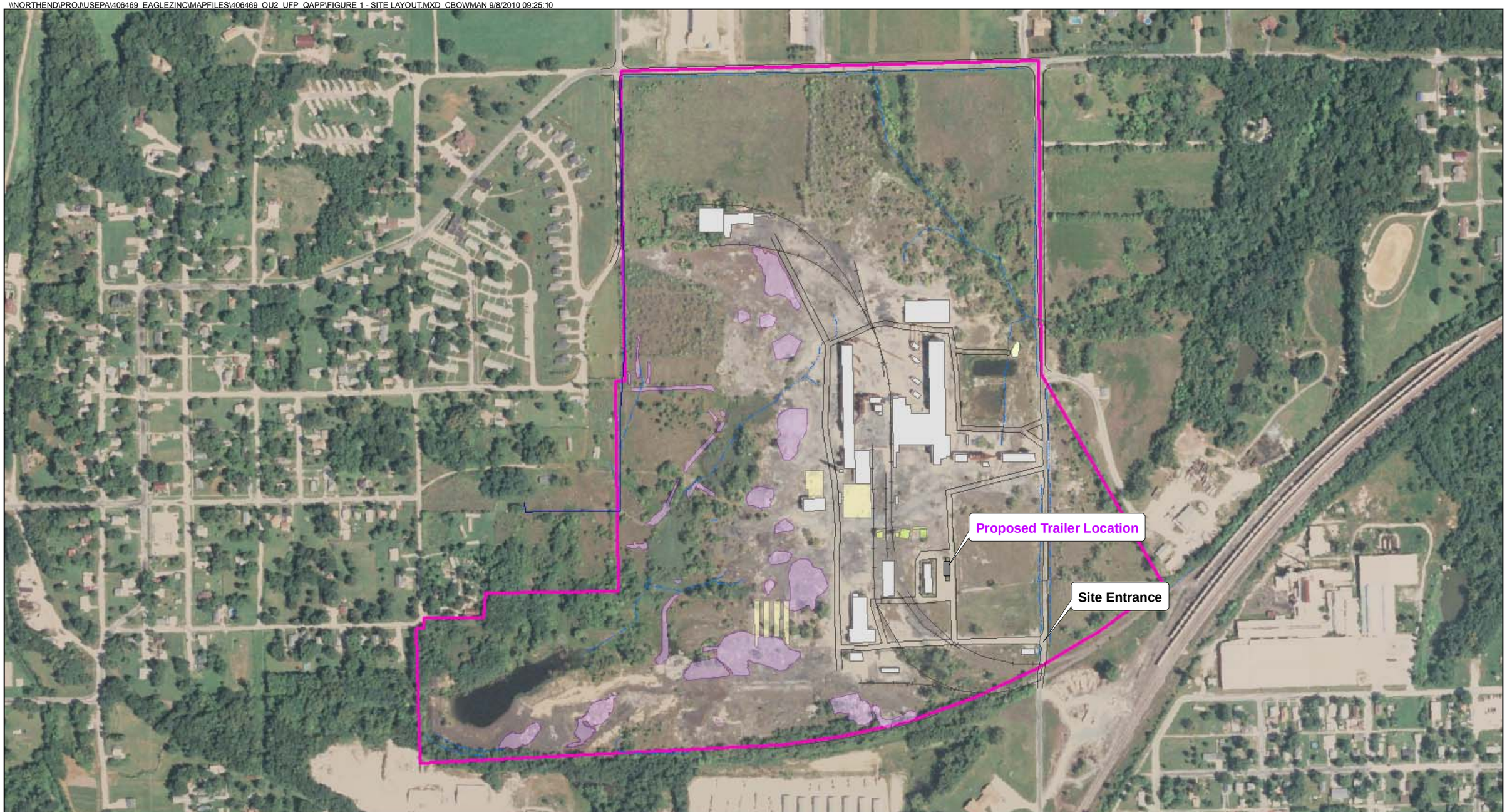
Recordkeeping

The following records and documents will be maintained:

- Transportation and offsite disposal records, including:
  - Transportation and disposal log

  - Profiles and associated characterization data
  - Manifests (generator/transporter signatures), LDR notifications/certifications (for hazardous waste), and weight tickets
  - Fully executed manifests, certificates of disposal/destruction/recycle
- Training records
- Inspection records

\\NORTHEND\PROJ\USEPA\406469_EAGLEZINC\MAPFILES\406469_OU2_UFP_QAPP\FIGURE 1 - SITE LAYOUT.MXD CBOWMAN 9/8/2010 09:25:10



Legend

- Fence
- Ditch
- Railroad
- Site Boundary
- Tank
- Foundation
- Building
- Residue Pile
- Rip Rap
- Culvert
- Trailer

N
W E
S

0 200 400 800
Feet

Figure 1
Site Layout
Site Management Plan
Eagle Zinc Superfund Site - Hillsboro, Illinois

CH2MHILL

Appendix C
Field Standard Operation Procedures

List of SOPs

SOP 01 Note Taking and Field Logbook

SOP 02 Utility Clearance for Intrusive Operations

SOP 03 Soil Sample Collection from Sonic and/or Direct Push Drilling Methods

SOP 04 Soil Boring Logging

SOP 05 Monitoring Well Installation

SOP 06 Monitoring Well Development

SOP 07 Water Level and Total Depth Measurements

SOP 08 Groundwater Sampling Procedures

SOP 09 Surface and Subsurface Soil Sampling

SOP 10 Building Material Sampling

SOP 11 Surface Water and Sediment Sampling

SOP 12 Field Water Quality Measurements and Calibration

SOP 13 Equipment Decontamination Procedures

SOP 14 Packing and Shipping of Environmental Samples

SOP 15 Sample Handling and Chain-of-Custody Procedures

SOP 16 Aquifer Testing

SOP 17 Monitoring Well and Borehole Abandonment

STANDARD OPERATING PROCEDURE 01

Note Taking and Field Logbook

Purpose

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording field and sampling information in a field logbook.

Scope

Data generated from the use of this SOP may be used to support the following activities: site characterization, risk assessment, and evaluation of remedial alternatives.

Equipment and Materials

- Field logbook
- Indelible black ink pen
- Write-in-the-rain pen (for extreme weather conditions—cold/rain)

Procedures and Guidelines

All information pertinent to a field or sampling effort will be recorded in a bound field logbook that will be initiated at the start of the first onsite activity. The field logbook will consist of a bound notebook with consecutively numbered pages that cannot be removed. The outside front cover of the logbook will contain the project (site) name and the specific activity (e.g., supplemental remedial investigation). The inside front cover will include the following:

- Site name and USEPA work assignment number
- Project number
- Site manager's name and mailing address
- Sequential logbook number
- Start date and end date of logbook

Each page will be consecutively numbered, dated, and initialed. All entries will be made in indelible black ink, and all corrections will consist of line-out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include the following:

- Time of arrival and departure of site personnel, site visitors, and equipment
- Instrument calibration information, including make, model, and serial number of the equipment calibrated
- Description of significant activities for the day

- Documentation of photographs taken during field activities (e.g., date, time, and description of photograph)
- Field observations (e.g., sample description, weather, unusual site conditions or observations, sources of potential contamination, etc.)
- Detailed description of the sampling location, including a sketch when necessary
- Details of the sample site (e.g., coordinates [x, y], water elevation [z], casing diameter and depth, integrity of the casing, etc.)
- Sampling methodology and matrix, including distinction between grab and composite samples
- Names of field team members and subcontractors
- Start or completion time of sample collection activities
- Field measurements (e.g., water depths, sediment probe depths)
- Type of sample (e.g., sediment, groundwater, surface water, soil, debris)
- Number, depth, and volume of sample collected
- Field sample number
- Requested analytical determinations
- Sample preservation
- Quality control samples associated with the sample
- Sample shipment information including chain-of-custody (COC) form number and laboratory, carrier, date, and time
- Health and safety issues (including level of personal protective equipment [PPE])
- Signature and date by personnel responsible for observations

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The field team leader will keep a master list of all field logbooks assigned to the sampling crew.

Attachments

None.

Key Checks and Items

None.

STANDARD OPERATING PROCEDURE 02

Utility Clearance for Intrusive Operations

Purpose

This document describes the utility mark-out/clearance process to be followed prior to completing any intrusive subsurface activities.

Scope and Applicability

This document describes the utility mark-out/clearance process to be followed by CH2M HILL prior to any intrusive activities. The document discusses steps that must occur prior to mobilizing and steps that must occur during intrusive work.

This document should be reviewed by the field project team prior to working in the field. In addition, this document should be used to develop scopes of work (SOW) for utility clearance subcontractors.

Procedures and Guidelines

Prior to Mobilizing to the Field

Prior to mobilizing to perform intrusive work, Illinois One Call, JULIE, must be called and utility companies must mark out their utility lines.

Public Utilities Under JULIE

JULIE (800.892.0123) **must** be called prior to any intrusive work. JULIE members will be notified by JULIE and dispatch company representatives within 48 hours (2 business days) beginning at 8 a.m. and ending at 4 p.m. (exclusive of Saturdays, Sundays, and holidays recognized by the State-wide One-Call Notice System or the municipal one-call notice system). All requests for locates received after 4 p.m. will be processed as if received at 8 a.m. the next business day.

You may not begin your excavation before the dig start time of your ticket, even if all utilities have been marked. Excavation must begin within 14 calendar days of the initial locate request.

The following general information must be provided during the call:

- Your name, company, address, and phone and fax number where you can be reached.
- The name and phone number of the site contact.
- The county and city or county and unincorporated area of the township of the excavation.

- The location of the intrusive work which may include, but not limited to, address, cross street, lot numbers, etc. One shall provide either (1) appropriate section and quarter section grid information; (2) sufficient address or descriptive information to allow the establishment or drawing of a dig site polygon; (3) sufficient address, street and cross-street information to allow for the determination of the appropriate section and quarter section grid(s) or (4) GPS coordinates for simple, single-site work areas for determination of a dig site polygon or appropriate section/quarter section during their locate request process through JULIE.
- The start date and time of the planned activities.
- The type and extent *(size of the excavation area)* of the work involved. Please indicate if the excavation area has been white-lined using white paint, flags and/or stakes.
- The section/quarter sections when the above information does not allow the State-wide One-call Notice System to determine this information.

While on the phone with JULIE, the following information should be collected and documented in the project files:

1. **Members Notified.** The identity of JULIE members notified will be provided to the caller. Retain a copy in the project files and keep it onsite while intrusive work is being performed.
2. **Case Reference Number.** An identification number associated with the call should be retained for future reference, if needed. Retain a copy in the project files and keep it onsite while intrusive work is being performed.

JULIE members are required to notify the contact person by fax or e-mail if they do not have any utilities at the work area. The Site Safety Coordinator should retain a copy in the project records and keep it onsite while intrusive work is being performed.

All public utilities in the area where intrusive work is to be performed should be marked out on the ground by the utility locator using the American Public Works Association (APWA) Uniform Color Code (Attachment 1).

Utility locates are good for 28 calendar days, including the day the call was made. Extended tickets are available and will be extended 28 calendar days from the extension. Extensions need to be requested 2 working days before the end of the original 28-day period. For more information, visit the website at http://www.illinois1call.com/.

Private Utility Clearance

Private utilities must be cleared as follows:

1. The location(s) where intrusive work will occur should be identified during a site visit with the designated utility locator. The proposed areas where intrusive work will be performed should be pre-marked by CH2M HILL before this site visit. It is important to take access issues into consideration while pre-marking.

2. The utility locator should clear an area for intrusive work. Additional area (if possible) to be cleared by the utility locator is based on the work to be performed. When possible, the following areas will be cleared:

   - Boring: At some locations where utilities are congested, the boring location only will be cleared. (i.e., only an "X" will be cleared). At other locations that are less congested with utilities, a 3-foot radius around the boring location may be cleared, allowing additional borings within that radius if refusal is encountered on the first attempt. This will be communicated on the utility clearance signoff sheet by the private utility locator. For borings that are located near certain lines (e.g., boiler feed lines, other water lines, etc.) and for which Dow cannot pinpoint the line's location, additional methods will be used to clear the location (see #4 under **Prior to Intrusive Work**).

   - Test Pit: Five feet beyond the extent of the test pit area will be cleared. Areas that are highly congested with utilities or areas where certain lines cannot be pinpointed will be avoided if possible. Additional methods to locate thes lines will be required if it is not possible to avoid these areas (see #4 under **Prior to Intrusive Work**).

   - Trenching for lines: Three feet on each side of the proposed trench will be cleared. If the trench turns, curves, or if larger excavations are required at tie-ins, the clearance area likely will need to be widened. Areas that are highly congested with utilities or where certain lines cannot be pinpointed will be avoided if possible. Additional methods to locate these lines will be required if it is not possible to avoid these areas (see #4 under **Prior to Intrusive Work**).

3. The area that is cleared by the utility locator for intrusive work should include the marking of all utilities in the immediate area (at least a 10-foot buffer around the cleared area) using orange spray paint. If it is not possible to mark utilities, then a figure should be provided that will show the field team exactly where these utilities are located.

4. A utility clearance signoff sheet will be provided to CH2M HILL after all areas, where intrusive work will be completed, have been cleared. The sign-off sheet will document the location of all underground utilities and obstructions in the immediate area of the intrusive work (per #3, above). If the utilities could not be marked out on the ground, then a figure showing their location(s) should be provided with the signoff sheet.

5. The utility clearance is applicable for a 30-day period. Any intrusive work conducted after this 30-day period requires a new utility clearance.

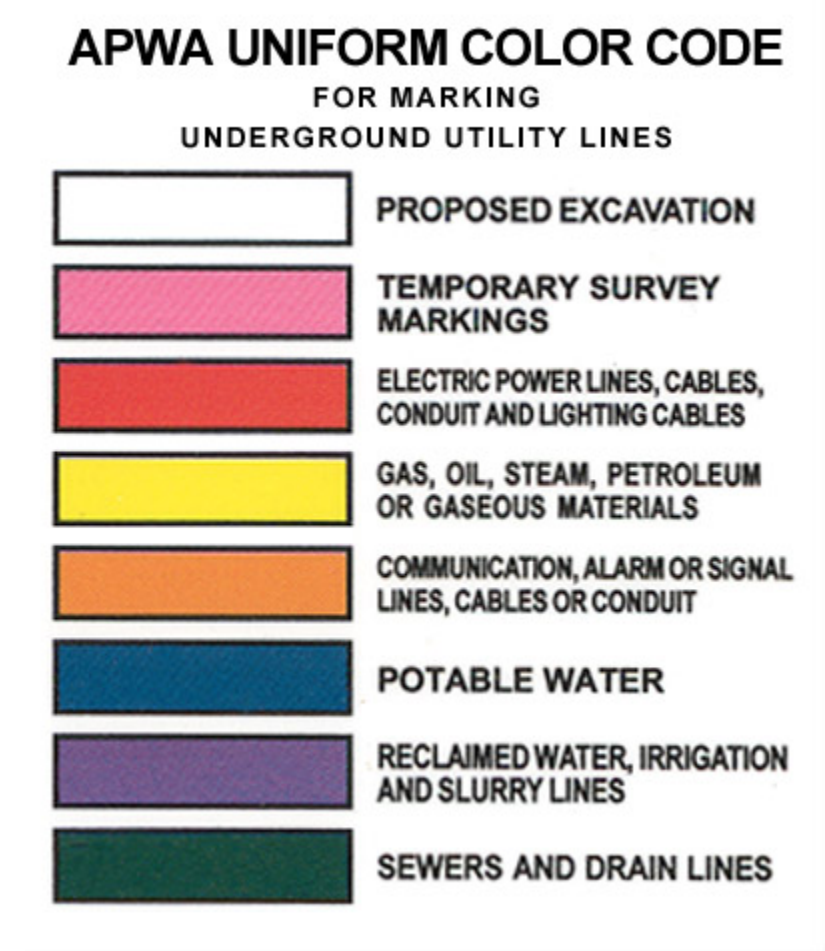
Prior to Intrusive Work

The following should be completed before commencing intrusive work:

1. Verify that all public utility companies have identified the presence of utilities with marking paint or have provided a response back indicating the absence of utilities in the area. To verify what the utility markings on the ground indicate, use the color code in Attachment 1 (for public utilities). **If utilities have not been marked or a negative response has not been confirmed, do not perform intrusive work in that area. Contact the appropriate companies to come out to mark their utility line or verify that they have no utility lines in that area. The Web site http://www.illinois1call.com/utility_response/utility_contacts.htm has a list of contacts.**

2. Review the utility clearance signoff sheet to verify that the location has been cleared for intrusive work if private utilities are present. Also, review the markings on the ground and compare this against the document provided by the utility locator that indicates the utilities in the area. **If markings are missing or the signoff sheet or figure provided indicates that cleared areas contain utilities, do not perform any intrusive work until the utility locator has been contacted and has marked the missing utility line(s) or evaluated whether the cleared area contains utilities.**
3. Review the utility clearance documentation with the subcontractor during the tailgate meeting.
4. Use other methods to identify utilities if there are numerous utility lines around the area and/or lines that cannot be clearly located where intrusive work is to be performed. If possible, hand digging or hand augering will be performed down to 5 feet below ground surface (bgs). Another method would involve the use of an air knife to bore 5 feet bgs with the use of high pressure air that would not damage any utilities encountered.
5. Intrusive work can only be performed in the cleared area. If intrusive work needs to be performed outside of the cleared area, the appropriate utility locator(s) must clear the new location. If the new area cleared involves private utilities, an addendum to the initial utility clearance signoff sheet should be provided.
6. While performing intrusive work, monitor for signs of an encounter with a utility line. These signs include encountering fill material such as gravel, sand, or other fill material; warning tape; plastic; or metal. If it is believed that a utility was struck stop work, call the appropriate personnel, and document in the field book.
7. If refusal occurs while boring and it is believed **not** to be related to a utility, then advancement will be tried up to two more times within cleared area (only applies to locations where the boring and a 3-foot radius was cleared). If the same refusal is observed, then the location will be abandoned.

Attachment 1



STANDARD OPERATING PROCEDURE 03

Soil Sample Collection from Sonic and/or Direct-Push Drilling Methods

Purpose and Scope

This SOP provides a general procedure for sampling subsurface soil using a 5-foot continuous sampler or 4-foot Macro-Core® in conjunction with Sonic or Rotosonic drilling and direct-push probing methods, respectively.

Equipment and Materials

- Drill rig equipped with tooling for Sonic or Rotosonic drilling methods using 5-foot continuous samplers or hydraulic direct-push rig using 4-foot Macro-Core® samplers
- Field logbook and waterproof pen
- Clean plastic sheeting
- Equipment and supplies required for logging soil boring (see SOP, Soil Boring Logging)
- Clean Department of Transportation (DOT)-approved 55-gallon steel drums with labels
- Equipment/instrument decontamination materials (see SOP, Equipment Decontamination Procedures)
- Laboratory-supplied analytical sample containers
- Clean latex or nitrile gloves
- Macro-Core® Liner Cutter for opening acetate liners

Procedures and Guidelines

- Set up and calibrate air quality monitoring instruments in accordance with manufacturer's instructions.
- Ensure that all equipment and tooling used downhole or contacting soil samples at ground surface is clean. Decontaminate all non-dedicated equipment and tooling in accordance with the SOP, Equipment Decontamination Procedures. Decontamination of tables, and ancillary equipment or tooling should be performed as deemed necessary to keep a clean neat work environment.
- Verify that all site utilities have been cleared in accordance with the field sampling plan (FSP).

- Place clean plastic sheeting on ground surface or surface on which the soil cores will be logged and sampled. It is preferable to log the soil cores beneath a canopy or other shade implemented to minimize volatilization of compounds within the soil core.
- Ensure that the subcontractor advances the augers or samplers to the top depth of the next successive sample interval or the desired sampling depth.
- Ensure driller advances the sampler at a rate that ensures maximum recovery within the sampler. Samplers advanced at too rapid of a rate may result in poor recovery or sample quality.
- Ensure that subcontractor removes the drill rods and samplers from the soil boring. The samplers shall be opened by the drilling subcontractor and turned over to CH2M HILL field personnel.
- Wear latex or nitrile gloves.
- Ensure driller indicates which end of the sampler is the top and bottom. CH2M HILL field personnel should orient the sample cores the same direction each time when logging to minimize errors in logging the cores backwards.
- Log the soil core in accordance with the SOP, *Soil Boring Logging*.
- Reserve a portion of the soil core in a resealable plastic bag for organic vapor screening. Clearly write the boring identification and sample depth on the outside of each bag. Treat all bags in similar manner from each boring – do not place half in the direct sun and half in the shade, for example, prior to screening with the OVA. Soil cores will be screened after at least 15 minutes has passed by slightly opening the bag and inserting the tip of the OVM. The reading should be recorded on the boring log.
- If the exact sample interval to be submitted for laboratory analysis is <u>known</u>, fill the laboratory-supplied sample containers with material directly from the soil core as soon as the soil is accessible, beginning with the containers for volatile organic compound (VOC) analysis, using decontaminated or dedicated sampling equipment. VOC samples shall be collected in accordance with the SOP, *VOC Soil Sample Collection*.
- If the exact interval to be submitted for laboratory analysis is <u>unknown</u>, and sampling with a <u>DPT rig</u>, screen and log the soil, and leave the remainder of the soil in the Macro Core Sleeve. Upon completion of the soil boring, select the appropriate sample interval(s) to be submitted for laboratory analysis and fill the laboratory-supplied sample containers as described in the previous bullet.
- If exact interval to be submitted for laboratory analysis is <u>unknown</u>, and sampling with a <u>Sonic or Rotosonic rig</u>, screen and log the soil as described above. Collect VOC samples from the un-homogenized portion of the sample used for field screening. Homogenize the remainder of the soil from each interval. Place the portion of soil that may be needed from each interval for SVOC analysis into a laboratory supplied, labeled container, and put the remainder of the homogenized soil from each interval into a labeled plastic bag. Upon completion of the soil boring, select the appropriate sample interval(s) to be submitted for laboratory analysis and fill the remaining laboratory-supplied sample containers as described in the previous bullet. Discard the unused

SVOC sample jars. (The approach described above is to avoid detections of SVOC contaminants that may be present in plastic bags but not a contaminant in the soil.)

- Place the sample containers in an ice-bearing cooler away from sources of cross contamination.
- Place investigation-derived waste (such as soil cores and drill cuttings) in 55-gallon drums. Label the 55-gallon drum in accordance with the FSP and stage in the temporary drum staging area.
- Decontaminate all non-dedicated equipment and tooling in accordance with the SOP, Equipment Decontamination Procedures.
- Backfill the boring with cuttings, grout, or hydrated bentonite chips and repair the surface with like material (for example, asphalt patch, concrete, etc.), as required, if the soil boring is not to be completed as a monitoring well.
- Mark the location with pin flag or a surveyor's stake, if appropriate.

Key Checks

- Verify that the drill rig is clean and in proper working order, and check for hydraulic fluid or oil leaks and have corrected if present, prior to use.
- Ensure that the driller thoroughly decontaminates the sampler between sample intervals, and the augers between soil borings.
- Ensure that the borehole has been backfilled and ground surface restored.
- Mark soil boring location with a labeled survey flag, if appropriate.

Attachments

None.

STANDARD OPERATING PROCEDURE 04

Soil Boring Logging

Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations. The logging of soil samples will be conducted in general accordance with ASTM Designation D 2488-93: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), a copy of which is affixed to this SOP.

Equipment and Materials

- Soil boring log forms
- Soil logging guide
- Field logbook and water proof pen
- Clean plastic sheeting
- Clean DOT-approved 55-gallon steel drum and label
- Tape measure
- Pocket pentrometer (optional)
- Photoionization detector (PID)
- Clean latex or nitrile gloves
- 12-inch ruler
- Hand lens
- Color Chart for Soil and Rock

Procedures and Guidelines

This section covers several aspects of the soil characterization: instructions for completing the CH2M HILL soil boring log, field classification of soil, and standard penetration test procedures.

Instructions for Completing Soil Boring Logs

Soil boring logs will be completed on the CH2M HILL soil boring log. The information collected in the field to perform the soil characterization is described below. Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Analytical samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets. Print all information on the field log form—do not write in cursive.

Heading Information

Boring Number. Enter the boring number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each location.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities.

Contractor. Enter name of the company and the city and state where it is based.

Drilling/Excavation Method and Equipment. Identify the bit size and type and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted. For excavations enter type of equipment used (e.g., make/model of equipment).

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole/excavation. If free water is not encountered during drilling/excavation or cannot be detected because of the drilling method, this information should be noted. Record date and time of day of each water level measurement.

Date of Start and Finish. Enter the date(s) and time(s) the boring/excavation was begun and completed.

Logger. Enter the first initial and full last name of the person completing the form and describing the materials from the borehole.

Technical Data

Depth Below Ground Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

For Soil Borings:

- **Sample Type and Number.** Enter the sample type and number. DP-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.
- **Sample Recovery.** Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material (e.g., slough) in the measurement. Record recovery in feet.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (e.g., rod drops, rod bounce as in driving on a cobble, and equipment malfunctions). In addition, note if casing was used, the sizes, and depths installed. You should instruct the driller to alert you to any significant changes in

drilling (changes in material, occurrence of boulders). Such information should be attributed to the driller and recorded in this column.

Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example “Sandy CLAY”
2. Group symbol, in parentheses, for example, “(CL)”
3. Color, using Munsell color designation if appropriate
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order generally follows the format described in ASTM D 2488.

Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is Silty SAND with gravel, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is Sandy SILT. The gravel portion is not included in

the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML). However, the description of this sample should include the term…"with some gravel" after the descriptive terminology of the primary soil group.

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated.

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group.

Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

Moisture Content

The relative degree of moisture present in a soil sample should be defined as dry, moist, or wet.

Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586). If an auto-hammer is not used to collect samples, this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly determined by the use of a pocket penetrometer. For purposes of environmental sampling, the 'rule of thumb' can be used, for example, very soft means the soil can be easily penetrated several inches by fist, soft is easily

penetrated several inches by thumb, firm can be penetrated several inches by thumb with moderate effort, stiff is readily indented by thumb, but penetrated only with great effort, very stiff is readily indented by thumbnail, and hard is indented with difficulty by thumbnail.

Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described. Man-made debris encountered in drilling, such as slag from mineral smelting activities, should be identified as such on the log, and otherwise described similar to soils, considering grain size, angularity, moisture content, etc.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

Equipment and Calibration

No equipment needs to be calibrated if not sampling with the auto hammer.

Attachments

1. Soil Boring Log Template

Key Checks

- Check entries to the soil boring log and field logbook in the field for accuracy
- Check that drilling and sampling equipment is decontaminated prior to use at each location using the procedures defined in the SOP, Equipment Decontamination Procedures.

PROJECT NUMBER	BORING NUMBER SHEET 1 OF 2

SOIL BORING LOG

PROJECT : Eagle Zinc OU2 Supplemental Remedial Investigation LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	PID READING (ppm)	CORE DESCRIPTION SOIL TYPE, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF SURFACE CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND START/STOP TIMES OF DAILY DRILLING RUNS.
5						
10						
15						
20						
25						
30						
35						
40						
45						

PROJECT NUMBER	BORING NUMBER SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Eagle Zinc OU2 Supplemental Remedial Investigation
LOCATION :
ELEVATION :
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED :
WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	PID READING (ppm)	CORE DESCRIPTION SOIL TYPE, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF SURFACE CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND START/STOP TIMES OF DAILY DRILLING RUNS.
50						
55						
60						
65						
70						
75						
80						
85						
90						

STANDARD OPERATING PROCEDURE 05

Monitoring Well Installation

Purpose and Scope

To provide site personnel with a review of the well installation procedures that will be performed.

Monitoring well installations are planned for shallow unconsolidated aquifers. However, the three 100 foot deep wells may encounter some consolidated materials.

Equipment and Materials

1. Drilling rig (HSA, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, end caps, vented well caps, centering guides for the three deep wells, sand, powdered bentonite grout, and surface-finish materials)
3. Mud scales for weighing of bentonite grout

Procedures and Guidelines

1. Wells will be installed in accordance with the Illinois Well Construction Code.
2. The threaded connections on casing and screen sections will be water-tight.
3. Well screens will be constructed of nominal 2-inch diameter, 10-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments; the final length will be determined in the field. The exact screen length will be determined by the field team supervisor, site geologist and driller, and if necessary by discussion with the Senior Hydrogeologist or Project Manager.
4. A record of the finished well construction details, including types of materials used, depths of top and bottom of screen and casing, depth of top and bottom of any materials added to the annular space between the screen and casing and the well borehole, or any additional our casings, etc., will be compiled.
5. All soils and liquids generated during well installations will be drummed for proper disposal. Soils and liquids will be segregated into separate drums and may be consolidated with materials from multiple borings or wells.

Monitoring Well Installation

- Monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations. Generally, 2-inch diameter well materials, i.e., screen and casing, set into a 6-inch-diameter boring

will leave a nominal 2-inch annulus into which well seal materials and sand packs will be placed.

- Monitoring wells will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC or stainless steel screen and solid casing, fitted with a threaded end cap.
- Screens will have 0.010-inch slots and will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #2) will extend from the bottom of the boring to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed as a slurry, using a tremie pipe and flowing water.
- A secondary filter sand pack (typically Morie #00) 1 foot thick may be placed above the primary sand pack, if site conditions require.
- Annular well seals will consist of 2 feet of pelletized or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water in one foot lifts. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 1 hour before work in the well continues.
- The annular space above the bentonite seal will be filled to grade with grout appropriate for the application, grout will be placed as slurry, and a side discharge tremie pipe will be used to apply the grout. A minimum of 13-14 lbs of powdered bentonite per gallon of water will be used.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the bottom of the space to be grouted to the surface. Grout will continue to be pumped into the well until the grout returns at the surface are within 3 percent, by weight, of the consistency of grout being introduced into the well to reduce the chance of grout dilution. Mud scales will be used to measure the grout being pumped into the well and the grout returns at the top of the borehole.
- After allowing the grout to settle and set up overnight, additional grout may be added to maintain grade. The minimum grout settling time prior to well development will be based on manufacturer's requirements. The grout to be used should have manufacturer's requirements for settling time of 24 hours or less.

- A protective steel casing equipped with keyed alike locking well protectors will be cemented in place for each new well. Wells will be above grade completions. The casing will extend at least 8-inches above grade, and will be painted a bright color.

Attachments

1. Illinois Environmental Protection Agency Well Completion Report template.

Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

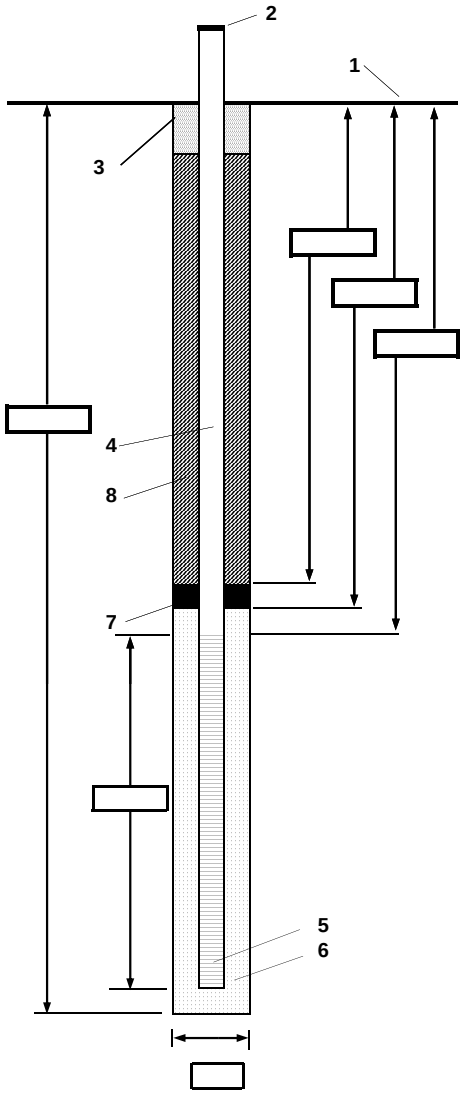
MONITORING WELL COMPLETION DIAGRAM

PROJECT : Eagle Zinc OU2 Supplemental Remedial Investigatio LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
   a) drain tube?
   b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Primary Sand Pack _____
   a) Quantity used _____

7- Bentonite Seal _____
   a) Quantity used _____

8- Annular Seal _____
   a) Grout mix used _____

   b) Method of placement _____
   c) Vol. of well casing grout _____

   Development method _____

   Development time _____

   Estimated Purge volume _____

   Comments _____

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

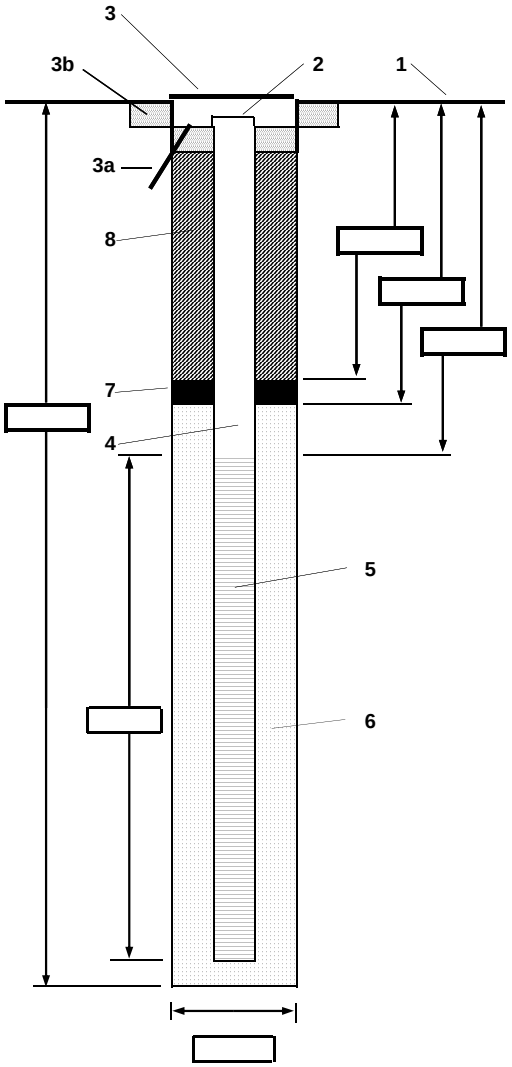
MONITORING WELL COMPLETION DIAGRAM

PROJECT : Eagle Zinc OU2 Supplemental Remedial Investigation LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
a) drain tube? _____
b) concrete pad dimensions _____

4- Dia./type of well riser _____

5- Type/slot size of screen _____

6- Primary Sand Pack _____
a) Quantity used _____

7- Secondary Sand Pack _____
a) Quantity used _____

8- Annular Seal
a) Grout mix used _____
b) Method of placement _____
c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

STANDARD OPERATING PROCEDURE 06

Monitoring Well Development

Purpose and Scope

The purpose of this SOP is to provide site personnel with a review of the well development procedures that will be performed.

Equipment and Materials

1. Pump capable of removing at least 3 gallons per minute from the well, or bailer for low recharge wells
2. Tubing for pump
3. Water level indicator
4. Surge block
5. Well development form
6. Decontamination supplies; see SOP-13, Equipment Decontamination Procedures
7. Container for water removed from the well

Procedures and Guidelines

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened. The minimum grout settling time prior to well development will be based on manufacturer's requirements. The grout to be used should have manufacturer's requirements for settling time of 24 hours or less (See SOP-05, Monitoring Well Installation).
- The well will be developed by surging and pumping, or bailing for low recharge wells where pumping is not appropriate.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least contaminated well first.
- Well is to be surged with a surge block for 10 minutes before pumping begins. The surge block should be relatively close fitting within the well, and should preferably be connected to a solid rod during surging.

- Development will include surging the well by rapidly moving the surge block up and down several feet at a time inside the well screen interval of the well, abruptly stopping flow and allowing water in the well column to fall back into the well.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well if the water table is relatively close to the land surface or the well diameter and volume of air available are sufficient to lift water and sediment all the way to the top of the well, and the produced water can be captured and contained. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- A YSI water quality meter or equivalent will be used to collect water quality data from the produced groundwater, including temperature, PH, specific conductivity, and turbidity. A Hach Turbidity Meter should be used to collect more accurate turbidity readings. The water quality meter is to be calibrated in accordance with SOP, *Field Water Quality Measurements and Calibration*.
- Well development will continue until the water produced is visibly free of turbidity, sand, and silt. Monitor purge water until turbidity is below 50 nephelometric turbidity units (NTU), and the other parameters are within 10 percent over three readings, or until 10 boring volumes have been purged, whichever is first.
- Development water will be handled as if it is hazardous and placed in sealed 55-gallon U.S. DOT-approved steel drums. CH2M HILL will label and date the drums, and arrange transport of the drums to a designated site for storage. An "on hold pending analysis" label will be used until laboratory results return, at which time the appropriate label will be applied.

Attachments

1. Well development form

Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Ensure all drums are properly labeled and stored.
- Check that all information has been recorded on the well development form.

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

WELL DEVELOPMENT FORM

PROJECT : Eagle Zinc OU2 Supplemental Remedial Investigation

PERSONNEL:

EQUIPMENT:

START :

END :

START WATER LEVELS :

WELL DEPTH:

WELL VOLUME:

MAXIMUM DRAWDOWN DURING DEVELOPMENT:

TOTAL QUANTITY OF WATER DISCHARGED:

Make attempt to remove at least three well volumes during development (Calculate well volume before starting development!)
Development will be continued until pH, temperature, and specific conductance, and turbidity stabilize within 10% over 3 readings or until 10 well volumes have been purged.

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	pH	Temperature (°C)	Specific Conductivity (mS/cm)	Turbidity (NTU)	Remarks (color, odor, sheen, sediment, etc.)
		Stabilization Criteria:	±10%	±10%	±10%	< 50 NTU	

STANDARD OPERATING PROCEDURE 07

Water Level and Total Depth Measurements

Purpose and Scope

This SOP provides guidelines for measuring depths to groundwater and total depth in soil borings, piezometers, and monitoring wells. This SOP also covers the topic of measuring light nonaqueous phase liquid (LNAPL) that may be present. It includes only guidelines for discrete measurements of static water levels.

Equipment and Materials

- Field logbook and water proof pen
- Equipment/instrument decontamination materials (see SOP, Equipment Decontamination Procedures)
- Well keys and wrenches/T-bar
- Clean latex or nitrile gloves
- Electronic water level meter or oil/water interface probe (Solinst® or equivalent) with a minimum 100-foot tape with graduations in increments of 0.01 foot or less

Procedures and Guidelines

- Set up instrument in accordance with manufacturer's instructions.
- Decontaminate equipment/instruments in accordance with the SOP, Equipment Decontamination Procedures.
- Open the protective cover on well.
- Unlock and remove all monitoring well caps. A minimum time of 30 minutes shall be allotted between the removal of a well cap and measuring the depth to groundwater in the same monitoring well unless the well casing has a hole in it to allow barometric pressures to constantly equilibrate. This will allow the groundwater surface within the riser to stabilize with atmospheric pressure prior to taking a depth to water measurement.
- Lower the probe slowly into the monitoring well or soil boring until the probe just contacts the groundwater surface; the unit will respond with a tone or light signal. Make sure that the top of the riser pipe does not have a sharp edge that may damage the protective coating around the wires in the tape.
- Note the depth to groundwater relative to a reference point indicated on the monitoring well riser pipe. If no reference is clearly visible, reference the northern edge of the riser

pipe or soil boring. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the field logbook.

- Measure water levels to the nearest 0.01 foot.
- Record the condition of the concrete pad, padlock, well cap, protective cover, and bollards (if present) in the field logbook, along with the depth to the groundwater surface.
- Compare the newly measured depth to water in each well to the historical depth to water in that and adjacent wells and re-measure if the new data are outside the historic range for an individual well or if the new data are inconsistent with general patterns of water table rise and fall, considering all wells being monitored. [For example, if most wells measured are generally a few feet higher than the past monitoring event but one well is measured as being several feet lower than past data indicate, re-measure and verify the depth.]
- The total depth of the monitoring well or soil boring should be measured and recorded in the field logbook every time the well is monitored. The total well depth shall be measured in the same general manner as the depth to groundwater except that no indication [light or buzzer] will be produced by the instrument when bottom is reached. Instead, the field personnel will have to monitor the relative weight of the tape and probe as it is lowered into the well and use feel to determine when bottom is reached. The feel of the bottom of the well should also be recorded, this would be soft if the bottom appears to be covered in silt, or firm if the bottom feels clean.
- Decontaminate the probe and tape as it is removed from the well or boring in accordance with the SOP, Equipment Decontamination Procedures.

If LNAPL is anticipated or encountered, an oil/water interface probe shall be used to determine the depth to the top of LNAPL and depth to groundwater. If LNAPL is encountered, a solid tone will sound from the oil/water interface probe. The probe must be lowered very slowly through the LNAPL to obtain an accurate depth to groundwater without agitating the LNAPL. When the probe passes through the LNAPL and contacts groundwater, the solid tone will change to a beeping tone. The depths to both media shall be measured in the same manner as previously discussed and recorded in the field logbook. If possible, the color and consistency of the LNAPL should also be recorded in the field logbook.

Key Checks

- Verify that the battery of the water level meter or oil/water interface probe is charged before each use by pressing the test button on the side of the unit.
- Verify that the unit is operating correctly by testing the probe in tap water (not distilled or deionized water) and verifying that the light and buzzer are activated at the same depth. If one measures higher or lower than the other, continue testing in tap water and determine which indicator is more accurate, and use that indicator for the field measurements.

- Inspect the tape for abrasions that may have been exposed to the wires. The unit will not function properly if there is a short in the wiring.
- It is recommended that a map of all wells to be monitored be carried into the field when monitoring occurs.
- Prior to mobilizing to the site, use historical data to determine which wells to be monitored are cleanest and which are dirtiest/most contaminated and start monitoring with the clean wells first and moving to more contaminated wells last.

Attachments

None.

STANDARD OPERATING PROCEDURE 08

Groundwater Sampling Procedures

Purpose and Scope

This SOP presents general guidelines for collecting groundwater or groundwater grab samples from monitoring wells using low-flow sampling techniques. The SOP, Water Level and Total Depth Measurements, should be consulted in conjunction with this SOP. This SOP does not cover purging and sampling of monitoring wells by bailing or other high-flow methods. The SOP, Groundwater Sampling – Bailer Method, should be consulted if a monitoring well cannot be purged and sampled using low-flow groundwater sampling techniques.

Equipment and Materials

- Field logbook and water proof pen
- Clean latex or nitrile gloves
- Clean DOT-approved 55-gallon steel drums with labels
- Clean 5-gallon bucket
- Groundwater pump
  - Adjustable rate, submersible pumps are preferred (centrifugal or bladder pump)
  - Peristaltic pump with portable battery may be used with caution. USEPA guidance states that that "suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds"
- Water level meter
- Groundwater quality meter capable of collecting groundwater quality parameters using a flow-through cell (YSI or similar water quality meter; capable of measuring temperature, specific conductance, dissolved oxygen, turbidity, pH, and oxidation-reduction potential [Eh, or ORP] or equivalent)
- Turbidity meter to obtain more accurate turbidity readings
- Disposable Teflon tubing
- Disposable silicon tubing (for peristaltic)
- Measuring cup to assess flow rate
- 0.45 micron filter for dissolved phase TAL metals sample collection
- Stopwatch
- Equipment/instrument decontamination materials (see SOP, Equipment Decontamination Procedures)

- Laboratory-supplied analytical sample containers

Water Quality Indicator Parameters

The six field indicator parameters to be monitored include dissolved oxygen, turbidity, ORP, specific conductance, pH, and temperature. Of these, dissolved oxygen, ORP, specific conductance, pH, and temperature are moderately to extremely sensitive to contact with atmospheric oxygen and will be measured in-line using a flow-through cell. Turbidity also will be measured separately to reduce the influence of suspended solids that are retained in the flow-through cell. Indicator parameters will be monitored continuously during purging and values recorded every 5 minutes.

Dissolved Oxygen, ORP, Specific Conductance, pH, and Temperature

The stabilization criteria for dissolved oxygen, ORP, specific conductance, pH, and temperature are three successive readings separated by a time interval sufficient to pump at least one sampling tubing volume plus flow-through cell volume of water through the system at a flow rate equal to or greater than 100 milliliters per minute [mL/min] but less than 500 mL/min while not lowering the water level in the well more than 0.5 foot, within the following ranges:

- Dissolved oxygen: ±0.1 milligrams per liter (mg/L) for values less than 1 mg/L, *or* ±10 percent for values greater than 1 mg/L
- Eh (ORP): ±10 millivolts (mV)
- Conductivity: ±20 µmho/cm
- pH: ±0.1 unit
- Temperature: ±0.5 degrees Celsius (°C)

Note: A minimum of 3 system volumes must be purged before evaluating whether stabilization criteria are met and purging is complete before sampling.

Turbidity

Turbidity is considered stabilized if values are less than 50 NTU for three successive readings. If the other parameters stabilize but turbidity remains greater than 50 NTU, field personnel should continue purging at the determined sustainable flow rate to determine whether the turbidity decreases with additional pumping. If turbidity does not decrease, the project manager should be notified. It should be noted that turbidity measurements may not stabilize within the aforementioned criteria before collecting a sample in accordance with the procedures for purging a low-recovery well.

Procedures and Guidelines

1) Set up and calibrate instruments in accordance with manufacturer's instructions.
2) Decontaminate sampling equipment and other instruments to be placed in the monitoring well riser before sampling in accordance with the SOP, Equipment Decontamination Procedures.

3) Measure the depth to groundwater before performing low-flow sampling, as described in the SOP, Water Level and Total Depth Measurements. **Do not measure the depth to the bottom of the well at this time** in order to reduce the possibility that accumulated sediment in the well will be disturbed. Obtain total well depth from the monitoring well development log, or acquire total depth during water level measurements, but the well should not be sampled the same day as depth to bottom is measured.

4) Place field equipment and supplies on clean plastic sheeting to minimize contamination.

5) Determine the system volume which is the volume of water that will pass through the tubing in the well, pump, and flow-through cell. A minimum of 3 system volumes must be purged before evaluating whether stabilization criteria are met and purging is complete before sampling.

6) Follow these procedures if using a peristaltic pump:

   a) Connect the silicone tubing to the peristaltic pump.

   b) Lower the Teflon tubing slowly to the top of the water column. The field team shall use a tape measure to measure out the tubing.

   c) Place the tubing intake in the middle of the well screen if the entire length of the well screen is below the potentiometric surface. If the potentiometric surface is within the well screen, the intake should be set approximately 2 feet off the bottom of the well to minimize the intake of fines accumulated on the bottom of the well and maximize the length of water column above the tubing intake.

   d) Cut the Teflon tubing, secure to the top of the well riser with a clamp, and connect to the silicone tubing in the peristaltic pump. Allow extra polyethylene tubing in case the water does not recharge as fast as the pumping rate, so the tubing can be lowered further into the well.

   e) Ensure that the pump flow direction is correct on the peristaltic pump. It is best to verify the flow direction before connecting the polyethylene tubing by inserting the silicone tubing in a cup of distilled water.

   f) Connect silicone tubing to the water quality meter flow through cell (bottom connector). Run the outlet tubing (upper connector) to the 5-gallon bucket.

7) Follow these procedures if using a centrifugal pump:

   a) Connect Teflon tubing to pump.

   b) Lower the pump slowly to the required depth, and use a tape measure to measure the tubing.

   c) Place the pump intake in the middle of the well screen if the entire length of the well screen is below the potentiometric surface. If the potentiometric surface is within the well screen, the intake should be set approximately 2 feet off the bottom of the well to minimize the intake of fines accumulated on the bottom of the well and maximize the length of water column above the tubing intake.

d) Connect the Teflon tubing to the bottom of the flow through cell. Run the outlet tubing from the upper connector to the 5-gallon bucket.

8) Use peristaltic pump, if bailing:

a) Bailing should only be used in conjunction with the peristaltic pump if bailing the well dry due to excessive drawdown. Water quality parameters do not need to be collected if bailing the well dry.

9) Start pumping. Purge rate should be less than 500 mL/min. Monitor the water level carefully after beginning the pumping process.

10) Turn on the groundwater parameter field instrument and let the readings stabilize. Once temperature has stabilized for 30 seconds, record initial groundwater parameters and depth to groundwater on a groundwater purging and sampling form.

11) Containerize purged groundwater initially in a plastic 5-gallon bucket and subsequently transfer to a clean 55-gallon steel drum or other labeled storage container.

12) Purge to stability with a total water surface drop of one foot or less if water level is stable or only slowly dropping, to ensure stagnant water stored in the well casing is not being sampled and that only fresh groundwater is sampled.

13) Monitor carefully if water level is dropping more than .3 ft/5 minutes. Consider lowering the purge rate to keep the water level drop to less than .3 ft/5 minutes, and a total water table drop of one foot or less.

14) Do not sample at this time if the decline in the water level continues at more than .3 ft/5 minutes and the flow rate is 150 mL/min or less, and if the water table does not stabilize at one foot or less drop below the water table in the well prior to purging, since only stagnant water standing in the well is entering the pumping system. Call the project manager or senior consultant and determine another method for sampling this well. Pumping or bailing the well dry and collecting the sample within 24 hours is acceptable, if approved by the project manager or senior consultant.

15) Disconnect the Teflon tubing from the flow-through cell if the well was purged. **Groundwater samples must never be collected from the outlet of the flow-through cell.** When collecting samples, ensure that the flow rate of the pump is equal to or less than the flow rate used to purge the monitoring well. Collect groundwater samples directly from the outlet of the polyethylene tubing starting with volatile organic compound (VOC) samples first.

16) Dissolved phase TAL metals are to be collected by attaching a 0.45 micron filter to the tubing and purging the water through the filter and into the sample jar.

17) Label the sample containers following the collection of groundwater samples, and place the samples in an ice-bearing cooler away from sources of cross contamination.

18) Remove the tubing from monitoring well and discard. Secure the well cap and lid on the well immediately after removing the tubing to prevent objects from being dropped in the well.

19) Decontaminate all equipment and instruments in accordance with the SOP, *Equipment Decontamination Proceedures*.

20) Store instruments in accordance with the manufacturer's instructions.

21) Purged groundwater will be handled in accordance with the Site Management Plan.

Key Checks

- Ensure that the water quality meters are calibrated and cared for in accordance with manufacturer's instructions.
- Keep sampling system and monitoring probes out of direct sunlight.
- Verify DO readings by checking reported DO against a chart and correlating theoretical DO readings at actual site temperatures. Do not record any DO readings that are outside theoretical limits or that do not make sense, like negative concentrations.
- Check that the flow direction switch on the peristaltic pump is in the correct direction. Flow in the wrong direction may create bubbles in the well riser, thus affecting dissolved oxygen readings.
- Charge battery to peristaltic pump and water quality meter when not in use. Low battery on the water quality meter may not allow unit to connect properly with sonde.

Attachments

- Groundwater Purging and Sampling Form

Low Flow Ground Water Sampling Form

Project Name: Eagle Zinc OU2 Supplemental Remedial Investigation Project Number: 406469.FI.01 Page

Sample Source (Well No./Location): _____ Date: _____

Weather Conditions: _____

Well Condition: _____

Sample Team:

Well Stabilization Data

Well Datum: TOC Purge Method: Low Flow Time Purging begins (T_o): _____

Well Diameter & Type: _____ Equipment: _____ Water Level at time T_o: _____

Well Depth: _____ (ft) _____ Time Purging ends (T_1): _____

Static Water Level: _____ (ft) _____ Water Level at time T_1: _____

Water Column: _____ (ft) _____

System Volume: _____ (gal) _____

Pump intake: _____ (ft bgs) PID Reading: _____

***Purge minimum of 3 system volumes before evaluating whether stabilization criteria is met and purging is complete before sampling.**

Time	Volume Removed (gal)	pH ±0.1 unit	SPCOND (mS/cm) ±20 µmho/cm = ±0.02 mS/cm	TEMP (deg C) ±0.5 degrees Celsius	Eh/ORP (mV) ±10 millivolts	Water level (ft)	DO (mg/L) < 1mg/L = ±0.1 mg/L; > 1mg/L = ±10 %	Turbidity (NTU) < 50 NTU	Purge rate (mL/min) < 500 mL/min with drawndown < 0.5 ft	Appearance

Sample Information

Sample ID: _____

Analysis: _____

Date: _____

Time: _____

Field Filtering: _____

Laboratory: _____

Method of Shipment: _____

Remarks : _____

STANDARD OPERATING PROCEDURE 09

Surface and Subsurface Soil Sampling

Purpose

The purpose of this SOP is to describe the methodology for collecting discrete soil and building debris samples.

Scope

The depth to which surface and subsurface soil samples will be collected may vary from specific sample location. For a more detailed description, refer to the Worksheet #18 *(Sampling Locations and Methods/SOP Requirements)*. The methods described for soil and building debris sampling will be used to collect representative samples.

Equipment and Materials

- Field log book and boring logs
- Permanent marker
- Stainless steel bowls and spoons/trowels
- Photoionization (PID) detector
- Appropriate decontamination equipment; refer to SOP-13, Equipment Decontamination Procedures
- Plastic sheeting
- Aluminum foil
- Appropriate PPE
- Appropriate sample containers
- Sample labels, refer to SOP-15, Sample Handling and Custody
- Sample cooler with ice
- Ziploc® (or comparable) freezer bags
- Sample containers
- Stainless steel split spoon, split barrel, continuous sampler, or Macro-Core® samplers.
- A drill rig and associated boring equipment or hand tool devices that can be used to remove soil from the ground. Only stainless steel, Teflon, or glass materials should be

used. The only exception is split spoons, which are most commonly available in carbon steel. Split spoons that are not stainless steel are acceptable for use **only** if they are not rusty. Refer to SOP-03, Soil Sample Collection from Sonic and/or Direct-Push Drilling Methods.

Procedures and Guidelines

Decontamination

Before collecting any soil samples, all sampling devices shall be decontaminated. The appropriate decontamination supplies must be on hand, refer to SOP-13, Equipment Decontamination Procedures. Each piece of reusable equipment shall be decontaminated between each sample location or interval. Disposable sampling equipment will be used whenever it is feasible to minimize decontamination and the potential for cross-contamination.

Surface Soil Sampling

Surface soil is defined as the soil located between the ground surface and a depth of 2 feet below ground surface (bgs) to meet site-specific project objectives.

In paved locations, surface asphalt or concrete would need to be removed mechanically or by hand, as well as any base course located beneath the paving. In unpaved locations, surface vegetation may need to be removed before sampling. The sampler, wearing clean disposable nitrile gloves, will remove materials, including pebbles, roots and large gravel-sized or larger fragments of rock or concrete from the mixture as the sample is collected.

Each soil sample collected for analyses will be thoroughly homogenized in a clean, dedicated container using the sampling spoon or trowel. The homogenized material will then be divided equally among the appropriate sample containers. The sample containers will then be sealed tightly. Care should be taken to ensure that the container (such as a bowl or pan) used for homogenization and the sampling utensils do not interfere with the analytes of interest (for example, an aluminum pan should not be used for soil samples submitted for metals analyses; only stainless steel bowls are allowed).

Subsurface Soil Sampling

Shallow Subsurface Soil Sampling (Depth Obtainable with Hand Tool Equipment)

Shallow subsurface soil samples will be collected with hand tool equipment if a drill rig can/should not access a sampling location (for safety reasons or because of obstructions). Each subsurface soil sampling location should be checked and cleared before intrusive activities according to SOP-02, Utility Clearance for Intrusive Operations.

Subsurface soil samples can be collected using a wide variety of sampling equipment and devices. Common equipment used to collect shallow subsurface soil samples include thin-walled cube samplers, and various types of hand augers, including bucket type hand augers, continuous-flight hand augers, and posthole hand augers. Of these, only the thin-wall tube sampler collects an undisturbed soil sample. Depending on field conditions or sampling objectives, several types of sample collection equipment can be used to collect a soil sample at a single location.

Using decontaminated hand tool equipment, the soil borehole will be advanced to the depth immediately above the sampling interval, and all cuttings will be removed from the borehole. During advancement of the auger, cuttings from in and around the borehole will be periodically removed and placed on a plastic sheet. If the sample is to be collected using the same hand auger, the auger bucket will be decontaminated before collecting the sample. The discrete sample will then be collected by advancing the sampling equipment to the appropriate depth interval and retrieving the soil sample.

Each soil sample collected for analyses will be thoroughly homogenized in a clean, dedicated container using a decontaminated stainless steel spoon or trowel. Care should be taken to ensure that the container used for homogenization (such as a bowl or pan) and the sampling utensils do not interfere with the analytes of interest. The homogenized material will then be divided equally among the appropriate sample containers. Depending on the number of sample containers to be filled at each location, additional soil sample media may be required from the sample location. The sample containers will then be sealed tightly. Immediately following sample collection, place the sample bottles in a cooler with ice. Maintain the samples at 4°± 2°C.

Deep Subsurface Soil Sampling

Subsurface soil sampling will be performed using a hollow stem auger and/or direct-push drilling methods, refer to SOP-03, Soil Sample Collection from Sonic and/or Direct-Push Drilling Methods.

Take an organic vapor reading of the soil sample using a PID and record response in field notebook.

Each soil sample collected for analyses will be thoroughly homogenized in a clean, dedicated container using a decontaminated stainless steel spoon or trowel. Care should be taken to ensure that the container used for homogenization (such as a bowl or pan) and the sampling utensils do not interfere with the analytes of interest. The homogenized material will then be divided equally among the appropriate sample containers. Immediately following sample collection, place the sample containers in a cooler with ice. Maintain the samples at 4° ± 2° C.

Key Checks and Items

- Clear each sample location (utilities) before intrusive activities.
- Wear proper PPE.
- Put on new sampling gloves per sample location.
- Transfer samples for volatiles first, avoid mixing.
- Decontaminate utensils before reuse.

Attachments

- Soil boring log provided as an attachment to SOP-04.

STANDARD OPERATING PROCEDURE 10

Building Material Sampling

1.0 Purpose and Scope

This Standard Operating Procedure (SOP) describes procedures for obtaining building material samples. The SOP covers collecting building material samples from vertical surfaces (walls) or horizontal surfaces (floor slabs) using a portable hammer drill.

2.0 Equipment and Materials

- Heavy-duty, portable hammer drill and associated drill bits
- Power source for hammer drill (portable generator) and associated extension cord to reach portable hammer drill
- Water source for core-drill cooling (optional), and associated hose to connect water spigot to core drill rig
- Large hammer
- Large concrete/masonry chisel
- Heavy plastic bags
- Stainless-steel mixing bowls
- Stainless-steel trowels
- Protective eyewear (safety glasses)
- Latex gloves
- Dust masks
- Ear plugs
- Sampling jars (supplied by laboratory)

3.0 Procedures and Guidelines

3.1 Building Material Drilling

Building material sample drilling will be performed using a heavy-duty, portable hammer drill. Depending on the availability, a tungsten hammer drill bit will drill a borehole into the building wall or floor slab anywhere from 1 inch in diameter to 3 inches in diameter to collect the building material sample.

Choose a location to drill that is away from any utilities that might run through the slab or wall and accessible to power using extension cords and a portable generator if necessary. It is also

recommended that a location be accessible to a water source (water spigot), but this is not necessary. Hammer drilling can be performed dry, but this will shorten the life of the drill bit. Additionally, when drilling through a building material surface that is not on grade, be sure to secure the area on the floor below where the sample cuttings might fall.

Once a suitable location is chosen, install the drill bit per the manufacturer's instructions, and then connect the drill to the power source and water source if available. It is recommended that safety glasses, a dust mask, and earplugs be worn. Turn on the drill and lower the drill bit to the desired building material surface. Constant pressure must be applied to the feed mechanism during drilling in order to advance the drill bit. If available, periodically discharge water on the bit. This water will also serve to keep the dust down. At no time should the hammer drill be left unattended while it is operating.

Typical hammer drill bits will allow a cut of 12 to 13 inches deep. The desired depth for sample collection is 1 to 2 inches below the exposed surface of the building material. In order to determine the depth of the drill bit, the operator will monitor its vertical displacement with a ruler during drilling operations. Once the desired sample depth is achieved the drill bit will be decontaminated and the borehole will be cleared of drilling dust. The drill bit will be lowered back into the borehole and advance an additional 3 to 4 inches into the building material to collected the building material sample. The building material sample will be collected from the drill cuttings in the borehole and on the drill bit. It should be noted that several building material penetrations may be necessary at each sample location in order to collect a sufficient amount of concrete/masonry to satisfy the analytical laboratory's sample quantity requirements. Sample preparation and rules for collection volume are discussed in the following section.

3.2 Sampling

Once the building material samples are collected from a given location, the samples will be placed into a re-sealable plastic bag. The re-sealable plastic bag will then struck with a rock hammer, if sample material in plastic bag is large than sand grain size, to pulverize sample material down to desired grain size. Once a building material sample is pulverized down to the desired grain size, empty the sample into a large mixing bowl and thoroughly mix it with a trowel or spoon in order to get a true homogeneous, composite sample. Remove any pieces of rebar or miscellaneous debris that may have been included in the building material sample. A general rule for determining how many building material penetrations to perform at a given location is as follows: 3 to 4 inches of a 2-inch-diameter borehole will fill a single 4-ounce jar when pulverized to a sand consistency. Using a trowel or spoon, fill the required number of sample containers with the pulverized material.

The samples will be placed in a pre-chilled sample cooler with blue or wet ice to ensure that the samples remain at 4°C.

Appropriate information will be documented in the project field notebook and a photo will be taken at each sampling location.

All sampling equipment used for a given location must be decontaminated prior to use at the next sampling location. This includes the hammer, chisel, bowl, trowel, and hammer drill bit.

3.3 Abandonment

Boreholes will be filled with grout or other inert material.

3.4 Decontamination

Before sampling begins and between each sampling event, equipment will be decontaminated according to the procedures identified in *Equipment Decontamination Procedures SOP*.

4.0 Waste Management

All materials generated during sampling (debris, personal protective equipment) will be placed in 55-gallon drums or rolloffs for storage pending analysis and disposal off site as outlined in the Appendix B *Site Management Plan*.

5.0 Key Checks and Preventative Maintenance

Check that the hammer drill bit is in working order prior to beginning operations. Check the condition of the hammer drill bit after each run. If the bit shows excessive wear, have it replaced. If possible, try and choose sample locations where a water source can be accessed.

STANDARD OPERATING PROCEDURE 11

Surface Water and Sediment Sampling

Purpose and Scope

This SOP describes the techniques to be used in collecting surface water and sediment samples. Materials, equipment, and procedures may vary.

Materials and Equipment

- Field log book
- Clean latex or nitrile gloves
- Leather gloves (for hand augering)
- Equipment/instrument decontamination materials (see SOP, Equipment Decontamination Procedures)
- Laboratory-supplied sample containers
- Meter capable of collecting surface water quality parameters (see SOP, Field Water Quality Measurements and Calibration)
- Turbidity meter such as HACH or similar
- Clean glass or plastic container
- Peristaltic pump and disposable polyethylene tubing
- Stainless steel hand auger (2 inches in diameter), or similar
- Stainless steel bowl and trowel, or disposable aluminum tray and trowel
- Digital camera
- Disposable turkey baster

Procedures and Guidelines

Surface Water

(Refer to the appropriate section of the site-specific plan for sampling locations and depths.)

- The required supplies and equipment will be assembled. Set up and calibrate instruments in accordance with the manufacturer's instructions.
- Reusable sampling equipment will be decontaminated before sampling and between each sampling location (SOP, Equipment Decontamination Procedures).

- Appropriate PPE will be worn.
- During the collection of samples, one member of the two-person sampling team is designated as the one with "dirty hands"; the second member is designated as the one with "clean hands." The individual designated as "clean hands" handles all operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle. "Dirty hands" is responsible for preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.
- In general, sampling will begin at the most downstream location in bodies of flowing water. The designated sampling locations will be accessed by boat or by wading, depending on water depth. A personal floatation device (PFD) and waders should be worn if personnel enter the water. When wading into a body of water, personnel should take special care to minimize the amount of disturbance to the underlying sediment, and the water sample should be collected outside the area of disturbance (upstream of the disturbance in the flowing water). **Surface water samples are to be collected before co-located sediment samples and biota samples are collected to minimize disturbance.**
- For samples taken from water deeper than one foot, the sampling device for water will be a horizontal flow-through water sampler (Van Dorn sampler or other similar sampling device). Sampling equipment will be constructed of stainless steel, glass, PVC, or Teflon®. The sample will be collected by lowering the sampler to the desired depth (generally to 40 percent of the water column, measured down from the water surface). The sampler will be closed by remotely activating the release mechanism.
- For samples taken in shallow water (between 3 and 12 inches deep), the sampling device will be a pre-cleaned laboratory container held in a gloved hand. Water will be collected from just below the water surface, with the opening facing upstream in flowing water. Care should be taken not to disturb the bottom sediment. If possible, avoid transferring sediment from the collection container into the final laboratory containers.
- If the depth of water at a designated sampling location is less than 3 inches, no surface water sample will be collected.
- The sample will be transferred from the sampler to the appropriate sample containers. The water sampled will be collected and transferred into sample containers.
- Samples will be handled and labeled according to SOPs, Packing and Shipping of Environmental Samples and Sample Handling and Custody. Samples should also be placed in a cooler with ice and maintained at $4° \pm 2°$ C.
- Dissolved oxygen, specific conductance, temperature, turbidity and pH should be measured at the sampling location prior to sample collection and recorded in a field log book.
- The equipment should be decontaminated (SOP, Equipment Decontamination Procedures) and wrapped for protection in aluminum foil for the next sample location.
- The surface water sample location should be marked with a labeled survey flag or stake. Generally, the location should be marked on the shore of the water body sampled to

minimize the possibility of the marker being washed away. The offset distance to the actual sample location should be recorded (that is, centerline of the creek).

Sediment

(Refer to the appropriate section of the site-specific plan for sampling locations and depths.)

- The required supplies and equipment will be assembled. Set up and calibrate instruments in accordance with the manufacturer's instructions.
- Reusable sampling equipment will be decontaminated before sampling and between each sampling location (SOP, Equipment Decontamination Procedures).
- Appropriate PPE will be worn.
- If both surface water and sediment sample are to be collected at a designated location, the surface water sample should be collected first, followed by the sediment sample.
- Beginning at the most downstream sampling location, sediment samples will be collected using a stainless steel sampling dredge (such as Ponar, Ekman, Wildco, etc.) or other similar sampling device. In shallow water (less than 2 feet) or in areas where the sediment is very stiff, sediment samples can be collected using a stainless steel hand auger or slide hammer. Alternatively, submerged sediment samples can be collected using a barge-mounted, direct-push rig. A sufficient volume of sample will be collected to fill all sample containers.
- In general, sampling will begin at the most downstream location in bodies of flowing water. The designated sampling locations will be accessed by boat or by wading, depending on water depth. A PFD and waders should be worn if personnel enter the water. When wading into a body of water, personnel should take special care to minimize the amount of disturbance to the underlying sediment.
- When using a grab sampler (dredge), the speed of the descent should be controlled with no free fall allowed. A rigid handle may be fitted to the device for sampling in shallow water or no-water situations. After the sample is collected, the sampling device will be lifted slowly off the bottom and steadily raised to the surface.
- Sediment samples will be collected from the top 6 inches of sediment.
- Once the sampler is retrieved, the surface of the sediment should be inspected to determine if the sample is acceptable. If the surface shows signs of disturbance (channeling, loss of surface integrity in the sampler), discard the sample (into a waste container to avoid re-sampling).
- Once an acceptable sample is collected, a photograph of the sample should be taken, and then the overlying water removed using a disposable turkey baster, taking care not to disturb the sediment surface. Overlying water will be used for the grain size sediment sample.
- Leaves, sticks, and large stones should be removed from the surface of the sample.

- The remainder of the sediment sample will be placed into a stainless steel bowl or disposable aluminum tray, homogenized, and put into the appropriate containers. The sample will be homogenized by breaking up and mixing the soil with a stainless steel spoon or trowel. All sticks, rocks, leaves, and or other nonsediment objects will be removed during the homogenization process.
- If multiple grabs are necessary to fill all containers, sediment will be collected immediately adjacent to the original location and homogenized. Sample containers for AVS/SEM will be filled first, followed by TAL metals, organic carbon, grain size, and then sediment for bioaccumulation bioassays.
- Samples will be handled and labeled according to SOPs, Packing and Shipping of Environmental Samples and Sample Handling and Custody. Samples should also be placed in a cooler with ice and maintained at 4° $\pm$ 2° C.
- The equipment should be decontaminated (SOP, Equipment Decontamination Procedures) and wrapped for protection in aluminum foil for next sample location, or disposed if disposable aluminum trays and trowels are used.
- If sediment is collected from 6 to 12 inches at the same location, the above steps will be repeated beginning with inspection of the sample and ending with equipment decontamination.
- The sediment sample location should be marked with a labeled survey flag or stake. Generally, the location should be marked on the shore of the water body sampled to minimize the possibility of the marker being washed away. The offset distance to the actual sample location should be recorded (that is, centerline of the creek).

Key Checks

- Mark sample locations with pin flags or surveyor stakes.
- Start downstream and work upstream.
- Collect surface water first, followed by sediment, where surface water and sediment samples are co-located.
- Log exact locations using permanent features.
- Beware of hidden hazards.

Attachments

None.

STANDARD OPERATING PROCEDURE 12

Field Water Quality Measurements and Calibration

Purpose

This SOP provides a general guideline for using the YSI 600XLM or similar device for field water quality measurements such as pH, specific conductance, dissolved oxygen, ORP, and temperature and using a HACH turbidity meter or similar device for measuring turbidity. The operator's manual should be consulted for detailed calibration and operating procedures.

Scope and Applicability

All water quality measurements will be taken in accordance with this SOP. Record keeping to document calibration activities and environmental sample results will be documented in the field log book in accordance with SOP-01, Note Taking and Field Logbook.

Example Equipment and Materials

- Nitrile gloves
- Field Notebook
- YSI 600XLM Water Quality Meter, or similar device
- Distilled or deionized water in spray bottle
- Liquinox® in spray bottle
- Calibration standard solution for pH (4, 7, and 10), conductivity, and ORP
- HACH turbidity meter, or similar device

Procedures and Guidelines

Calibration

Prior to each day's use, clean the YSI probe according to the manufacturer's direction and calibrate using specified solutions. Follow the instructions provided with the water quality meter. If there is a problem with calibration, the meter will return an error. In this case, the cause of the error must be researched in the manual or with the supplier of the equipment before using. Calibrate temperature probe with a laboratory grade thermometer using hot and cold tap water to establish accuracy over a range of temperatures.

Prior to each day's use, confirm calibration of the HACH turbidity meter according to the manufacturer's direction. Turbidity will be measured in NTUs.

Sample Measurement

As the water passes through the probe, allow readings to stabilize and record in the field notebook or on proper documentation sheets.

Key Checks and Items

- Calibrate meters
- Clean probe with Liquinox® and rinse with deionized or distilled water before calibrating, between calibration fluids, and when done
- Refer to operations manual for recommended maintenance
- Check batteries, and have a replacement set on hand
- Store the YSI probe must be stored in non-deionized water when not in use to prevent damage to the DO membrane. If the membrane is damaged, the replacement method can be found in the manual.

STANDARD OPERATING PROCEDURE 13

Equipment Decontamination Procedures

Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

Scope

This is a general description of decontamination procedures.

Equipment and Materials

- Distilled or deionized water
- 2.5-percent (W/W) Alconox®, Liquinox®,or equivalent phosphate-free detergent and water solution
- Large plastic pails or tubs for Alconox®, Liquinox®, or equivalent and water, scrub brushes, squirt bottles for detergent solution resealable plastic bags, paper towels, and sheets
- DOT approved 55-gallon drum for disposal of waste
- Unpowdered chemical-resistant gloves (i.e., nitrile gloves)
- Aluminum foil

Procedures and Guidelines

A. Personnel Decontamination

The following procedures are to be performed after the completion of tasks whenever the potential for contamination exists, and also upon leaving the exclusion zone:

1. Wash boots in detergent solution, and then rinse with water. If disposable latex booties are worn over boots in the work area, remove and discard into a DOT-approved 55-gallon drum.
2. Remove and discard outer chemical-resistant gloves into a DOT-approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into a DOT-approved 55-gallon drum (if worn).
4. Remove respirator (if worn). Dispose of filter cartridges and replace daily.

5. Remove inner gloves and discard.
6. Shower entire body at the end of the work day, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. Sampling Equipment Decontamination—Other Equipment

Reusable sampling equipment is decontaminated after each use as follows:

1. Wear unpowdered chemical-resistant gloves.
2. Rinse and scrub with potable water.
3. Wash all equipment surfaces that came into contact with the potentially contaminated soil/water with detergent solution.
4. Rinse with potable water.
5. Rinse with distilled water.
6. Completely air dry or wipe dry with a clean paper towel. Wrap exposed areas with aluminum foil (shiny side out) or enclose equipment in clean plastic for transport and handling if equipment will not be used immediately.
7. Collect all rinsate and place in a DOT-approved 55-gallon drum.
8. Dispose of decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment in DOT-approved 55-gallon drums.

C. Health and Safety Monitoring Equipment Decontamination

1. Wrap soil contact points in plastic before use, to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with detergent solution, and finally two times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

D. Sample Container Decontamination

The outside of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure for sample container decontamination is as follows:

1. Wipe container with a paper towel dampened with detergent solution, or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used detergent solution and paper towels in a DOT-approved 55-gallon drum or in trash bags placed into appropriate dumpsters, keeping liquids and solids in separate drums.

Attachments

None.

Key Checks and Items

1. Do not use acetone for decontamination.
2. Drum all contaminated rinsate.
3. Clean with solutions of Alconox®, Liquinox®, or equivalent phosphate-free detergent, and distilled water.

STANDARD OPERATING PROCEDURE 14

Packing and Shipping of Environmental Samples

Purpose

The purpose of this SOP is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

Scope

This SOP is applicable for all samples collected and prepared for analysis at an offsite laboratory.

Equipment and Materials

- Waterproof hard plastic coolers
- Plastic zip lock bags
- Plastic garbage bags
- Absorbent packing material (not vermiculite)
- Inert cushioning material (not vermiculite)
- Ice
- USEPA Region 5 sample tags
- Forms II Lite software
- Laptop and printer
- Adhesive labels 2 x 4 inches (generated by Forms II Lite software)
- Chain-of-custody forms (generated by Forms II Lite software)
- USEPA Region 5 Custody seals
- Airbills and shipping pouches (e.g., FedEx)
- Clear tape
- Strapping tape
- Mailing labels

Procedures and Guidelines

A. Prepare Bottles or Bags for Shipment

1. Arrange sample containers in groups by sample number.
2. Check that sample container lids are tight.
3. Secure appropriate USEPA Region 5 sample tags around lids of container with string or wire.

4. Arrange containers in front of assigned coolers.
5. Affix appropriate adhesive labels to each container.
6. Enclose each sample in a clear; resealable, zip lock bag, making sure that sample labels are visible.

B. Prepare Coolers for Shipment

1. Tape drains shut, inside and out.
2. Affix "This Side UP" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
3. Place mailing label with laboratory address on top of the coolers.
4. Place inert cushioning material (e.g., bubble wrap, preformed poly-foam liner) in the bottom of the cooler. Do not use vermiculite.
5. Place appropriate chain-of-custody records with corresponding custody seals on top of each cooler.
6. Double bag and seal loose ice in resealable, plastic, zip lock bags to prevent melting ice from leaking and soaking the packing material. Place the ice outside the garbage bags containing the samples. Place sufficient ice in cooler to maintain the internal temperature at 4±2°C during transport.
7. Put an absorbent pad in the bottom of the cooler and fill the cooler with enough packing material to prevent breakage of the sample bottles and to absorb the entire volume of the liquid being shipped (offsite sample shipment only).
8. Record the USEPA Region 5 custody seals on the chain-of-custody forms. Sign each chain-of-custody form (or obtain signature) and indicate the time and date the cooler was custody sealed.
9. Seal the laboratory copies of the chain-of-custody forms in a large resealable plastic zip lock bag and tape to the inside lid of the cooler. Retain the Region 5 copies of the chain-of-custody forms for return to USEPA. Each cooler must contain a chain-of-custody form (or forms) that corresponds to the contents of the cooler.
10. Close lid and latch.
11. Peel custody seals carefully from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
12. Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals.
13. Relinquish to carrier (e.g., FedEx). Place airbill receipt inside the mailing envelope and send to sample documentation coordinator, along with the other documentation.

Attachments

None.

Key Checks and Items

None.

STANDARD OPERATING PROCEDURE 15

Sample Handling and Chain-of-Custody Procedure

Purpose

The purpose of this SOP is to provide a definition of "custody" and describe protocols for documenting the transfer of custody from one party to the next (e.g., from the site to the laboratory). A documented custody trail is established through the use of sample tags and a USEPA chain-of-custody form that uniquely identifies each sample container, and who has possession of it from the sample's origin to its final destination. The chain-of-custody form also describes the sampling point, date, time, and analysis parameters.

Scope

Sample personnel should be aware that a sample is considered to be in a person's custody if the sample meets the following conditions:

- It is in a person's actual possession
- It is in view after being in a person's possession
- It is locked up so that no one can tamper with it after having been in physical custody

When samples leave the custody of the sampler, the cooler must be custody-sealed and possession must be documented.

Data generated from the use of this SOP may be used to support the following activities: site characterization, risk assessment, and evaluation of remedial alternatives.

Equipment and Materials

- Computer with Forms II Lite software loaded
- Laser printer with paper (8.5- × 11-inch) and ink cartridge (black)
- USEPA Region 5 Sample Tag
- Forms II Lite generated tag label (2- x 4-inch adhesive labels)
- Indelible black ink pen

Procedures and Guidelines

A. Chain-of-Custody Forms

The chain-of-custody form must contain the following information:

- CASE NUMBER/CLIENT NUMBER: If a CLP laboratory is used, enter the case number provided by EPA's RSCC. If the CLP is not used, enter the SAS number provided by CH2M HILL's Sample & Analytical Coordinator.
- EPA REGION: Enter Region "5".
- EPA ID: FOR EAGLE ZINC, USE "ILD980606941".
- SPILL ID: FOR EAGLE ZINC, USE "B5Y7".
- SITE NAME/STATE: FOR "EAGLE ZINC", "IL".
- PROJECT LEADER: ENTER THE CH2M HILL SITE MANAGER.
- ACTION: FOR EAGLE ZINC, CHOOSE "REMEDIAL INVESTIGATION".
- SAMPLING CO.: "CH2M HILL".
- SAMPLE NO.: This is the unique number that will be used for sample tracking. For CLP, this number is taken from a block of numbers assigned by the EPA RSCC. For non-CLP, the CH2M HILL Sample & Analytical Coordinator will assign this number.
- MATRIX: DESCRIBES THE SAMPLE MEDIA (E.G., SEDIMENT ETC.).
- SAMPLER NAME: THE NAME OF THE SAMPLER OR SAMPLE TEAM LEADER.
- CONCENTRATION: LOW (L), LOW/MEDIUM (M) OR HIGH (H).
- SAMPLE TYPE: "GRAB" OR "COMPOSITE".
- ANALYSIS: THIS INDICATES THE ANALYSES REQUIRED FOR EACH SAMPLE.
- TAG NO.: This number appears on the bottom of the sample tag and includes a prefix ("5") followed by a series of numbers. The entire number must appear on the chain-of-custody form.
- PRESERVATIVE: Document what preservative has been added to the sample (e.g., "HCl", "Ice Only", "None").
- STATION LOCATION: THIS IS THE CH2M HILL STATION LOCATION IDENTIFIER.
- SAMPLE COLLECT DATE/TIME: USE MILITARY TIME.
- QC TYPE: THIS IS FOR FIELD QC ONLY, AND INCLUDES FIELD DUPLICATE, FIELD BLANKS, EQUIPMENT BLANKS, AND TRIP BLANKS.
- DATE SHIPPED: THE DATE THAT SAMPLES ARE RELINQUISHED TO THE SHIPPING CARRIER.
- CARRIER NAME: (E.G., "FEDEX").
- AIRBILL: AIRBILL NUMBER USED FOR SHIPPING.
- SHIPPED TO: THIS IS THE LABORATORY NAME AND FULL ADDRESS, INCLUDING THE LABORATORY CONTACT. IF THE CONTACT IS NOT KNOWN, USE "SAMPLE CUSTODIAN".
- CHAIN-OF-CUSTODY RECORD FIELDS: THE SAMPLER'S SIGNATURE MUST APPEAR IN THE "SAMPLER Signature" and the "Relinquished By" fields. The date and time (military

time) must also be included. If additional personnel were involved in sampling, their signatures should appear in the "Additional Sampler Signature(s)" field.

Although the samples are "relinquished" to the shipping carrier, the shipping carrier does not have access to the samples as long as the shipping cooler is custody sealed. Consequently, the shipping carrier does not sign the chain-of-custody form.

- SAMPLE(S) TO BE USED FOR LABORATORY QC: THIS IDENTIFIES WHICH SAMPLES ARE TO BE USED FOR MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSES.
- INDICATE IF SHIPMENT FOR CASE IS COMPLETE: USE "Y" OR "N".
- CHAIN-OF-CUSTODY SEAL NUMBER: RECORD THE CUSTODY SEAL NUMBERS THAT APPEAR ON THE Region 5 custody seals that can be found on the shipping container. There is usually a minimum of two per shipping container.

B. Sample Tags

Each sample container will be identified with a uniquely numbered sample tag issued by USEPA Region 5. Each tag will contain the following information:

- Case/SAS number
- The unique sample number for sample tracking
- CH2M HILL station location (i.e., the sample identifier)
- Date of sampling
- Time the sample was collected (in military time)
- All parameters for which the sample will be analyzed
- Preservative used (if any)
- Sample type (grab or composite)
- Sample concentration (low, medium, high)
- Sample matrix (sediment, etc.)
- The signature of sample team leader
- Identification when sample is intended to be used by the lab for MS/MSD duplicate

Attachments

- Attachment 1: Forms II Lite Quick Reference Guide
- Attachment 2: Example Chain-of-Custody Form, Sample Tag, Custody Seal

Key Checks and Items

- All sample containers must be properly tagged.
- Each cooler must have a chain-of-custody form and the samples in the cooler (as identified by the sample tags) must match what is on the chain-of-custody form.
- Each chain-of-custody form must be properly relinquished (signature, date, time).
- The custody seal numbers must be written on each chain-of-custody form.
- The shipping cooler must be custody sealed in at least two places.

SOP-15, Attachment 1
Forms II Lite Quick Reference Guide

Getting Started

(a) Click on the **Start** button on the Windows Desktop and select **Program**s. Select **Forms II Lite** and click on the FORMS II Lite item. The FORMS II Lite application will begin.

(b) Click **File** on the Main Menu bar. Click on the **New Site** item. The first data entry screen will appear.

Step 1 – Enter Site Information

a) Enter all relevant information necessary for chain-of-custody paperwork (in accordance with Regional guidance). For CLP Traffic Reports (TRs), this includes the following:

- Site Name
- State
- EPA Region Number
- CLP Case Number
- Lead Sampler

b) Click the **Next** button to proceed to Step 2.

Step 2 – Select Sampling Team

a) Select sampling team members from the **Unassigned Team Members** window by clicking on each name.

b) Click the **>** button. The selected name will move to the **SelectedTeam** window. Repeat until all team members for this sampling event are selected.

c) Click the **Add/Edit Team Members** button to add any remaining sampling team members' names that do not appear in the **Unassigned Team Members** window.

d) Enter the first and last name of each sampler. If you would like to add the sampler to the permanent list, click the **Add to Permanent List** box. After you have entered the samplers' names, click the **OK** button. These samplers will appear in the **Selected Team Members** window on the Select Sampling Team screen.

e) Click the **Next** button to proceed to Step 3.

Step 3 - Select Analysis

a) Select an analysis from the **Available Analyses** window by clicking on the analysis.

b) Click the **>** button. The selected analysis will move to the **Selected Analyses** window. Repeat until all analyses to be performed on samples collected for this sampling event are selected.

c) To edit Turnaround Time, click the **Edit Turnaround Days** button. The **Edit Project and Turnaround** screen will appear.

d) Click on the **Turnaround Time** drop down menu to select the number of days or type in a value. Click **Close** to close screen.

e) Click the **Next** button to proceed to Step 4.

Step 4 – Enter Station

a) Enter all relevant information necessary for chain-of-custody paperwork (in accordance with Regional guidance). For CLP TRs, this includes the following:

- Station Name and Location
- Sample Matrix
- Sample Date/Time
- Sample Type
- Sampler Name

b) The Sample Date/Time field is strictly military time. You may click on the System Date/Time checkbox to populate the current system date/time value into the sample date/time.

c) Click the **Add Station** button to enter the name of a new station and continue with the station locations. To enter a new station location associated with a previously entered station, click on the station name, then click the **Add Location** button, and enter the name of the new station location.

d) Click the **Next** button to proceed to Step 5.

Step 5 – Assign Bottles and Samples

a) Select the Station Location from the **Station/Location** window.

b) Select the analyses associated with the containers from the **Analysis** window. If more than one analysis is associated with a container, select the additional analysis(es) by holding down the control key, and clicking on the additional analysis(es).

c) Enter the number of bottles that will be assigned a specific analysis or set of analyses.

d) Enter the sample tag prefix and starting tag number. Click **Auto Increment Tag Number** if you wish to assign sequential tag numbers for your sampling event. Sample numbers are automatically and sequentially assigned for your sampling event and are unique per Station Location.

e) By default, CLP sample numbers are automatically used for CLP analyses. Note that FORMS II Lite generates CLP sample numbers using a BASE 32 system that differs from the CLASS-generated CLP sample numbers.

f) Edit the sample number and other pertinent information for these samples in the space provided. After entries are confirmed, click the down arrow.

g) Repeat steps 5b through 5f until all desired analyses have been assigned to bottles.

h) Click the Next button to proceed to Step 6.

Generate Labels

a) Click the **Generate Labels** button in Step 5. The application automatically displays samples for the current Station Location. These are the samples for which labels will be generated. Click the appropriate checkbox at the bottom of the screen to select all samples for the station or site. Enter the number of labels to print next to each record if more than one is needed.

b) Click the **Generate Labels** button and select the appropriate label template to view, then click **OK.** Edit an existing template by clicking the **Edit Label** button. If a new label template needs to be added, click the **Add New Label** button and follow the wizard to create a new template. Enter the number of blank labels to control printing on a label other than the first one on the page.

c) View the labels at the end of the edit label or new label process. If labels are not acceptable, close the view and edit the label template. If the labels are acceptable, print the labels.

d) Select **File** and then **Print** from the Main Menu bar. Select the desired number of copies to be printed and click the **OK** button to print the labels. Click **Close** to return to Step 5.

Step 6 – Select Samples and Assign Lab

a) Select a laboratory from the **Lab Code** drop down menu. If the laboratory where samples will be shipped does not appear in the list, click the **Add Lab** button and add the lab information.

b) Select samples from the **Unassigned Samples** window by holding down the [Ctrl] key and clicking on each sample that will be shipped to this laboratory. After you have selected all the samples for the laboratory, click the down arrow.

c) Repeat steps 6a and 6b until all samples have been assigned to laboratories.

d) Click the **Next** button to proceed to Step 7.

Step 7 - Select Labs and Assign Shipping

a) Enter the carrier, date of shipment, and airbill number.

b) Select samples from the **Unassigned** window by holding down the [Ctrl] key and clicking on each sample that will be shipped using this airbill. After selecting the samples to be shipped, click the down arrow.

c) Repeat steps 7a and 7b until all samples have been assigned airbill numbers.

d) Click the **Finish** button for system generated TRs. FORMS II Lite will then display a screen that enables viewing and printing TRs for the site.

e) Click **Next** and proceed to Step 8 to customize TRs for specific sets of samples.

Step 8 – Customize Traffic Report

a) Confirm the last four digits of the TR number. (The first two digits represent the Region number, the next nine digits are a random number, and the next six digits are the date

the TR was created, and the last four digits are automatically incremented by the system but may be edited by the user.)

b) Select a shipment from the **Shipping** window. Select the samples from the **Samples** window that will be assigned to this TR. After selecting the samples, click the down arrow. (NOTE: samples must be of the same program type and must have the same project code to be assigned to a single TR.)

c) Repeat steps 8a and 8b until all samples have been assigned.

d) Click the **Finish** button. FORMS II Lite will display a screen that will enable viewing, printing, archiving, and exporting TRs. Follow the directions to print the TRs.

Quick Edit

a) On the **View/Print TR** screen displayed after completion of Step 8, click the **Quick Edit** button.

b) The user may edit most data fields, except those in red, prior to printing a TR, and arealso able to sort and filter any column and print a report.

Helpful Hints to Use FORMS II Lite 5.1

This Quick Reference Guide is designed to help FORMS II Lite users enter information for their sampling events and generate bottle labels and chain-of-custody paperwork. FORMS II Lite provides users the flexibility to enter most of their information ahead of the sampling event.

FORMS II Lite allows users to perform the following:

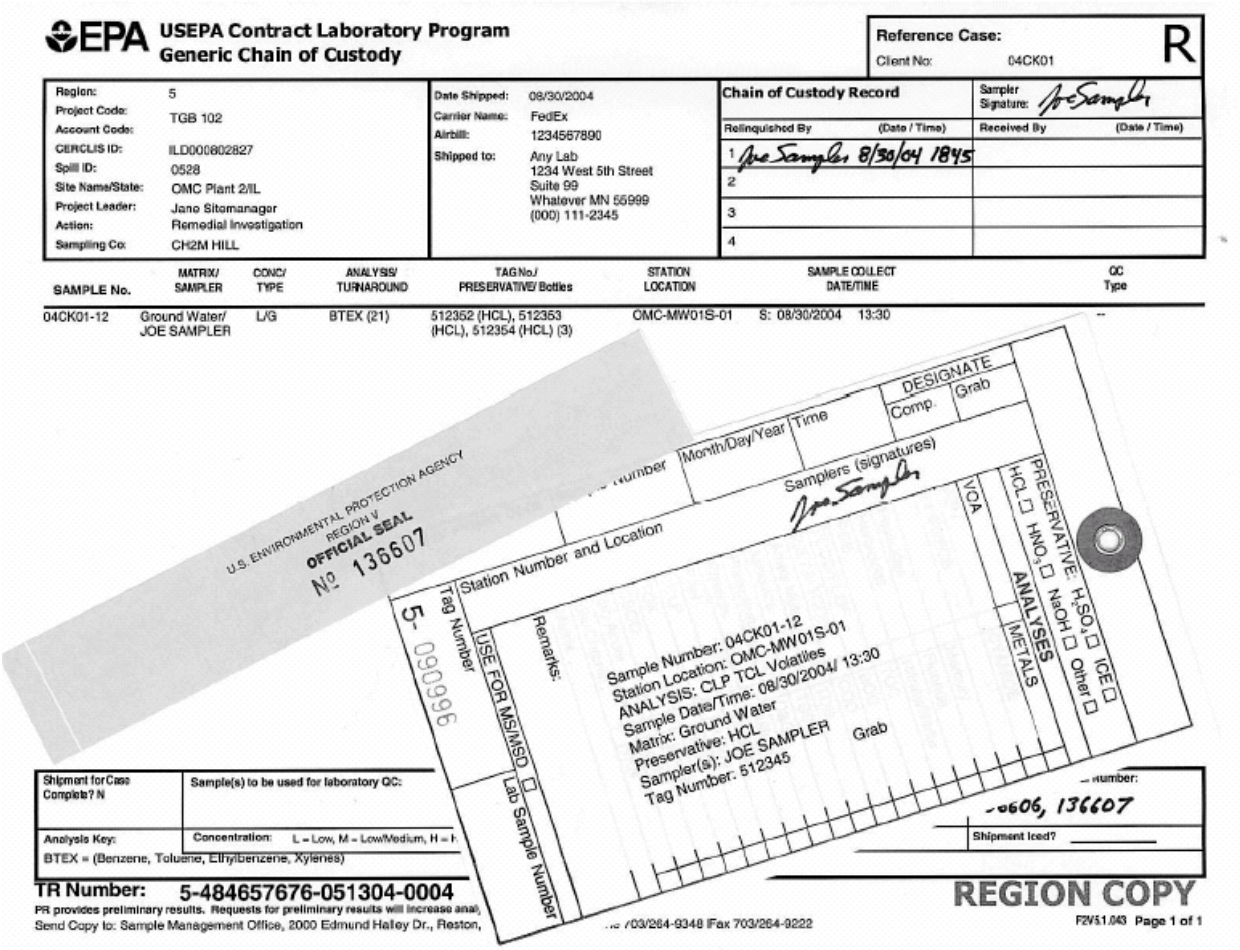
- Add values that are not included in the "list and pick" menus: Select **Admin** from the Main Menu bar, enter the password to log in. **Admin** now shows the user as being **(logged in**). Select **Reference Table**s, and choose the table that requires editing.
- Customize screens and disable non-key fields: While logged into **Admin** on the Main Menu Bar, select **Custom Features** and click on **Field Name**s. Field names and non-key fields can be renamed or hidden on the screen.
- Review the data entered throughout the data entry process by clicking on the **Quick View** button in Steps 4 through 8.
- Select multiple items by highlighting the first item, then hold down the [Ctrl] key and click on the additional items. Or simply click and drag to highlight multiple items.
- Sort data displayed in windows by clicking on the column label. Click on a second column label for a secondary sort.
- Specify more than one sampler's name for samples collected at a specific station location. In Step 4, select a sampler's name, then click within the data entry field after the name. Type a comma and type in the second name.
- Export Site information as either a text or (.xml) file.

- **Note:** FORMS II Lite will not allow information that has been typed over to be saved as a separate file. Once a value in a field has been replaced (edited) with a new value, the original value is lost.

User Preferences

- The following features are maintained in **User Preferences** under **Admin** on the Main Menu bar and can be turned on or off.
- Select **Copy Station** to make the button available in Step 4 to duplicate the current station and its station location information. **Copy Location** duplicates station locations.
- Select the option **Use Default Number of Bottle**s, set in the Analysis Reference Tables, to populate the number of containers for each analysis in Step 5.
- Select **Assign All** to make the button available in Step 5 to assign each of the analyses to a separate container. Set the number of containers for each analysis in the bottles field or define through User Preferences.
- Select **One-Step Printing** to make this button available in Step 5 to print labels or tags with a single click. Label template, and number of copies are defined in User Preferences.

SOP-15, Attachment 2
Chain-of-Custody Form, Sample Tag, Custody Seal



EPA USEPA Contract Laboratory Program
Generic Chain of Custody

Reference Case: R
Client No: 04CK01

Region:	5	Date Shipped:	08/30/2004
Project Code:	TGB 102	Carrier Name:	FedEx
Account Code:		Airbill:	1234567890
CERCLIS ID:	ILD000802827	Shipped to:	Any Lab, 1234 West 5th Street, Suite 99, Whatever MN 55999, (000) 111-2345
Spill ID:	0528		
Site Name/State:	OMC Plant 2/IL		
Project Leader:	Jane Sitemanager		
Action:	Remedial Investigation		
Sampling Co:	CH2M HILL		

Chain of Custody Record — Sampler Signature: Joe Sampler

Relinquished By	(Date / Time)	Received By	(Date / Time)
1 Joe Sampler	8/30/04 1845		
2			
3			
4			

SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	QC Type
04CK01-12	Ground Water/ JOE SAMPLER	L/G	BTEX (21)	512352 (HCL), 512353 (HCL), 512354 (HCL) (3)	OMC-MW01S-01	S: 08/30/2004 13:30	

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION V OFFICIAL SEAL No. 136607

Station Number and Location | Month/Day/Year | Time | DESIGNATE Comp. Grab | Samplers (signatures): Joe Sampler

Tag Number 5- 090996

USE FOR MS/MSD ☐ | Remarks: | Lab Sample Number

Sample Number: 04CK01-12
Station Location: OMC-MW01S-01
ANALYSIS: CLP TCL Volatiles
Sample Date/Time: 08/30/2004/ 13:30
Matrix: Ground Water
Preservative: HCL
Sampler(s): JOE SAMPLER Grab
Tag Number: 512345

ANALYSES: VOA | METALS
PRESERVATIVE: HCL ☐ HNO3 ☐ H2SO4 ☐ NaOH ☐ Other ☐ ICE ☐

Shipment for Case Complete? N | Sample(s) to be used for laboratory QC:
Analysis Key: | Concentration: L = Low, M = Low/Medium, H = H
BTEX = (Benzene, Toluene, Ethylbenzene, Xylenes)

Number: 0606, 136607
Shipment Iced? _____

TR Number: 5-484657676-051304-0004
PR provides preliminary results. Requests for preliminary results will increase anal
Send Copy to: Sample Management Office, 2000 Edmund Halley Dr., Reston, ... 703/264-9348 (Fax 703/264-9222

REGION COPY
F2V51.043 Page 1 of 1

STANDARD OPERATING PROCEDURE 16

Aquifer Testing

Purpose and Applicability

This procedure describes the method for performing a slug-type aquifer test to determine hydraulic conductivity of formation material in the screened interval of partially or fully penetrating wells.

Definitions

None.

Procedure

Testing of several wells is necessary to characterize an aquifer because slug tests only measure aquifer properties immediately adjacent to the borehole or well. The water level in the well to be tested shall be static before the test begins. That is, the water level must not be recovering or receding as a result of sampling, development, pumping of nearby wells, or related activities. The slug test shall be performed using a slug or by withdrawing water from the well. No water or other fluid shall be introduced or put into the well.

Slug tests are performed by causing a positive or negative displacement in the water level in the well and measuring the rate at which the water level returns to static conditions. A solid cylinder of known volume will be used to displace the water in the well. The slug test procedure for the rising head method is presented below. The following equipment is required for slug tests:

1. Rope
2. Solid slug (closed PVC pipe or bailer)
3. Water-level measuring device (pressure transducer and electronic data logger)

All downhole equipment should be decontaminated prior to testing and between each well test.

Rising Head Slug Test

The test is performed as follows:

1. Measure the static water level in the well and note the position of the water level in relation to the top of the screen.
2. Place a pressure transducer that is connected to an electronic data logger near the bottom of the well.
3. Place a solid slug into the well so that the entire slug is submersed in groundwater. Let the water level recover to near static conditions (within 5 percent).

4. Program the data logger to record data on a logarithmic cycle and set the transducer to the desired reference level (e.g., zero).
5. To begin a test, quickly withdraw the slug while simultaneously pressing the start key on the data logger to begin recording data. Continue recording data until the water level has recovered to within 10 percent of the static water level based on the maximum displacement caused by the slug or until enough data has been collected to produce a useable time-recovery curve.
6. At the conclusion of the test, download the recovery data to a computer. For data analysis, use a semi-log plot of change in head versus time using the Bouwer and Rice method of analysis (Bouwer, 1987) for determining hydraulic conductivity in unconfined aquifers, or other appropriate methods.

Attachments

None.

Key Checks and Items

None.

STANDARD OPERATING PROCEDURE 17

Monitoring Well and Borehole Abandonment

I. Purpose and Scope

The purpose of this procedure is to outline equipment and methods that will be used for abandoning monitoring wells. Temporary or permanent monitoring wells or boreholes should be abandoned, or sealed, in order to prevent the borehole or well from as acting as a conduit and/or to prevent cross contamination between hydrogeologic units. Abandoning surface casings installed for double-cased wells also is discussed.

The purpose; location; groundwater quality; age; condition of the well, borehole, or any surface casing; potential for groundwater contamination and cross contamination between water-bearing units; and well, borehole, or surface-casing construction should be considered to determine if a borehole or monitoring well should be abandoned. State-specific requirements for well abandonment should be reviewed and consulted along with this SOP; such requirements may be included in the well permit, if such documents are required. Adequate information to define the former well or borehole location should be collected and maintained in the project files to ensure that the location can be relocated in the future, if necessary.

II. Equipment and Materials

- Drilling rig with appropriate equipment
- Pure, additive-free powdered bentonite for grout
- Cement-Bentonite Grout. Proportion 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.
- Tremie pipe
- Containerization for well riser, casing, and/or cuttings produced if riser and casing are drilled out and for water displaced from the well, borehole, or surface casing during abandonment.

III. Procedures and Guidelines

Boreholes and monitoring wells may be abandoned by sealing in place using grout or by removing or drilling out the well riser and sealing the remaining borehole. Surface casings may be abandoned by similar means.

A. Leaving the Well Screen and Riser and Sealing In-Place

Monitoring wells known to be constructed with an impermeable annular space seal may be abandoned by leaving the well riser in place and sealing the well by filling with grout.

1. The monitoring well screen and casing should be split or "ripped" prior to emplacement of the grout slurry whenever possible. This can be accomplished through the use of a casing splitting tool and drill rig. The splitting tool is attached to the lead drill rod and pushed down through the center of the monitoring well. As the tool is forced down, the splitting tool splits the PVC well casing and screen. This will allow better penetration of the grout slurry into the former annular space of the borehole and provide a more thorough grout seal.

2. Boreholes and monitoring wells should be completely filled with cement grout, bentonite-cement grout, bentonite grout, or concrete. The sealant should be delivered as a slurry which is pumped via a tremie pipe from the bottom of the borehole/monitoring well.

3. Following the completion of the grouting, the monitoring well stick-up or flush mounted protective cover and ground surface seal should be removed and the well riser should be cut off at least 24 inches below the ground surface. The location should then be finished at ground surface with like material (e.g., asphalt or concrete for paved areas and soil or sod in dirt or grass areas).

B. Well Riser Removal or Drilling Out and Sealing the Remaining Borehole

Monitoring wells that are not known to be constructed with an impermeable annular space seal should be abandoned by removing the well riser, if possible, or drilling out the well riser and then sealing the remaining borehole.

1. Prior to abandonment, the monitoring well stick-up or flush-mounted protective cover and ground surface seal should be removed.

2. The well riser may be removed by pulling on the riser or by overdrilling around the riser and then pulling the riser out of the ground. If it is not possible to remove the well riser, the well riser may be drilled over and removed from the borehole in pieces as the augers are removed from the borehole as borehole cuttings. The diameter of the auger or casing used for the overdrilling should be at a minimum, the same size or larger than the diameter of the borehole to ensure that all of the well material is removed.

3. After the well riser is removed or drilled out, the remaining borehole should be sealed according to Section A above.

C. Surface Casing Removal for Double-Cased Wells and Sealing the Remaining Borehole

1. In the event that a surface casing is present around the well riser, information on the construction of the surface casing should be obtained, if possible. A decision must be made as to whether or not to remove the surface casing. If the integrity is uncertain, then the surface casing may be serving as a mode of cross connection. However, the assumption is that the surface casing does not fully penetrate the confining layer into which it is set, so it is often appropriate to leave it in place and abandon the well inside of it. The available information on

the surface casing and its age and appearance should be considered in making this decision.

2. Any work to abandon the surface casing should be done after the well riser and screen have been removed and the borehole grouted up to the bottom of the surface casing. Otherwise, soil, groundwater, and possibly contamination may fall down the surface-casing borehole into the well borehole.

3. If the decision is made to leave the casing, it can be grouted up according to Section A above and the aboveground part of the surface casing and any concrete pad removed.

4. If the decision is made to remove the surface casing, typically the surface casing should be overdrilled with a large auger or casing and then removed. The borehole then is sealed according to Section A above. Alternatively, if the integrity of the annular seal appears to be poor, the surface casing may be removed by inserting an extraction tool in the surface casing, engaging it into the sides of the casing, and removing the casing accordingly. Again, the borehole then is sealed according to Section A above.

IV. Attachments

None.

V. Key Checks and Items

- Know the state or local regulations associated with abandoning the well or borehole
- Know the construction details of the well, surface casing, or borehole so that sound decisions can be made
- If well-construction materials are being removed from the borehole, remove as much as possible so that the borehole can be adequately grouted up
- Use a tremie pipe to ensure proper placement of grout
- Be sure the well or borehole is sealed completely to the surface
- Control IDW
- Maintain well- and borehole-location records in the project files

Appendix D
Analytical Standard Operation Procedures

List of Analytical SOPs – CT Laboratories

Inductively couple Plasma - ICP OES 6000 Series – SOP 6105B-6000

Acid digestion of Solids and Semi-solids for total metals - SOP 6230B

Grain size - SOP CC-27

Total Organic Carbon in Solids – SOP CC-TOC Solid

TCLP and SPLP extraction for non-volatile solids – SOP CL-8B

Determination of Acid Volatile Sulfied and Selected Simultaneously Extractable Metals in Sediment – SOP QA-1343

Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry – SOP QA-1365

Determination of Trace Metals by ICP-MS Analysis – SOP QA-1369

RD 2/19/10

CT Laboratories
Baraboo Laboratory Divison

Title: **Inductively Coupled Plasma Emission—ICP-OES 6000 Series**

SOP Number:

Prepared by: 1/15/10
Date

Technical Review by: 02/15/10
Date

Reviewed by: 2/16/12
Quality Assurance *Date*

17-Feb-2010
Laboratory Director *Date*

SOP Manual Control Number:_____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued.

1.0 Identification of Test Method

1.1 This procedure is used for the analysis of trace elements (metals) following EPA SW 846 Methods 6010B and/or 6010C (Inductively Coupled Plasma –Atomic Emission Spectrometry) and Method 200.7 (SDWA).

2.0 Applicable Matrix or Matrixes

2.1 This method is applicable to the determination of various metals in drinking water, surface water, groundwater, sludge, soils, and industrial wastes.

3.0 Detection Limits

3.1 Method detection limits (MDLs) are determined annually and results vary from element to element. For DOD-QSM, ACOE-LCG work MDL's and LOQ's are verified initially and quarterly thereafter. MDL checks are analyzed up to 3x the calculated MDL (to verify sensitivity). If MDL checks are not detected at the spiked level for any given element than increase the level of the spike until the element is detected (minimum 2 successful analyses). The level at which an element was successfully detected becomes the reported MDL. LOQ checks are used for accuracy verification and shall meet project or client specific control limits. Failing LOQ checks may also need elevation of the spike levels for a given element. The concentration that successfully meets control criteria is used as the reported LOQ. Procedures for conducting MDL studies can be found in CT Laboratories Initial Method Performance and Reporting SOP (CL-2, rev. 5).

4.0 Scope and Application

4.1 Metals in solution can be readily analyzed by atomic emission using an Inductively Coupled Plasma (ICP) spectrometer. All matrices, excluding filtered groundwater samples and drinking waters with a turbidity less than 1 NTU, will require a digestion prior to analysis.

5.0 Method Summary

5.1 If necessary, prior to analysis, samples are digested using an approved method. See SOPs 6205B, 6225B, 6230B, M200.2, and M-soluble for further information on sample digestion.

5.2 This method describes multielement determinations using an iCAP 6000 Series ICP-OES which use an Echelle optical design and a Charge Injection Device (CID) solid-state detector to provide elemental analysis. Most Samples are liquids that are pumped through a nebulizer to produce a fine spray. The large droplets are removed by a spray chamber and the small droplets then pass through to the plasma. The solvent is evaporated. The residual sample is decomposed to atoms and ions that become excited and emit characteristic light which is measured, giving measurement of the concentration of each element type in the original sample. Control of the spectrometer is provided by the PC based iTeva software (refer to the Thermo ICP-OES software manual). Samples are routinely analyzed using an internal standard solution of 50 mg/L Yttrium to eliminate certain matrix interference problems. Line switching is also used to extend the dynamic range of an element.

5.3 The data is exported to the LIMS system and reviewed by the analyst. Following analyst review, the data is given to a qualified reviewer for complete data review. After the data has been reviewed and it is determined that it is valid data, the reviewer sends the data to the "validated" mode in the LIMS system.

6.0 Definitions

6.1 Reagent Blank- A solution of de-ionized water, (containing in correct proportion, all reagents required by the method), used with the calibration standards to standardize the instrument, as a calibration blank, and for sample dilution.

6.2 Calibration Standards - A series of known standard solutions, which shall include the reagent blank, used for calibration of the instrument within the measurable linear range. Calibration standards shall contain, in correct proportion, all reagents required by the method. Acceptance of the calibration requires a correlation coefficient (r) of 0.995 or better. No samples shall be analyzed without acceptable calibration. For DOD-QSM data the low calibration standard shall be equal to or less than the MRL.

6.3 Calibration Verification Standard-Initial (ICV) & Continuing (CCV) - A midpoint calibration standard which is analyzed at the beginning of the run (ICV), at a frequency of 1 per 10 samples during a run (CCV), and at the end of a run to verify calibration throughout the run. The ICV must be from a second source different than that of the calibration standards.

Note for method 200.7 that limits for ICV are tighter than those for the CCV (see section 16).

6.4 Low-Level Calibration Check Standard – If a single point calibration is used (for DOD-QSM data) then a low level standard shall be analyzed. The acceptance criterion is +/- 20% of the expected value.

6.5 CB (Calibration Blanks- Initial and Continuing) - A reagent blank solution, which is analyzed immediately following the ICV (Initial Calibration Blank-ICB), at a frequency of 1 per 10 samples during a run (Continuing Calibration Blank-CCB), and at the end of a run to check for drifts in calibration, or possible analyte carry-over. Warning criteria include that the value be less than or equal to the three times the IDL for a given analyte for SW-846 work, less than the MDL for DOD-QSM data, or less than ½ the MRL for ACOE work. Control criteria consist of the CB value being less than or equal to 2 times the MDL for a given analyte for SW-846 and is determined by the QAPP for DOD/ACOE work. If this range is exceeded, a new calibration will be necessary.

6.6 LCS (Laboratory Control Sample) - A mid-range standard, prepared from a source different from that used for calibration standards, which is carried through the entire preparation and analytical method. The LCS is used to verify the accuracy of the preparation method. A minimum of one LCS is prepared per batch and is analyzed at the beginning of an analytical batch.

6.7 MB (Method Blank) - A Reagent Blank (see 3.1) which is carried through the entire preparation and analytical method. The method blank is used to detect possible contamination that may occur prior to or during the sample preparation. A minimum of one MB is prepared per batch and is analyzed at the beginning of an analytical batch. Blank recovery must be less than 2x the MDL for SW846, less than the MDL for SWDA samples, less than ½ the RL for DOD-QSM, and is determined by the QAPP for ACOE samples.

6.8 MS-MSD (Matrix Spike-Matrix Spike Duplicate): - Two separate sample aliquots to which a known concentration of analyte has been added which is carried through the entire preparation and analytical procedure. The purpose of a matrix spike is to reveal any matrix effect from the sample on the recovery of the analyte by the method being used. An MS-MSD pair is prepared for every 20 samples of a given matrix per day for 6010B and once for every 10 samples of a given matrix per day for 200.7. For ACOE work only an MS is prepared and a duplicate sample is prepared rather than an MSD. Failure to meet criteria may be due to poor recovery during the

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

preparation method or due to matrix interference within the digestate. To be considered acceptable, MSD must meet both the same % recovery criteria as an MS, and the same % RPD as a duplicate sample.

6.9 Duplicate sample- A separate sample aliquot which is carried through the entire preparation and analytical procedure. A duplicate is prepared for every 20 samples for ACOE/LCG work and per batch for DOD-QSM (in replacement of an MSD).

6.10 Method Reporting Limit (MRL) or Contract Required Detection Limit (CRDL) Standard: Detection level standard at a level near the reporting limit, or at a level specified by client contract. When required, it is to be analyzed following the ICB, and prior to the last CCV standard in the run.

6.11 Interelement Correction Factors (IEC) – These correction factors are determined by analyzing a concentration range of known interferents (Al, Ca Co, Cr, Cu, Fe, Mg, Mn, Ni, V and Zn) and examining all other lines for a significant linear response. A line is considered to be significantly affected when the correlation coefficient for the interference is 0.99 or better and the correction factor multiplied by ten is greater than the MDL of the affected line. For interferents known to occur at high levels in environmental samples (Al, Ca, Cr, Cu, Fe, Mg and Zn) the interference will be considered to be significant when the correction factor multiplied by 100 is over the MDL of the affected line and the correlation coefficient in 0.99 or better. Interelement correction is used where applicable.

6.12 Linear Dynamic Range (LDR) – The upper limit of the linear dynamic range is established for each wavelength utilized by determining the signal responses from a minimum of three different concentration standards across the range. One of these will be near the upper limit of the range. The ranges used for the analysis of samples are judged by the analyst from the resulting data. The data and calculations are kept on file. The upper range limit is an observed signal no more than 10% below the level extrapolated from the lower standards. Determined analyte concentrations above the upper range limit are diluted and reanalyzed. New dynamic ranges are determined whenever there is a significant change in instrument response. For analytes that routinely approach the upper limit of the range, the range will be checked biannually. For analytes that are known interferents and exceed the dynamic range, the analyst will check that IEC's have been correctly applied. DOD-QSM requires that a LDR (or high level check standard) study be perform at least every six months.

Note: for ACOE/LCG work, analyte concentrations above the upper calibration limit are diluted and reanalyzed.

6.13 ICS-A (Interelement Correction Standard-A): A standard containing the elements Al, Ca, Fe, and Mg at 500mg/L. This standard is analyzed when using method 200.7 or performing ACOE work following the ICV at the beginning of the run to determine that interelement correction factors are correctly compensating for interference from these elements on other analyte lines. The ICSA may be required to be run before the last CCV of the run for ACOE work. Check the QAPP to determine if this is necessary.

Note: For ACOE work, the ICSA should be within the absolute value of two times the MDL for all analytes except Al, Ca, Fe and Mg unless a different requirement is specified within the contract.

6.14 ICSAB (Interelement Correction Standard-AB): A standard containing the elements Al, Ca, Mg, and Fe at 500mg/L and all other elements at 500ug/L. This standard is analyzed following the ICV at the beginning of each run. It is analyzed to determine that the IEC are correctly preventing interference by these elements on the

UNCONTROLLED CT Laboratories SOP Updates and revisions will not be issued.

measurement of other analytes. The ICSAB may be required to be run before the last CCV of the run for ACOE work. Check the QAPP to determine if this is necessary

6.15 PDS (Post Digestion Spike): When a serial dilution or matrix spike falls outside of the acceptance limits a post digestion spike is used to determine if the sample digestion matrix is interfering with the analysis of the analyte. The sample is spiked at a level similar to that of the matrix spike.

Note: For ACOE/LCG work, a PDS will be conducted at a minimum rate of one per prep batch per unique matrix.

6.16 SD (Serial Dilution Analysis): A sample is diluted 5x with method blank solution and analyzed. The diluted result and the undiluted result should agree within a limit of precision defined by the program (SW846, CLP, 200.7) or client QAPP.

Note: For ACOE/LCG work, a SD will be conducted at a minimum rate of one per prep batch per unique matrix.

6.17 Batch- A batch consists of 20 samples of the same matrix analyzed on the same day or 20 samples of the same medium that have been prepared together.

6.18 IDL (Instrument Detection Limit); A series of blanks analyzed during initial setup or after significant changes, or as per DOD-QSM requirements. The limits established shall be < LOD for any given element.

6.19 Method detection limit (MDL): The minimum concentration of an analyte that can be identified measured and reported with 99% confidence that the analyte concentration is greater than zero.

6.20 LOQ Check: An internally prepared standard at a level near the Limit of Quantitation (LOQ) or at a level specified by a specific program or contract. An LOQ Check is required after MDL studies and quarterly thereafter for QSM work. Recovery limits are required for LOQ Checks and are usually program/contract specific.

6.21 Method Detection Limit (MDL) Check: An internally prepared standard prepared at approximately 1-2 time the calculated MDL for a given analyte (1-4 times for multi-component analyses). The MDL check sample is used as verification of the calculated MDL's. Detection of the individual analytes in the MDL check is the only requirement. The MDL check is required after MDL studies and on an analytical run for LCG work when there are failures on the MRL spikes or quarterly for QSM.

7.0 Interferences

7.1 Background emission and stray light are corrected using background correction. See ICP 6000 Series operator's manual for further instructions on background correction application.

7.2 Spectral overlaps are corrected for using interelement correction factors (IEC). When IEC are used, the interfering elements must be analyzed along with the elements of interest. The accuracy of IEC shall be verified daily by analyzing the ICSAB. All IEC factors shall be updated every six months or when an instrumentation change occurs; such as, changing a torch, nebulizer, injector, or plasma conditions.

7.3 Physical interferences such as viscosity are minimized by using an internal standard. Post digestion spike and serial dilutions help to determine if physical interferences are present.

7.4 Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Chemical interferences are not normally seen during ICP analysis and are highly matrix dependent.

7.5 Memory interferences occur when a sample of high analyte concentration does not thoroughly rinse prior to the analysis of the next sample. This causes elevated

UNCONTROLLED CT Laboratories SOP - Updates and revisions will not be issued

readings for that analyte in the subsequent sample. Memory effects can be minimized by rinsing at least 60 seconds between samples.

8.0 Safety

8.1 Gloves and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.

8.2 Insure that waste collection vessels contain enough room to accommodate all wastes that will be produced during the operation of the instrument.

9.0 Equipment and Supplies

9.1 ICP 6500, Cetac autosampler, computer, & network printer.
9.2 Argon (Airgas-liquid high purity or gaseous pre-purified grade or equivalent).
9.3 Class A volumetric flasks and pipettes (Chemglass or equivalent).
9.4 Disposable 15-mL polystyrene culture tubes.
9.5 100 uL pipette (Eppendorf or equivalent).
9.6 10-mL pipette (Eppendorf or equivalent).

10.0 Reagents and Materials

8.1 Reagents

8.2.1 Mixed and single element stock metals standards. See Section 9 and Appendix A, B, C and D for instructions on making the working standards.
8.2.2 Nitric acid, conc. (Fisher, Trace Metals grade or equivalent)
8.2.3 Hydrochloric acid, (Fisher, Trace Metals grade or equivalent)
8.2.4 Deionized water (Milli Q, > 10 mega ohm).

11.0 Sample Preservation and Storage

9.1 Samples must be preserved and analyzed within holding times stated in chart. Liquid samples are stored on shelves in the Laboratory warehouse and soil samples are stored in a walk-in refrigerator unit.

	Liquids	Solids
Preservative:	pH <2 with HNO_3	4^oC (+/-2)
Hold Time:	180 days	180 days

12.0 Quality Control

12.1 This SOP is designed to follow a variety of different projects and programs requirements. Table 3. is designed to illustrate the control steps and provisions required to adequately producing acceptable data.

12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.3 For the routine analysis of groundwater, wastewater, leachate, surface water, soil, sludge, TCLP/SPLP extracts following method 6010B:
Required QC following instrument calibration is as follows :

12.1.1 ICV (initial calibration verification); The ICV is prepared from an alternate source standard whose concentrations are within the linear working range of the instrument. The results of the ICV should agree within 10% of the expected value for a given analyte. The relative standard deviation (RSD) between the replicate integrations should be <5%. If results are outside of this range, corrective action must be taken before samples can be analyzed.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

12.1.2 ICB (initial calibration blank); analyze the calibration blank. The results of the initial calibration blank must be < 3x IDL for a given analyte. If the average of the replicates is not < 3x IDL, terminate the analysis, correct the problem and recalibrate or appropriately qualify the data. If the blank is less than 1/10th the concentration of the action level of interest and no sample is within ten percent of the action limit, analyses need not be rerun and re-calibration is not necessary before continuing with the analysis.

12.1.3 ICSAB (interference check solution); analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start troubleshooting .

12.1.4 LCS (laboratory control sample); analyze an alternate source reference sample. Control limits are +/- 20% of true value or in-house limits, whichever is more restrictive, or as specified in a client QAPP or the DOD-QSM manual.

12.1.5 MB (method blank); analyze a reagent blank. The method blank is a reagent blank that has been taken through the preparations steps along side the samples being analyzed. Control limits are the MDL. If the average of the replicates is not < MDL terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and twenty times the concentration of the analyte in the method blank.

12.1.5 CCV (continuing calibration verification); analyze a check standard after every ten samples and following the last sample in the run. This standard should be at a level approximately mid-scale. Control limits are +/- 10% of true value. If values fall outside this range, all samples back to the last acceptable ICV or CCV must be repeated.

12.1.6 CCB (continuing calibration blank); The results of the continuing calibration blank must be < 3x IDL for a given analyte. If the result falls outside this, reanalyze all samples back to the last acceptable CCB or qualify all sample <20 times the blank and greater than the MDL.

12.1.7 MS/MSD (matrix spike/matrix spike duplicate); for non-digested samples, prepare a bench spike in duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are +/- 25% of true value, and 20% RPD, or use calculated limits, whichever is tighter. See Sec. 18.0 for bench spike preparation. For digested samples, see "Predigestion Spike" chart in section 18.0. For digested samples, analyze the MS/MSD samples as they apply to each digestion set. Follow the above for control limits. For digested spikes with sample results greater than four times the digested spike level, prepare and analyze a PDS sample if the MS and/or MSD are outside the control limits. Prepare the PDS at a level approximately two times the sample level.

12.2 For SDWA analysis following method 200.7
Required QC following instrument calibration is as follows:

12.2.1 ICV: Referred to in 200.7 as LPC (laboratory performance check); analyze the mid-cal standard. Control limits are +/- 5% of true value. If values fall outside this range, recalibrate for the affected analytes.

12.2.2 ICB (initial calibration blank); analyze the calibration blank. The absolute value of the result should be below the MDL for the analyte(s) of interest. If

UNCONTROLLED CT Laboratories SOP Updates and revisions will not be issued.

the blank result falls outside this, evaluate the effect on the sample results and/or recalibrate for the affected analytes. Samples with results >10x the associated blank value need not be reanalyzed.

12.2.3 ICSA (interference check solution: interference only) analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe. This sample must be analyzed at the beginning of the analytical run before the ICSAB. Recovery for interfering analytes is +/- 20% true value. All other analytes need to be ± 2x the MDL. If recovery/result is outside the acceptable range, corrective action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start trouble shooting.

12.2.4 ICSAB (interference check solution); analyze a solution containing 500 mg/L Al, Ca, Mg, Fe and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start trouble shooting.

12.2.5 LCS (laboratory control sample); analyze an alternate source reference sample per batch of 20 samples of the same matrix. Control limits are +/- 10% of true value, or manufacturer's limits, whichever is tighter.

12.2.6 MB (method blank); analyze a reagent blank per 20 samples of the same matrix. The method blank is a reagent blank that has been taken through the preparations steps along side the samples being analyzed. If the average of the two replicates is not < MDL terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and twenty times the concentration of the analyte in the method blank .

12.2.4 CCV: Referred to in 200.7 as LPC (laboratory performance check); analyze the mid-cal standard after every 10 samples. Control limits are +/- 10% of true value. If values fall outside this range, reanalyze all samples back to the last acceptable ICV or CCV.

12.2.5 CCB (continuing calibration blank); analyze the calibration blank immediately after each CCV. The value of the result should be below the MDL for the analyte(s)of interest. If the result falls outside this, evaluate the effect on the sample results. Sample results >10x the associated blank value need not be reanalyzed. Otherwise, reanalyze all samples back to the last acceptable CCB or qualify data that is >LOD and <10x the associated blank.

12.2.6 MS/MSD (matrix spike/matrix spike duplicate); for non-digested samples, prepare a bench spike in duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are +/- 25% of true value, and 20% RPD, or use calculated limits, whichever is tighter. See Sec. 18.0 for bench spike preparation. For digested samples, see "Predigestion Spike" chart in section 18.0. For digested samples, analyze the MS/MSD samples as they apply to each digestion set. Follow the above for control limits. For digested spikes with sample results greater than four times the digested spike level, prepare and analyze a PDS sample if the MS and/or MSD are outside the control limits. Prepare the PDS at a level approximately two times the sample level.

12.3 For the CLP-like level 4 analysis of groundwater, surface water, wastewater and soil

Note: A default of three replicate exposures per sample should be used for ACOE/LCG work unless specified differently in the QAPP.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Required QC following instrument calibration:

12.3.1 ICV (initial calibration verification): analyze the alternate source check standard immediately following calibration. Control limits +/- 10 % true value.

12.3.2 ICB (initial calibration blank): analyze the calibration blank. The absolute value of the result must be below the contract required detection limit (CRDL) or the limit stated within the QAPP for the project. The ICB results shall be less than the LOD/MDL for ACOE/ DOD-QSM data (or project specific). If a result falls outside this, reanalyze (recalibration may be necessary).

12.3.3 CRDL (contract required detection limit standard) or MRL (Method Required Limit): analyze a standard at a level two times the contract-required detection limits (CRDL) or at the level stated within the QAPP for the project. Follow limits stated within the QAPP as there are no EPA specified control limits for this standard. This sample must be analyzed at the beginning and the end of the run for ACOE samples.

12.3.4 ICSA (interference check solution: interference only) analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe. This sample must be analyzed at the beginning of the analytical run prior to the ICSAB. Refer to QAPP for acceptability criteria. For ACOE work, the default criteria is the absolute value of two times the MDL for all analytes except Al, Ca, Mg and Fe which must have a recovery between 80-120%. Refer to QAPP to determine if the ICSA must also be analyzed at the end of the run.

12.3.5 ICSAB (interference check solution: interference plus analytes); analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe, and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points as a place to start troubleshooting. This sample must be analyzed at the beginning of the run. Refer to the QAPP to determine if the ICSAB must be analyzed at the end of the run.

12.3.6 Digested Sample set to include MB (S or W), LCS (S or W), MS, and DUP.

12.3.7 Serial Dilution: Analyze a x5 dilution of a sample from the digestion set. For sample results > 50x the MDL, the %RSD between the serial dilution result and the sample result must be $\leq$ 10.

12.3.8 Post digestion spike addition (bench spike): An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within +/- 25% of the known value or as specified by the client QAPP. The spike addition should produce a minimum level of 10 times the instrumental detection limit. If the spike recovery falls outside the limits, a matrix effect should be suspected.

12.3.9 CCV (continuing calibration verification): Analyze a mid-level standard after every ten samples. The CRDL/MRL, ICSA, ICSAB and batch QC all count as samples. Control limits are +/- 10% of true value. If any result falls outside this, all samples back to the last acceptable ICV/CCV must be reanalyzed.

12.3.10 MB (method blank); analyze a reagent blank per 20 samples of the same matrix. The method blank is a reagent blank that has been taken through the preparations steps along side the samples being analyzed. If the average of the two replicates is not < MDL (< ½ the RL for ACOE/DOD-QSM, or <

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

project specified limits), terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and ten times the concentration of the analyte in the method blank.

12.3.11 CCB (continuing calibration blank); Analyze the calibration blank after each CCV (or every ten samples). Refer to the QAPP for CCB acceptance limits. The CCB results shall be less than the LOD for DOD-QSM data and <1/2 the RL for ACOE data (or project specific). If any result falls outside these limits, all samples with results less 10 times the CCB must be reanalyzed back to the last acceptable CCB or appropriately qualified.

12.3.12 MS/DUP (matrix spike/matrix duplicate); for non-digested samples, prepare a bench spike and a duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are specified in client QAPP. or see "Predigestion Spikes"(Table 1). For digested samples, analyze the MS/DUP samples as they apply to each digestion set and follow Table 3 control limits.

12.4 New or unusual matrices: It is recommended that whenever a new or unusual sample matrix is encountered, a serial dilution and post digestion (bench) spike be performed prior to reporting results. These tests will ensure that neither positive nor negative interferences are affecting sample results.

Note: For ACOE work, a serial dilution and a post digestion spike will be performed at a rate of one per matrix with each prep batch.

12.4.1 Serial Dilution: If the analyte concentration is sufficiently high (minimally a factor of ten above the instrumental detection limit after dilution), an analysis of a 1:5 dilution should agree within +/- 10% of the original determination. If not, a chemical or physical interference effect should be suspected.

12.4.2 Post digestion/bench spike addition (Table 2): An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within +/- 25% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike recovery falls outside these limits, a matrix effect should be suspected..

13.0 Calibration and Standardization

13.1 The default calibration for TAL plus list (excluding Na and K) of metals for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called 'DOD calibration' which uses 12 mixed standards and a calibration blank.

13.2 The default calibration for the metals Sodium and Potassium for ACOE/ LCG, DOD-QSM and routine work is a multi-point calibration method called 'Sodium and Potassium' which uses 8 mixed standards and a calibration blank.

13.3 The default calibration for the metal Boron for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called 'Boron' which uses 5 standards and a calibration blank

13.4 The default calibration for the metal Lithium for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called 'Lithium' which uses 7 standards and a calibration blank. Refer to section 11.0 for further instructions on how to perform the calibration.

Note: See Appendix A for preparations of calibration standards and blank for the DOD calibration method calibration. See Appendix B for the preparation of the calibration standards and blank for the Sodium and Potassium method

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

calibration. See Appendix C for the preparation of the calibration standards and blank for the Boron calibrations. See Appendix D for the preparation of the calibration standards and blank for the Lithium calibration. See Tables 4 (a, b, & c), 5, 6, and 7 for individual element calibration concentrations/ranges.

13.5 Calibration Blank: Into a 1 L. volumetric flask, add 750 mL of Milli-Q water and 10mL of conc. HNO3 and 10mL HCl. Mix, dilute to volume with Milli-Q H2O. Transfer to a clean 1 L. nalgene bottle. Prepare every 6 months or as needed.

13.6 Yttrium Internal std (Used for all methods) : Into a 2000mL volumetric flask, add 500mL of Milli-Q H2O, 10 ml 10,000 mg/L Yttrium standard dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean 2L Nalgene bottle. Prepare every 6 months or as needed. Concentration = 50 mg/L Yttrium solution.

13.7 Initial/Continuing Calibration Verification (ICV/CCV): Into a 1000mL volumetric flask, add 500mL of Milli-Q water, 10 mL of conc. HNO3 and 10mL HCl. Add the following:

10 mL SPEX Certiprep Spike Sample Standard 1 or Equivalent
0.5mL Mo 1000mg/L
0.05ml Ag 1000mg/L
2 ml Interferents-A-SPEX Certiprep or equivalent

Dilute to volume with Milli-Q water, mix and transfer to a clean 1 L Nalgene bottle. Make new every 6 months or as needed.

Concentration	Analyte
50ug/L	Cd, Be
100ug/L	Ag
200ug/L	Cr
250ug/L	Cu
500ug/L	Co, Mn, Mo, Ni, Pb, Sb, V, Zn
2000ug/L	Ba, As, Tl, Se
5,000ug/L	Fe
10,000ug/L	Ca, Mg
12,000ug/L	Al

13.8 Interference Check Solution (ICSA): Into a 500 mL volumetric flask, add 300 mL of Milli-Q H2O, 5 mL of conc. HNO3 and 5mL conc. HCl. Add the following stock solutions in the volumes listed:

50 mL Spex Certiprep Interferents A or equivalent
15 ml Fe 10,000mg/L or equivalent

Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean 500 mL Nalgene bottle. Prepare every 6 months or as needed.

Concentration	Analyte
500,000 ug/L	Al, Ca, Mg, Fe

13.9 Interference Check Solution (ICSAB): Into a 500 mL volumetric flask, add 300 mL of Milli-Q H2O, 5 mL of conc. HNO3 and 5 mL conc. HCl. Add the following stock solutions in the volumes listed:

50 mL Spex Certiprep Interferent A or equivalent
15 ml Spex Certiprep Fe 10,000 mg/L or equivalent
2.5 ml Spex Certiprep QC-21 or equivalent
0.25 ml Ultra Scientific Ag 1000 mg/L or equivalent
0.25 ml Ultra Scientific Ba 1000 mg/L or equivalent

Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean 500 mL Nalgene bottle. Prepare every 6 months or as needed.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

Concentration	Analyte
500,000 ug/L	Al, Ca, Mg, Fe
500 ug/L	Ag, As, Ba, Be Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, Zn

13.10 CRDL/MRL solution: Concentrations needed depend on the CRDL/MRL of a given contract.

14.0 Procedure

14.1 Instrument start-up procedure:

14.1.1 Open valve at argon tank, turn on chiller and instrument.. For best results, the instrument should be on and with an argon purge for at least 24 hours

14.1.2 Inspect pump tubing on instrument and on autosampler and change if necessary.

14.1.3 Fill DI rinse reservoir with DI water and preserve with HNO3 to1%.

14.1.4 Open up the ITeva software on the PC. Choose user, wait until instrument initializes.

14.1.5 Plasma startup and shutdown: Refer to the ICAP 6000 Series ICP-OES Spectrometer Operator manuals pages 11-1 thru 11-4. After plasma startup check the "Debug Wavelength Checks" at the bottom of the ITeva control center. The absolute value of x and y #s should be less than 5, if not, stop and call Thermo service.

14.1.6 After a 30-minute warm-up period, check condition of nebulizer. Put pump tube into a 100mg/L solution Yttrium Std. With the lights off and after enough time has elapsed for the Yttrium standard to reach the plasma, a red cone should be noticeable in the center of the plasma. If the nebulizer is in good condition and the nebulizer gas flows are set properly, the red cone should project about 2mm beyond the coils. If not, check the settings, the pump tubes, and inspect the nebulizer under a microscope for any obstructions or breakage.

14.2 To create an autosampler sequence:

14.2.1 Refer to the ICAP 6000 Series ICP-OES Spectrometer Operator manuals pages 11-9 thru 11-11 to start an autosampler sequence.

14.2.2 Add all samples, LCS, Blanks, MS-MSD, etc. in order of program, agency or client request.

14.2.3 Print Autosampler Table: This will be used when preparing all samples and standards.

14.2.4 Using the printed autosampler table sheet, prepare all standards, QC samples, and samples in their designated positions in the autosampler. Prepare any bench spikes and place them in autosampler. Calibration standards, CCV, ICV, CCB, ICB and ICSAB all go into 50 ml vials in the designated S-# positions of the autosampler. All others are poured into 15 ml plastic vials into the designated areas within the 60 position racks.

14.3 Calibration and Analysis.

14.3.1 Once all calibration standards have been placed in the autosampler make sure the autosampler is initialized by clicking on the autosampler icon and the sequence is saved and then press the yellow arrow icon to start the calibration and prepare the remaining samples as the calibration is being carried out.

14.4 Instrument shutdown

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

14.4.1 If run will not be finished during work hours, program the instrument to shutdown at the end of the analytical run. When setting up on the sequence page click the "End Action (after all sequences) Box to "Shutdown Plasma". This will shut down the plasma.

14.4.2 For manual shutdown go to the flame icon in the bottom right corner and click, and then select the plasma off icon. After the plasma is shutdown loosen the pump tubes and shut off the chiller.

15.0 Calculations

15.1 Sample Calculations:

Liquid Concentration (ug/L) = A x C

Solid Concentrations (mg/kg) = $\frac{A \times B \times C}{D \times E}$,

Where: A = instrument reading for sample (ug/L)
B = total volume of digestion (L)
C= dilution factor, if necessary (ex. For a 1 to 10 dilution, C = 10)
D = amount of sample used in digestion (g)
E = percent solids/100, if necessary (fraction equivalent)

15.2 Spike Recovery Calculations:

LCS Recovery (%) = $\frac{(\text{Result obtained}) \times 100}{(\text{Spike amount})}$

MS/MSD Spike Recovery (%) = $\frac{(\text{Spiked sample conc.} - \text{Sample conc.}) \times 100}{(\text{Spike amount})}$

%RPD = $\frac{(MS - MSD) \times 100}{(MS + MSD)/2}$

Where: MS = Matrix spike concentration obtained
MSD = Matrix spike duplicate concentration obtained

15.2 "Total Hardness" (by calculation) can also be determined by using the values for calcium and magnesium obtained by this procedure. The "Total Hardness" value is calculated in the LIMS system using the following equation:

Total Hardness (mg/L) or Hardness equivalent $CaCo^3$/L =

2.497[Ca mg/L} + 4.118[Mg mg/L]

16.0 Method Performance

16.1 Certified standard solutions, properly used instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies. Internal blind spikes are also utilized to check analyst performance.

16.2 Initial demonstration of capability (IDC) is another technique used to ensure acceptable method performance. An analyst must demonstrate initial precision and

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

accuracy through the analysis of 4-5 laboratory control spikes for each matrix and sample type. After analysis, the analyst calculates the average recovery (AR) and the relative standard deviation (RSD) of the recoveries for each analyte. In the absence of specific criteria found in the EPA methods or project specific limits, the default criteria of 70-130% recovery and 20 % RSD are used until internal limits are generated.

16.3 Proper instrument maintenance is another means to ensure adequate method performance.

16.3.1 Pump tubing and rollers: Ensure that the pump rollers turn freely. Inspect pump tubing daily and replace when it starts failing to retain its shape.

16.3.2 Drain line: Spray chamber drain line must flow unimpeded directly into waste jug. Make sure line is draining properly.

16.3.3 Spray Chamber: If the spray chamber becomes dirty, the sample waste may not drain properly. Remove and wash with hot soapy water, then rinse with DI H_2O.

16.3.4 Torch and O-rings: The O-rings surrounding the torch may need to be replaced if the plasma becomes unstable or internal standard emission counts fall off. See ICP6000 manual for technique. Torch needs to be cleaned occasionally with aqua regia followed by sonication. See sections 5 and 6 in the "ICAP 6000 Series ICP-OES Spectrometer Operating Manuals" for further assistance if needed.

17.0 Pollution Prevention

17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.

17.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18.0 Data Assessment and Acceptance Criteria for QC Measures

18.1 When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. The analyst will review the data to ensure QC is acceptable and that exceedances are addressed. Acceptable data is then captured into the LIMS system (See SOP ICP6000 Data Capture for instructions on data capture).

18.2 After data has been captured by LIMS, it is reviewed by the analyst for accuracy and completeness. See checklist (Table 8) for data review guidance.

18.3 Once analyst has reviewed and approved the data, it is given to a peer or supervisor for review.

18.4 After the second reviewer approves the data, the reviewer sends the data to "validated" status in LIMS.

18.5 A paper hard copy of the data is then filed or archived. The package includes the checklist, the sequence run log, and a copy of the bench sheet (if applicable), the LIMS run log, and verification of calibration data.

19.0 Corrective Measures for Out-of-Control Data

19.1 When data is out of control, a number of corrective actions may need implementing. If the nonconformities involve failing QC within the analytical sequence batch, then reanalysis of samples may eliminate any out of control data. If the out of control data

UNCONTROLLED CT Laboratories SOP - Updates and revisions will not be issued

is the result of instrument malfunctions, then maintenance or repair of the downed instrument followed by reanalysis of affected data may correct the problem. If sample matrix affect or contamination is the reason for poor data, the instrument may need cleaning and decontamination. In all cases, when out of control data presents itself, the appropriate corrective measures need to be enacted to eliminate unusable data. The Quality Control Requirements chart can be used as a guide as to which corrective actions should be taken for different QC-type failures or nonconformities (Table 3.).

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 Due to limited sample volume, expiration of hold times, downed instrumentation, and analyst error, the sample data may be out of control or unacceptable to report. Since these potential instances can arise, contingency plans need to be in place to prevent and/or minimize their affect on data.

20.1.1 The first thing addressed is prevention of producing unacceptable data. When limited sample volume is the issue, the analyst should determine if splitting the sample into lesser volumes or weights is an option. To avoid sample hold time issues, the analyst's first responsibility is to plan accordingly. The analyst is responsible for budgeting enough time for sample analysis, so if a problem arises, reanalysis is an option. Analyst error is prevented by a second analyst confirmation and validation. If the initial analyst makes an analysis error or inadvertently reports unacceptable data, the second analyst is responsible for finding and/or correcting those errors.

20.1.2 When out of control or unacceptable data is produced and it is too late for corrective measures, a number of actions can be taken. The first and foremost is alerting the client service personnel of the problem. Client services will inform the client and/or responsible parties. In some instances, more samples can be made available or re-sampling can occur, so it is important to alert the appropriate personnel as soon as possible.

20.1.2.1 If the out of control data affects only specific analytes, it is important to let the appropriate person(s) know in case his or her site assessment is based on a specific target analyte list.

20.1.2.2 In all instances, if results are reported from data that is out of control or unacceptable, that data should be qualified accordingly. Once the client has been notified and he or she instructs us to report the data, flag the data indicating what type of nonconformity has occurred.

20.1.2.3 Out of control data is still retained by the laboratory and filed and archived along with acceptable data. The file folder should be labeled as such, indicating that the data is out of control.

20.1.2.4 A non-conformance/corrective action report (CAR) form must be filled out whenever these types of events occur. The information on the report includes the problem encountered, planned corrective actions, and corrective action follow-up. The form is then discussed with and signed by the analyst, the client representative, the QA officer, and the laboratory manager. The purpose of the form is to document problems in order to eliminate the possibility of repeating nonconformance and to ensure that the proper corrective actions are employed.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

21.0 Waste Management

21.1 Samples are routinely held for up to six weeks from analysis date before they enter the waste stream. Waste disposal of samples and standards follows the procedures documented in the Laboratory Waste Disposal SOP (Quality Assurance Section, SOP NO. FO-8, Rev. 4).

22.0 REFERENCES

17.1 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010B, rev. 2, December 1996.
17.2 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010B, rev. 3, February, 2000.
17.3 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010C, rev. 3, February, 2007.
17.4 Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, Method 200.7, rev. 4.4, 1991.
17.5 USEPA - Contract Laboratory Program, Statement of Work for Inorganic Analysis, ILM04.0.
17.6 ICAP 6000 Series ICP-OES Spectrometer Operator's Manual, Thermo Electron (registration number 441506).
17.7 Department of Defense Quality Systems Manual for Environmental Laboratories, Versio4.1, Based on NELAC Voted Revisions 5 June 2003, April 22, 2009.
17.8 Thermo Electron Corporation Training Manual iCAP 6000 Series.
17.9 Louisville Chemistry Guideline (LCG), US Army Corps of Engineers-Louisville District, June 2002.
17.10 Louisville DOD Quality Systems Manual Supplement (LS), US Army Corps of Engineers-Louisville District, March 2007.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table1: Spike, LCS, & LFB Analysis- ICP
Pre-digestion Spikes

Element	Spike Amt. mL of	Spike Stock A, B, C	Stock Conc. mg/L	Final Vol. mL	Expected Conc. ug/L
Aluminum	1	**A**	200	50	4000
Antimony	1	**A**	50	50	1000
Arsenic	1	**A**	200	50	4000
Barium	1	**A**	200	50	4000
Beryllium	1	**A**	5	50	100
Cadmium	1	**A**	5	50	100
Calcium	0.5	**C**	20,000	50	200000
Chromium	1	**A**	20	50	400
Cobalt	1	**A**	50	50	1000
Copper	1	**A**	25	50	500
Iron	1	**A**	100	50	2000
Lead	1	**A**	50	50	1000
Manganese	1	**A**	50	50	1000
Magnesium	0.5	**C**	10,000	50	100000
Molybdenum*	0.1	**B**	1000	50	2000
Nickel	1	**A**	50	50	1000
Selenium	1	**A**	200	50	4000
Silver	1	**A**	5	50	100
Thallium	1	**A**	200	50	4000
Vanadium	1	**A**	50	50	1000
Zinc	1	**A**	50	50	1000

Spike Solutions ***		
Supplier	**Lot #/ std**	**Stock**
SPEX Certiprep or equiv.	SPIKE 1-500	**A**
Molybdenum * or equiv.	1000 mg/L	**B**
Custom Std***	SPEX	**C**

- * Addition of Boron, Lithium, Silicon, Tin, Strontium, Titanium, and Tungsten at 0.1 ml each of a 1000 mg/L solution from SPEX Certiprep or equivalent.
- ** Addition of Potassium at 0.5 ml of a 10,000 mg/L solution from SPEX Certiprep or equivalent.
- *** Sodium is also included in this standard at 10,000 mg/L

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 2: Bench Spike Analysis-ICP
Post Digestion/ Bench Spikes

Element	Spike Amt. ML of	Spike Soln.	Stock Conc. mg/L	Final Vol. mL	Expected Conc. ug/L
Aluminum	0.2	**A**	200	10	4000
Antimony	0.2	**A**	50	10	1000
Arsenic	0.2	**A**	200	10	4000
Barium	0.2	**A**	200	10	4000
Beryllium	0.2	**A**	5	10	100
Cadmium	0.2	**A**	5	10	100
Calcium	0.2	**B**	20,000	10	400000
Chromium	0.2	**A**	20	10	400
Cobalt	0.2	**A**	50	10	1000
Copper	0.2	**A**	25	10	500
Iron	0.2	**A**	100	10	2000
Lead	0.2	**A**	50	10	1000
Manganese	0.2	**A**	50	10	1000
Magnesium	0.2	**B**	10,000	10	200000
Molybdenum	0.02	**C***	1000	10	2000
Nickel	0.2	**A**	50	10	1000
Selenium	0.2	**A**	200	10	4000
Silver	0.2	**A**	5	10	10
Thallium	0.2	**A**	200	10	4000
Vanadium	0.2	**A**	50	10	1000
Zinc	0.2	**A**	50	10	1000

Standard Source * **	
Supplier	
SPEX	**A**
SPEX Custom Std	**B**
Molybdenum-1,000 mg/L Std*	**C***

- * Addition of Boron, Lithium, Silicon, Tin, Strontium, Titanium, and Tungsten at 0.02 ml each of a 1000 mg/L solution from SPEX Certiprep or equivalent.
- ** Addition of Potassium and Sodium at 0.1 ml of a 10,000 mg/L solution from SPEX Certiprep or equivalent.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued.

Table 3: Summary of Quality Control Requirements

QC Type	Frequency	Conc. Level	*Acceptance Criteria*	*Corrective Action*
Initial Calibration Verification(ICV)	1 per calibration	Mid. Calib. Range	SDWA: 95-105% SW846:90-110% or Project / Program Specific	Terminate run. Correct the problem before proceeding
Initial Calibration Blank (ICB)	Immediately after the ICV	<MDL	SW846: < 3x IDL SDWA: < MDL DOD-QSM < MDL LCG: <1/2 MRL or Project / Program Specific	Terminate analysis and correct the problem before proceeding.
Method Blank (MB)	1 per batch of 20 samples	<MDL	SDWA: < MDL SW846: < 2x MDL DOD-QSM / LCG: <1/2 MRL or Project / Program Specific	Access data and reanalyze/reprepare the MB and affected data or flag "B" analyte detected in Method Blank when insufficient sample remains
Laboratory Control Sample (LCS)	1 per batch of 20 samples	Mid. Calib. Range	In-house limits or, default 80-120% SDWA; 90-110% or Project / Program Specific	Terminate analysis: correct problem before proceeding.
Continuing Calibration Verification (CCV)	1 after every 10th sample	Mid. Calib. Range	SW846: 90-110% SDWA: 90-110% CLP:90-110%	Recalibrate and reanalyze all samples back to the last acceptable CCV or ICV
Continuing Calibration Blank (CCB)	Immediately following each CCV	<MDL	SW846: < 3x IDL SDWA: < MDL DOD-QSM < MDL LCG: < 2x MDL or Project / Program Specific	Reanalyze all samples back to the last acceptable CCB or flag "B" analytes detected
Interference Check Solution A (ICSA)	Immediately After LCS (& before final CCV if required by program / project specific QAPP)	500mg/L Al, CA, Mg 200mg/L Fe (non –ACOE) or 500mg/L Fe (ACOE)	80-120% for Interference Elements ABS of analytes not included must be < 2X MRL or Project / Program Specific	Terminate analysis, correct problem & reanalyze all samples back to last good ICSA/ICSAB
Interference Check Solution AB (ICSAB)	Immediately After ICSA (& before final CCV if required by program / project specific QAPP)	500mg/L Al, CA, Mg 200mg/L Fe (non-ACOE) or 500 mg/L Fe (ACOE) Other elements 500ug/L	80-120% for All Elements	Terminate analysis, correct problem & reanalyze all samples back to last good ICSA/ICSAB

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

MS	One per batch per matrix	See Table 1 spike chart	1. In-house limits: default 70-130 % Rec. 2. DOD-QSM: Use specified LCS limits. 3. LCG: 75-125 % Rec. when [matrix] is <4x[spike]	1. Reanalyze an alternative sample or perform a PDS, if MS and PDS fail qualify data as to matrix effect. 2. DOD-QSM: Used for matrix evaluation only. Determine source of difference (i.e. serial dilution/PDS). Reanalyze or qualify data as per client/ project requirement. 3. LCG: If MS fails and sample results are < 5x the MRL run a PDS. If sample results are > 5x the MRL perform a serial dilution.
MSD or Matrix Dup. (MD)	1. In-house & QSM-DOD: one MSD or MD per batch or matrix. 2. LCG: one MD per batch or matrix.	See Table 1 spike chart	1. In-house limits: default 70-130 % Rec. RPD = 20% 2. DOD-QSM: Use specified LCS limits for MSD. RPD = 20 % for MS/MSD or MD. 3. LCG: RPD = 20%	1. Perform PDS, if MSD and PDS fail qualify data as to matrix effect. 2. DOD-QSM: Used for matrix evaluation only. Determine source of difference (i.e. serial dilution/PDS). Reanalyze or qualify data as per client/ project requirement. 3. LCG: Qualify positive detects for precision failures between the sample and the MD.
Serial Dilution Analysis (SD)	1. In-house: Analyzed on the sample with a PDS failure. 2. DOD-QSM: Analyzed with each batch of samples. 3. LCG: After an MS failure with sample results > 5x the MRL.	5 fold dilution of chosen sample	RPD within 10% of value of diluted and undiluted sample, but only if sample conc. 1. In-house: > 10x LOQ 2. DOD-QSM: > 50x the MDL 3. LCG: > 5x the MRL	1. In-house: Qualify data only if sample result is > 10x the LOQ. 2. Analyze a PDS if sample result is > 50x the MDL. 3. Analyze a PDS if sample result is > 5x the MDL.
Post Digestion Spike (PDS)	1. In-house: Upon failure of MS or MSD. 2. DOD-QSM: When the SD test fails or all sample results < 50x the MDL and there is an MS or MSD failure. 3. LCG: When the MS fails and the sample result is <5x the MRL or when the SD test fails.	Between 10 and 100 times the MDL	1. In-house: 80-120% Rec. 2. DOD-QSM & LCG: 75-125% Rec.	1. In-house: Qualify for matrix interference or if requested analyze by MSA. 2. DOD-QSM: Run samples by MSA or ISA or qualify data using program/project specified criteria. 3. LCG: Run samples by MSA or qualify data using program/project specified criteria.
Method of Standard Additions (MSA) or Internal Standard Calibration (ISA)	1. In-house: When requested. 2. DOD-QSM & LCG: After the failure of a PDS.	Minimum of 3 standard levels and the unspiked sample	N/A	Document the use of an MSA or ISA

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 4a. TAL list Concentrations/Ranges for ICP ug/L

Element, Wavelength and Order	Blank		CalibStd=0.25		CalibStd=0.5		CalibStd=1		CalibStd=5		CalibStd=10		C
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?
Ag 328.068 {103}	☒	0	☐		☐		☐		☒	5	☒	10	☒
Ag 338.289 {100}	☒		☐		☐		☐		☐		☐		☐
Al 167.079 {502}	☒	0	☐		☐		☐		☐		☒	10	☒
Al 309.271 {109}	☒		☐		☐		☐		☐		☐		☐
Al 396.152 { 85}	☒		☐		☐		☐		☐		☐		☐
As 189.042 {479}	☒	0	☐		☐		☐		☐		☐	10	☐
As 193.759 {474}	☒		☐		☐		☐		☐		☒		☐
Ba 455.403 { 74}	☒	0	☐		☐		☒	1	☒	5	☒	10	☒
Ba 493.409 { 68}	☒		☐		☐		☐		☐		☐		☐
Be 234.861 {144}	☒	0	☐	0.25	☐	0.5	☐	1	☐	5	☐	10	☐
Be 313.042 {108}	☒		☒		☒		☒		☒		☒		☒
Ca 317.933 {106}	☒	0	☐		☐		☐		☐		☐	10	☐
Ca 393.366 { 86}	☒		☐		☐		☐		☐		☒		☒
Ca 396.847 { 85}	☒		☐		☐		☐		☐		☐		☐
Cd 226.502 {449}	☒	0	☒	0.25	☒	0.5	☒	1	☒	5	☐		☒
Cd 228.802 {447}	☒		☐		☐		☐		☐		☐		☐
Co 228.616 {447}	☒	0	☐		☐		☐	1	☒	5	☒	10	☐
Co 238.892 {141}	☒		☐		☐		☐		☐		☐		☐
Cr 205.552 {464}	☒	0	☐		☐		☐	1	☐	5	☐	10	☐
Cr 267.716 {126}	☒		☐		☐		☒		☒		☒		☒
Cu 224.700 {450}	☒	0	☐		☐		☐		☐	5	☐		☒
Cu 327.396 {103}	☒		☐		☐		☐		☒		☐		☒
Fe 234.349 {144}	☒	0	☐		☐		☐		☐		☐	10	☐
Fe 239.562 {141}	☒		☐		☐		☐		☐		☐		☐
Fe 259.940 {130}	☒		☐		☐		☐		☐		☒		☐
Mg 279.079 {121}	☒	0	☐		☐		☐		☐		☐	10	☐
Mg 279.553 {121}	☒		☐		☐		☐		☐		☒		☐
Mg 280.270 {120}	☒		☐		☐		☐		☐		☐		☐
Mn 257.610 {131}	☒	0	☐		☐		☐		☒	5	☒	10	☒
Mn 259.373 {130}	☒		☐		☐		☐		☐		☐		☐
Mo 202.030 {467}	☒	0	☐		☐		☒	1	☐		☒	10	☒
Mo 204.598 {465}	☒		☐		☐		☐		☐		☐		☐
Ni 221.647 {452}	☒	0	☐		☐		☐	1	☐		☐	10	☐
Ni 231.604 {445}	☒		☐		☐		☒		☐		☒		☒
Pb 216.999 {455}	☒	0	☐		☐		☐	1	☐		☐	10	☐
Pb 220.353 {453}	☒		☐		☐		☒		☐		☒		☒
Sb 206.833 {463}	☒	0	☐		☐		☐		☐	5	☐	10	☐
Sb 217.581 {455}	☒		☐		☐		☐		☒		☒		☒
Se 196.090 {472}	☒	0	☐		☐		☒	1	☐		☒	10	☐
Se 206.279 {463}	☒		☐		☐		☐		☐		☐		☐
Tl 190.856 {477}	☒	0	☐		☐		☐		☒	5	☒	10	☒
Tl 351.924 { 96}	☒		☐		☐		☐		☐		☐		☐
V 290.882 {116}	☒	0	☐		☐		☐	1	☐	5	☐	10	☐
V 292.402 {115}	☒		☐		☐		☒		☒		☒		☒
Y 360.073 { 94}*	☒	0	☐		☐		☐		☐		☐		☐
Zn 206.200 {463}	☒	0	☐		☐		☐	1	☐	5	☐	10	☐
Zn 213.856 {458}	☒		☐		☐		☒		☒		☒		☒

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 4b. TAL list Concentrations/Ranges for ICP ug/L cont.

Element, Wavelength and Order	Calibration Standards												
	CalibStd=20		CalibStd=50		CalibStd=100		CalibStd=500		CalibStd=1000		CalibStd=5000		CalibStd=10000
	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc
Ag 328.068 {103}	20	X	50	X	100		500		1000				
Ag 338.289 {100}				X		X		X					
Al 167.079 {502}	20	X	50	X	100	X	500	X	1000	X	5000		10000
Al 309.271 {109}										X		X	
Al 396.152 { 85}													
As 189.042 {479}			50		100		500	X	1000	X	5000	X	10000
As 193.759 {474}		X		X		X		X					
Ba 455.403 { 74}	20	X	50		100	X	500	X	1000	X	5000		10000
Ba 493.409 { 68}				X		X		X		X		X	
Be 234.861 {144}	20		50		100		500	X	1000	X	5000	X	10000
Be 313.042 {108}		X		X		X		X		X			
Ca 317.933 {106}	20				100		500		1000	X	5000	X	10000
Ca 393.366 { 86}				X		X		X					
Ca 396.847 { 85}				X		X		X		X		X	
Cd 226.502 {449}	20	X	50	X	100	X	500	X	1000		5000		10000
Cd 228.802 {447}								X		X		X	
Co 228.616 {447}		X	50	X	100	X	500	X	1000	X	5000		10000
Co 238.892 {141}								X		X		X	
Cr 205.552 {464}	20		50		100		500		1000	X	5000	X	10000
Cr 267.716 {126}		X		X		X		X		X			
Cu 224.700 {450}	20	X	50	X	100	X	500	X	1000	X	5000		
Cu 327.396 {103}		X		X		X							
Fe 234.349 {144}			50		100		500		1000		5000	X	10000
Fe 239.562 {141}						X		X		X		X	
Fe 259.940 {130}		X		X		X		X		X			
Mg 279.079 {121}			50		100		500		1000	X	5000	X	10000
Mg 279.553 {121}		X		X		X		X					
Mg 280.270 {120}						X		X		X		X	
Mn 257.610 {131}	20	X	50	X	100	X	500	X	1000	X	5000		10000
Mn 259.373 {130}										X		X	
Mo 202.030 {467}	20	X	50		100	X	500	X	1000		5000		10000
Mo 204.598 {465}						X		X		X		X	
Ni 221.647 {452}	20		50		100		500		1000	X	5000	X	10000
Ni 231.604 {445}		X		X		X		X		X			
Pb 216.999 {455}	20		50		100		500	X	1000	X	5000	X	10000
Pb 220.353 {453}		X		X		X		X					
Sb 206.833 {463}	20				100		500	X	1000	X	5000	X	10000
Sb 217.581 {455}				X		X		X		X			
Se 196.090 {472}			50	X	100	X	500	X	1000	X	5000		10000
Se 206.279 {463}								X		X		X	
Tl 190.856 {477}	20	X	50	X	100	X	500	X	1000	X	5000	X	10000
Tl 351.924 { 96}								X		X		X	
V 290.882 {116}	20		50		100	X	500	X	1000	X	5000	X	10000
V 292.402 {115}		X		X		X		X		X			
Y 360.073 { 94}*													
Zn 206.200 {463}	20		50		100		500		1000	X	5000	X	10000
Zn 213.856 {458}		X		X		X		X		X			

UNCONTROLLED CT Laboratories SOP updates and revisions will not be issued.

Table 4c. TAL list Concentrations/Ranges for ICP ug/L cont.

Element, Wavelength and Order	CalibStd-100k		CalibStd-100000		CalibStd-500000		CalibStd-1000k	
	?	Conc	?	Conc	?	Conc	?	Conc
Ag 328.068 {103}								
Ag 338.289 {100}								
Al 167.079 {502}				100000		500000		1e+006
Al 309.271 {109}			☒					
Al 396.152 { 85}			☒		☒		☒	
As 189.042 {479}								
As 193.759 {474}								
Ba 455.403 { 74}								
Ba 493.409 { 68}								
Be 234.861 {144}								
Be 313.042 {108}								
Ca 317.933 {106}			☒	100000	☒	500000	☒	1e+006
Ca 393.366 { 86}								
Ca 396.847 { 85}			☒					
Cd 226.502 {449}								
Cd 228.802 {447}								
Co 228.616 {447}								
Co 238.892 {141}								
Cr 205.552 {464}	☒	100000						
Cr 267.716 {126}								
Cu 224.700 {450}	☒	100000						
Cu 327.396 {103}								
Fe 234.349 {144}			☒	100000	☒	500000	☒	1e+006
Fe 239.562 {141}								
Fe 259.940 {130}								
Mg 279.079 {121}			☒	100000	☒	500000	☒	1e+006
Mg 279.553 {121}								
Mg 280.270 {120}								
Mn 257.610 {131}		100000						
Mn 259.373 {130}	☒							
Mo 202.030 {467}								
Mo 204.598 {465}								
Ni 221.647 {452}								
Ni 231.604 {445}								
Pb 216.999 {455}	☒	100000						
Pb 220.353 {453}								
Sb 206.833 {463}								
Sb 217.581 {455}								
Se 196.090 {472}								
Se 206.279 {463}								
Tl 190.856 {477}								
Tl 351.924 { 96}								
V 290.882 {116}								
V 292.402 {115}								
Y 360.073 { 94}*								
Zn 206.200 {463}	☒	100000						
Zn 213.856 {458}								

Note: These metals are calibrated using a blank and minimum of three standards. It is not allowable to remove any mid levels to obtain an acceptable calibration; all points must used. Multi-level calibrations must be sequential.

Appendix A.

Element specific standard prep for multipoint calibration of ICP.

A1 Calibration Standard 0.25 (Be, & Cd): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 0.25 ul of SPEX Quality Control Standard 7 and 0.25 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.25 ug/L.

A2 Calibration Standard 0.50 (Be & Cd): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 50uL of SPEX Quality Control Standard 7 and 50uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.50 ug/L.

A3 Calibration Standard 1.0 (Ba, Be, Cd, Co, Cr, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1 ml of conc. HNO3 and 1mL conc. HCl. Add 1.0 uL of SPEX Quality Control Standard 7 and 1.0 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 ug/L

A4 Calibration Standard 5.0 (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 5 uL of SPEX Quality Control Standard 7 and 5 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5 ug/L

A5 Calibration Standard 10.0 (Ag, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 10 uL of SPEX Quality Control Standard 7 and 10 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 ug/L

A6 Calibration Standard 20 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe Mn, Mo, Ni, Pb, Sb, Tl, & V): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 20uL of SPEX Quality Control Standard 7 and 20uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 20 ug/L

A7 Calibration Standard 50 (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 50uL of SPEX Quality Control Standard 7 and 50uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 ug/L

A8 Calibration Standard 100 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 100 uL of SPEX Quality Control Standard 7 and 100 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 ug/L

UNCONTROLLED CT Laboratories SOP - Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

A9 Calibration Standard 500 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 500uL of SPEX Quality Control Standard 7 and 500uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L

A10 Calibration Standard 1000 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 1000uL of SPEX Quality Control Standard 7 and 1000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L

A11 Calibration Standard 5000 (Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 5000uL of SPEX Quality Control Standard 7 and 5000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5000 ug/L

A12 Calibration Standard 10000 (Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 10000uL of SPEX Quality Control Standard 7 and 10000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10000 ug/L

A13 Calibration Standard 100000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 5mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL of HCl. Add 1mL of 10,000 mg/L Al, 1mL of 10,000 mg/L Ca, 1mL of 10,000 mg/L Fe and 1mL of 10,000 mg/L Mg . Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100,000 ug/L Al, Ca, Fe, Mn, and Mg.

A14 Calibration Standard 100K (Cr, Cu, Co, Ni, Mn, & Pb): Into a 100mL volumetric flask, add 5mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL of HCl and add 10 mls of Cr 1000 mg/L, 10 mls Cu 1000 mg/L, 10 mls Pb 1000 mg/L, 10 mls Co 1000 mg/L,10 mls Ni 1000 mg/L and 10 ml of Mn 1000 mg/L and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration:100,000 ug/L Co, Cr, Cu, Ni, Mn, and Pb.

A15 Calibration Standard 500000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL of HCl. Add 5mL of 10,000 mg/L Al, 5mL of 10,000 mg/L Ca, 5mL of 10,000 mg/L Fe and 5mL of 10,000 mg/L Mg. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500,000 ug/L Al, Ca, Fe and Mg

A16 Calibration Standard 1000000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL of HCl. Add 10mL of 10,000 mg/L Al, 10mL of 10,000 mg/L Ca, 10mL of 10,000 mg/L Fe and 10mL of 10,000 mg/L Mg. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1,000,000ug/L Al, Ca, Fe and Mg

A17 Calibration Blank: Into a 1 L. volumetric flask, add 750 mL of Milli-Q water and 10 mL of conc. HNO3 and 10mL HCl. Mix, dilute to volume with Milli-Q H2O. Transfer to a clean 1 L. nalgene bottle. Prepare every 6 months or as needed.

A18 ICV/CCV: Into a 1000mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO3 and 10mL of conc. HCl. Add 10.0mL Spex Certiprep Spike Sample Standard 1 or equivalent and 2.0mL Interference A or equivalent, 0.5 mls of 1000 ug/L Mo and 0.05 mls 1000 ug/L Ag . Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L

A19 ICSAB: Into a 100mL volumetric flask, add 500mL Milli-Q water, 5mL of conc. HNO3 and 5mL of conc. HCl. Add 50 ml of SPEX Interferents A or equivalent, 15.0mLs of 10,000 mg/L Fe, 2.5mL Spex Certiprep QC 7 and 2.5 ml Spex Certiprep-QC 21 or equivalent. Dilute to volume with Milli-Q water and mix by inverting several times.

Table 5. Sodium and Potassium Concentrations/Ranges for ICP (mg/L)

Element, Wavelength and Order	Calibration Standards																			
	Blank		CalibStd-0.5		CalibStd-1.0		CalibStd-5.0		CalibStd-10.0		CalibStd-50.0		CalibStd-100		CalibStd-200		CalibStd-500000	
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc
K 766.490 (44)	☒	0	☒	0.5	☒	1	☒	5	☒	10	☒	50	☒	100	☒	200	☐	
Na 330.237 (102)	☒	0	☐	0.5	☐	1	☐	5	☐	10	☒	50	☒	100	☒	200	☐	
Na 589.592 (57)	☒		☒		☒		☒		☒		☒		☐		☐		☐	
Al 309.271 (109)	☒	0	☐		☐		☐		☐		☐		☐		☐		☒	500
Ca 317.933 (106)	☒	0	☐		☐		☐		☐		☐		☐		☐		☒	500
Fe 259.940 (130)	☒	0	☐		☐		☐		☐		☐		☐		☐		☒	500
Mg 279.079 (121)	☒	0	☐		☐		☐		☐		☐		☐		☐		☒	500
Y 360.073 (94)*	☒	0	☐		☐		☐		☐		☐		☐		☐		☐	

Note: These metals are calibrated using a blank and minimum of three standards. It is not allowable to remove any mid levels to obtain an acceptable calibration; all points must be used. Multi-level calibrations must be sequential.

Appendix B

Standard Prep for Sodium and Potassium analysis.

B1 Calibration Standard 0.5: Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 2mL of conc. HNO3 and 2mL conc. HCl. Add 0.05mL Sodium 1000mg/L and 0.05mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.5 mg/L Na, K.

B2 Calibration Standard 1.0: Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 0.1mL Sodium 1000mg/L and 0.1mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 mg/L Na, K.

B3. Calibration Standard 5.0: Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 0.5mL Sodium 1000mg/L and 0.5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5 mg/L Na, K.

B4. Calibration Standard 10: Into a 100mL volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 1mL Sodium 1000mg/L and 5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 mg/L Na, K.

B5. Calibration Standard 50: Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 5mL Sodium 1000mg/L and 5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 mg/L Na, K.

B6. Calibration Standard 100: Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 10mL Sodium 1000mg/L and 10mL Potassium 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L Na, K.

B7. Calibration Standard 200: Into a 100mL volumetric flask, add H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 50mL Sodium 1000mg/L and 50mL Potassium 1000mg/L. Mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Na, K.

B8. Calibration Standard 500 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.

B9. ICV/CCV: Into a 100mL volumetric flask, add 50mL Milli-Q water, 1mL of conc. HNO3 and 1mL of conc. HCl. Add 1.0mL 10,000mg/L Na and 1.0mL 10,000 K. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L Na an K.

B8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO3 and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 1.0mL 10,000mg/L Na and 1.0mL 10,000 K. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100mg/L Na and K, 500,000ug/L Al, Ca, Fe and Mg.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 6. Boron and Silicon Concentrations/Ranges for ICP (ug/L)

Element, Wavelength and Order	Calibration Standards													
	Blank		CalbStd-50		CalbStd=50 &10		CalbStd=500 &1		CalbStd=1000&2		CalbStd=5000&1		CalbStd=500000	
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc
B 249.773 {135}	☒	0	☒	50	☒	100	☒	1000	☒	2000	☒	10000	☐	
Si 251.611 {134}	☒	0	☐		☒	50	☒	500	☒	1000	☒	5000	☐	
Al 308.215 {109}	☒	0	☐		☐		☐		☐		☐		☒	500000
Ca 317.933 {106}	☒	0	☐		☐		☐		☐		☐		☒	500000
Fe 234.349 {144}	☒	0	☐		☐		☐		☐		☐		☒	500000
Mg 279.079 {121}	☒	0	☐		☐		☐		☐		☐		☒	500000
Y 360.073 {94}*	☒	0	☐		☐		☐		☐		☐		☐	

Note: Boron and Silicon are calibrated using a blank and a minimum three standards. It is not allowable to remove any mid levels to obtain an acceptable calibration; all points must be used. Multi-level calibrations must be sequential.

Appendix C

Standard Prep for Boron and Silicon Analysis

C1. Calibration Standard 50 ug/L B: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 0.05 ml Spex Certiprep QC std. 7 or equivalent. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed.Concentration: 50 ug/L B

C2. Calibration Standard 50 ug/L Si & 100 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 0.1 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 ug/L Si & 100 ug/L B

C3. Calibration Standard 500 ug/L Si & 1000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Si &1000 ug/L B.

C4. Calibration Standard 1000 ug/L Si & 2000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration:1000 ug/L Si &5000 ug/L B.

C5. Calibration Standard 5000 ug/L Si & 10000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5000 ug/L Si &10000 ug/L B.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

C6. Calibration Standard 500 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 1mL of conc. HNO3 and 1mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL, Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.

C7. ICV/CCV: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q water, 1 mL of conc HNO3 and 1mL conc. HCl. Add 0.1mL of 1000mg/L Boron and 0.1mL of 1000mg/L Silicon (alternate sources from calibration source). Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L Boron and Silicon.

C8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO3 and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 0.05 ml 1000 mg/L B and 0.5 ml 1000 mg /L Si. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L B and Si, 500,000ug/L Al, Ca, Fe and Mg.

Table 7. Lithium, Tin, Strontium, Titanium, and Tungsten Concentrations/Ranges for ICP ug/L

Element, Wavelength and Order	Calibration Standards													
	Blank		1		10		100		1000		10000		500000	
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc
Li 670.784 { 50}	☒	0	☒	1	☒	10	☒	200	☒	1000	☒	10000	☐	
Sn 189.989 {477}	☒	0	☐		☒	10	☒	100	☒	1000	☒	10000	☐	
Sn 189.989 {478}	☒		☐		☒		☒		☒		☐		☐	
Sr 407.771 { 83}	☒	0	☒	1	☒	10	☒	100	☒	1000	☐	10000	☐	
Sr 421.552 { 80}	☒		☐		☒		☒		☒		☒		☐	
Ti 334.941 {101}	☒	0	☐	1	☒	10	☒	100	☒	1000	☒	10000	☐	
Ti 337.280 {100}	☒		☒		☒		☒		☒		☐		☐	
W 224.875 {450}	☒	0	☐		☒	10	☒	100	☒	1000	☒	10000	☐	
W 239.709 {141}	☒		☐		☐		☐		☒		☒		☐	
Al 309.271 {109}	☒	0	☐		☐		☐		☐		☐		☒	500000
Ca 317.933 {106}	☒	0	☐		☐		☐		☐		☐		☒	500000
Fe 259.940 {130}	☒	0	☐		☐		☐		☐		☐		☒	500000
Mg 279.553 {121}	☒	0	☐		☐		☐		☐		☐		☒	500000
Y 360.073 { 94}*	☒	0	☐		☐		☐		☐		☐		☐	

Appendix D

Standard prep for Lithium, Tin, Titanium, Strontium, and Tungsten

D1. Calibration Standard 1: Into a 1000mLvolumetric flask, add 50mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 0.01 ml Spex Certiprep QC std. 21 or equivalent and .001 1000mg/L Sn and W . Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 ug/L.

D2. Calibration Standard 10: Into a 1000mLvolumetric flask, add 50mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 0.1 ml Spex Certiprep QC std. 21 or equivalent and .01 1000mg/L Sn and W . Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 ug/L Li, Sr, Sn, Ti, and W.

D3. Calibration Standard 100: Into a 1000mLvolumetric flask, add 50mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 21 or equivalent and 0.1 1000mg/L Sn and W . Dilute to volume with Milli-Q H2O and mix by inverting

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 ug/L Li, Sr, Sn, Ti, and W.

D4. Calibration Standard 1000: Into a 1000mLvolumetric flask, add 50mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 10.0 ml Spex Certiprep QC std. 21 or equivalent and 1.0 1000mg/L Sn and W . Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L Li, Sr, Sn, Ti, and W.

D5. Calibration Standard 10000: Into a 1000mLvolumetric flask, add 50mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 100.0 ml Spex Certiprep QC std. 21 or equivalent and 10.0 1000mg/L Sn and W . Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10000 ug/L Li, Sr, Sn, Ti, and W.

D6. Calibration Standard 500000 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H2O, 10mL of conc. HNO3 and 10mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL, Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H2O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.

D7. ICV/CCV: Into a 1000mL volumetric flask, add 50mL of Milli-Q water, 10 ml of conc. HNO3 and 10mL conc. HCl. Add 0.5mL of 1000mg/L Li, 0.5mL of 1000ug/L Sn, 0.5mL of 1000ug/L Sr, 0.5 ml of 1000mg/L Silicon, 0.5 ml 1000mg/L Tungsten and 0.5 ml of 1000mg/L Titanium. (all alternate sources from calibration source). Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Li, Sr, Sn, Ti, and W.

D8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO3 and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 0.05 ml of 1000 mg/L Sr, 0.05 ml 1000 mg /L of Li, 0.05 ml 1000 mg /L of Sn, 0.05 ml 1000 mg /L of Ti, 0.05 ml 1000 mg /L of W. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Li, Sr, Sn, Ti, and W and 500,000ug/L Al, Ca, Fe and Mg.

Note: For DOD-QSM data the lowest level (Calib. Level # 1) on a multi point curve is prepared at concentrations equal to or less than the MRL for any given project and these levels are subject to change.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 8: Data Review Checklist

ICP6500 OES Data Review Checklist	Analysis Date:		Data File:		Date review:
Cal Std ID: LIMS # :	Analyst:		Reviewer:		Approved? Yes No
Calibration Parameters - 6010 200.7	**YES**	**NO**	**YES**	**NO**	**Comments:**
1) Calibration linearity - r > 0.995					
2) ICV 90-110% 95-105%					
3) ICB ABS 3X DL ABS DL					
4) ICSAB 80-120% True Value					
5) ICSA +/- 2X RL or LOD					
6) MRL - (2X RL or LOD) 70-130%					
7) CCV1/CCB1-90-110% / 3X DL ABS DL					
8) CCV2/CCB2					
9) CCV3/CCB3					
10) CCV4/CCB4					
11) CCV5/CCB5					
12) CCV6/CCB6					
13) CCV7/CCB7					
14) CCV8/CCB8					
15) CCV9/CCB9					
16) CCV10/CCB10					
Preparation Batch Parameters	**YES**	**NO**	**YES**	**NO**	**Comments:**
Prep Batch ID#:_____ Dig. Meth._____					
Prep. Blank - <LOD or RL					
LCS - generated limits; attached list					
Spiked samples in batch:					
a)_____ matrix = _____					
b)_____ matrix = _____					
c)_____ matrix = _____					
d)_____ matrix = _____					
e)_____ matrix = _____					
PDS 75-125% sample#_____					
Prep Batch ID#:_____ Dig. Meth._____					
Prep. Blank - <LOD or RL					
LCS - generated limits;attached list					
Spiked samples in batch:					
a)_____ matrix = _____					
b)_____ matrix = _____					
c)_____ matrix = _____					
d)_____ matrix = _____					
e)_____ matrix = _____					
PDS 75-125% sample#_____					
Prep Batch ID#:_____ Dig. Meth._____					
Prep. Blank - <LOD or RL					
LCS - generated limits; attached list					
Spiked samples in batch:					
a)_____ matrix = _____					
b)_____ matrix = _____					
c)_____ matrix = _____					
d)_____ matrix = _____					
e)_____ matrix =					

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

CT Laboratories
Baraboo Laboratory Division

Title: **Acid Digestion of Solids and Semi-solids for Total Metals**

SOP Number: **6230B**

Prepared by: _____ 10/12/07
Date

Technical Review by: _____ 10/17/07
Date

Reviewed by: _____ 10/18/07
Quality Assurance *Date*

_____ 18-Oct-2007
Laboratory Director *Date*

SOP Manual Control Number:_____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

1.0 SCOPE AND APPLICATION

1.1 This method is an acid digestion procedure used to prepare soils, sediments, sludges, oils, paint chips, tissue samples, wipes and other solid waste samples for analysis by ICP, FLAA, or GFAA spectroscopy for the following metals:

Aluminum*	Calcium*	Magnesium*	Silver*
Antimony*	Chromium	Manganese*	Sodium*
Arsenic	Cobalt	Molybdenum	Strontium*
Barium*	Copper*	Nickel *	Thallium
Beryllium	Iron	Potassium*	Vanadium*
Cadmium	Lead	Selenium	Zinc*

* Cannot be used for GFAA for selected element

1.2 For analysis by ICP or FLAA both HCl and HNO_3 are used in the digestion procedure. For analysis by GFAA, HNO_3 only is used.

2.0 METHOD SUMMARY

2.1 For the digestion of samples, a representative 0.5 gram sample or 1-2g sample for ACOE work is digested with repeated additions of nitric acid and hydrogen peroxide

2.2 For GFAA analysis, the resultant digestate is reduced in volume while heating and then diluted to a final volume of 50 mL.

2.3 For ICP (trace) or FLAA analyses, hydrochloric acid (HCl) is added to the initial digestate and the sample is refluxed. The digestate is then diluted to a final volume of 50 mL.

3.0 DEFINITIONS

3.1 Batch - A batch consists of a maximum of 20 samples of similar matrix which are prepared and analyzed in the same manner. Each batch is given a unique prep batch number for tracking purposes.

3.2 Reagent Blank - A solution of de-ionized water, (containing in correct proportion, all reagents required by the method), used with the calibration standards to standardize the instrument, as a calibration blank, and for sample dilution.

3.3 LCS (Laboratory Control Sample)- A mid-range standard prepared from a source different from that used for calibration standards. The LCS is used to verify the accuracy of the digestion procedure and is analyzed at the beginning of the analytical batch .

3.4 MB (Method Blank)- A reagent blank which is carried through the entire preparation and analytical method. The method blank is used to detect possible contamination that may occur prior to or during the sample preparation process. A minimum of one MB is prepared per batch and is analyzed at the beginning of an analytical batch.

3.5 MS-MSD (Matrix Spike-Matrix Spike Duplicate): - Two separate sample aliquots to which a known concentration of analyte has been added which is carried through the entire preparation and analytical procedure. The purpose of a matrix spike is to reveal any matrix effect from the sample on the recovery of the analyte by the method being used. An MS-MSD pair is prepared for every batch (see 3.1) of routine samples. An MS and a DUP are prepared for every ACOE batch. Failure to meet criteria may be due to poor recovery during the preparation method or to matrix interference within the digestate. To be considered acceptable, MSD's must meet both the same % recovery criteria as an MS, and the same % RPD as a duplicate sample. MS/MSD %RPD may be used as acceptance criteria for duplicate analysis.

3.6 Duplicate (DUP)- A separate aliquot of sample which has been carried through the entire preparation and analytical procedure the same as the original sample. One duplicate per batch is prepared for ACOE work.

4.0 HEALTH AND SAFETY

4.1 Gloves, protective eyewear, and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.

5.0 CAUTIONS

5.1 The extracts from GFAA and FLAA/ICP are not interchangeable and should only be used with the analytical determinations outlined.

5.2 This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

5.3 Reagent grade chemicals shall be used in all tests. The reagent blank must be less than the MDL in order to be used.

6.0 INTERFERENCES

6.1 Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed in accordance with the

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

quality control requirements to aid in determining whether Method 3050B is applicable to a given waste.

7.0 PERSONNEL QUALIFICATIONS

7.1 All personnel performing this analysis shall be instructed in the use of personal protective equipment prior to beginning analysis.

7.2 Personnel shall know how to read a meniscus and how to use a pipette correctly.

8.0 APPARATUS AND MATERIALS

8.1 Equipment Required

8.1.1 Environmental Express Hotblock Digestion Apparatus: To maintain a temperature of 90-95C.

8.1.2 50 mL Class A plastic hotblock digestion tubes, with watch glasses and storage caps. (Environmental Express p/n SC475 and SC505 or equivalent)

8.1.3 Qualitative filter paper and filter funnels.

8.1.4 Filtermate Teflon digestion tube filters: (Environmental Express p/n SC0401 or equivalent)

8.1.5 Thermometer: For monitoring temperature of the block at beginning and end of digestion process.

8.1.6 Balance: 0.01g capacity.

8.2 REAGENTS

8.2.1 ASTM Type II Water (ASTM D1193): Water should be monitored for impurities.

8.2.2 Concentrated Nitric Acid, trace metals grade (HNO_3): Acid is of sufficient purity and comes with a certificate of analysis. All metals levels are lower than our lowest detection limits for any given element. However, each acid lot is logged in and tracked to each individual bottle to identify potential contamination problems. If contamination is detected at any point and the problem is limited to a given bottle, the acid may be replaced with another bottle from the same lot. If the entire lot is a problem, then any remaining acid from the contaminated lot will be removed from the lab and a replacement acid from a different lot of sufficient purity shall be obtained. All acid used to make standards is recorded in the log book when the standard is made.

8.2.3 Concentrated Hydrochloric Acid, trace metals grade (HCl): Acid is of sufficient purity and comes with a certificate of analysis. All metals levels are lower than our lowest detection limits for any given element. However, each acid lot is logged in and tracked to each individual bottle to identify potential contamination problems. If contamination is detected at any point and the problem is limited to a given bottle, the acid may be replaced with

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

another bottle from the same lot. If the entire lot is a problem, then any remaining acid from the contaminated lot will be removed from the lab and a replacement acid from a different lot of sufficient purity shall be obtained. All acid used to make standards is recorded in the log book when the standard is made.

8.2.4 Hydrogen Peroxide, 30% (H_2O_2): Each peroxide lot is logged in and tracked to each individual bottle to identify potential contamination problems. If contamination is detected at any point and the problem is limited to a given bottle, the peroxide may be replaced with another bottle from the same lot. If the entire lot is a problem, then any remaining peroxide from the contaminated lot will be removed from the lab and a replacement hydrogen peroxide bottle from a different lot shall be obtained.

8.2.5 SPEX Certiprep Spike- SPEX catalog number SPIKE 1-500

8.2.6 Molybdenum- 1,000 mg/L standard SPEX PLMO9-2Y or equivalent

8.2.7 Potassium-10,000 mg/L standard PLK2-3X or equivalent

8.2.8 Ultra Custom Standard – Ultra catalog number ICUS192 or equivalent

8.2.9 Inorganic Venture Spike- Inorganic Venture catalog number SPK1 or equivalent

9.0 INSTRUMENT OR METHOD CALIBRATION

Please refer to the Hot Block operator manual for instrument temperature calibration.

10.0 SAMPLE COLLECTION, HANDLING AND PRESERVATION

10.1 All sample containers must be demonstrated to be free of contamination at or below the reporting limit. Plastic and glass containers are both suitable. Note: Environmental Express provides a certificate of analysis with each tube lot.

10.2 Samples shall be refrigerated upon receipt and analyzed within 180 days.

11.0 SAMPLE PREPARATION AND ANALYSIS

11.1 Turn on hot blocks to allow them to warm up. The switch is located on the right outer side of hood. Place a thermometer into a centrifuge tube of water and place it in the hot block to monitor the temperature of the hot block to insure the temperature is acceptable prior to use. The temperature should be 95 $\pm$ 5^{0}C for digestion.

11.2 Carefully weigh on a balance and then transfer a 0.5 g representative portion (for routine work) or for ACOE work 1-2g randomly of the sample to a tube, or use a known volume of a sludge sample based on the viscosity of the sample. Do not use metal spatulas. Refer to the subsampling SOP FO-10 for instructions on subsampling from the original sample. For some samples it is acceptable to use a larger sample size following the guidelines below:

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Wet solids:	Up to 1.0 g.
Wipes:	The entire wipe is used.
Biological tissue:	Up to 2.0 g.
"liquidy" sludges	Up to 2.0 g

11.3 For samples to be spiked (MS, MSD, LCS), add the appropriate amount of spiking solution to sample (see Pre-digestion Spikes-LCS & LFB chart attached).

11.4 Add 5 mL 1:1 HNO_3 to routine samples or 10mL of 1:1 HNO_3 for ACOE samples, mix, and cover the tube with a watch glass. Do not handle the underside of the watch glass at any time, in order to prevent contamination. Place the tubes in the hotblock and heat the samples until they reflux for 10-15 minutes. For wipe samples, add DI water to wet the entire wipe if needed.

11.5 Add 2.5 mL concentrated HNO_3 to all routine samples and 5mL of concentrated HNO_3 to ACOE samples.

11.6 Place thermometer in one block location record temperature in the sample prep book for the initial block temperature recording. Record again at the end of the digestion process in a different spot on the block. Rotate the placement of the thermometer between digestion batches to ensure that no "hot spots" develop on the block.

11.7 Return to the hotblock, and reflux the samples for 30 minutes. Do not allow the samples to go dry. If samples are still generating "brown" fumes, continue to add concentrated HNO_3 in 5mL increments until no more "brown" fumes are generated.

11.8 Allow the solution to evaporate to 5 mL without boiling or heat at $95^0C \pm 5^0C$ without boiling for 2 hours. Do not allow samples to go to dryness.

11.9 Remove the samples from the hotblock and let cool to avoid excessive effervescence of hydrogen peroxide. For routine samples add 1 mL of DI water and 1.5 mL of 30% hydrogen peroxide to each tube. For DoD samples add 2 mL of DI water and 3 mL of 30% hydrogen peroxide to each tube (omit this step for Tin). Return to hot block and heat gently until the effervescence subsides.

11.10 Repeat step 11.9 two times or until effervescence is minimal for routine samples using a maximum of 5mL of 30% hydrogen peroxide. For ACOE samples, add 30% hydrogen peroxide in 1mL increments, up to 10mL, until the sample effervescence is minimized or the sample consistency is unchanged. It will not be necessary to cool down the samples between additions if they do not react too strongly.

11.11 Return samples to hot block and heat until volume is reduced to 2.5mL or heat at $95^0C \pm 5^0C$ without boiling for 2 hours.

11.12 For samples to be analyzed by ICP or FLAA, add 5 mL concentrated HCl for routine samples or for ACOE samples add 10mL of concentrated HCl and reflux for an additional 15 minutes. Omit this step for samples to be analyzed by GFAA.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

11.13 Remove each tube from block using the tube racks provided and allow them to cool. Dilute to exactly 50 mL using the guide on the digestion tube and let sample sit to allow solids to settle out. If solids do not settle readily and remain suspended throughout sample, then it will be necessary to filter prior to analysis. Using the Environmental Express tube filters, push the filter down through the sample till it sits on the bottom. The digestion tubes are calibrated to 50mL $\pm$ 0.2mL.

11.14 Cap sample, taking care not to touch underside of cap or inside of container. To minimize contamination and for safety purposes appropriate gloves must be worn at any point where sample solution is being transferred. If gloves become stained and dirty, discard and replace, as the surface of the gloves themselves may also transfer contaminants.

11.15 If the digestate is clear and without solids distributed throughout the liquid portion, sample aliquots may be decanted for analysis. If not, then filtration will be necessary prior to analysis. Follow instruction provided with filter-mate filters.

12.0 TROUBLESHOOTING

12.1 If method blank is higher than MDL, identify source of contamination. Contamination can come from many sources including the reagents used in the procedure and samples that were digested in the batch.

12.2 Over time, hot blocks can develop "hot spots". Monitor the temperature in different block spaces ensure that temperature is consistent throughout the hot block unit.

13.0 DATA ACQUISITION, CALCULATIONS AND DATA REDUCTION

There are no calculations for this method.

14.0 COMPUTER HARDWARE AND SOFTWARE

14.1 Computer with StarLIMS

15.0 DATA MANAGEMENT AND RECORD MANAGEMENT

15.1 Batch data information is recorded in the Digestion Log book.

15.2 Prep data is entered into LIMS, and then the batch sheet is given to the metals analyst.

16.0 QUALITY CONTROL

16.1 For each batch of samples processed, a method blank should be carried throughout the entire sample preparation procedure.

16.2 By matrix, prepare one MS/MSD for routine work or one MS/DUP for ACOE work per 20 or fewer samples per matrix per digestion batch.

16.3 Prepare one LCS (lab control sample) for each digestion batch. The LCS source is carried through the entire digestion procedure. Prepare one LCS for every 20 samples per medium per day.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

17.0 REFERENCES

17.1 *Test Methods for Evaluating Solid Waste*. USEPA SW-846, Rev 2 Dec 1996, Method 3050B.

17.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 3, January, 2006.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued.

18.0 Prep Tables

18.1 ICP/FLAA Table

SPIKE, & LFB ANALYSIS- ICP/FLAA Predigestion Spikes-LCS & LFB					
Element	**Spike Amt mL**	**Spike Stock**	**Stock Conc mg/L**	**Final Vol mL**	**Expected Conc. ug/L**
Aluminum	1	**A**	200	50	4000
Antimony	1	**A**	50	50	1000
Arsenic	1	**A**	200	50	4000
Barium	1	**A**	200	50	4000
Beryllium	1	**A**	5	50	100
Cadmium	1	**A**	5	50	100
Calcium	0.5	**C**	20,000	50	200000
Chromium	1	**A**	20	50	400
Cobalt	1	**A**	50	50	1000
Copper	1	**A**	25	50	500
Iron	1	**A**	100	50	2000
Lead	1	**A**	50	50	1000
Manganese	1	**A**	50	50	1000
Magnesium	0.5	**C**	10,000	50	100000
Molybdenum	0.1	**B**	1000	50	2000
Nickel	1	**A**	50	50	1000
Potassium	0.5	**D**	10,000	50	100000
Selenium	1	**A**	200	50	4000
Silver	1	**A**	5	50	100
Sodium	0.5	**C**	10,000	50	100000
Thallium	1	**A**	200	50	4000
Vanadium	1	**A**	50	50	1000
Zinc	1	**A**	50	50	1000

Spike Solutions		
Supplier	**Lot #/ std**	**Stock**
SPEX Certiprep	SPIKE 1-500	**A**
Molybdenum	1000 mg/L	**B**
Ultra	ICUS 192	**C**
Potassium	10,000	**D**

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

18.2 GFAA Table

Pre-Digestion Matrix Spike Prep for (GFAA)					
Element	**Spike Amt mL**	**Spike Stock**	**Stock Conc mg/L**	**Final Vol mL**	**Expected Conc. ug/L**
Antimony-GFAA	1.0	**A**	1000.0	50.0	20.0
Arsenic-GFAA	1.0	**A**	1000.0	50.0	20.0
Lead-GFAA	1.0	**A**	1000.0	50.0	20.0
Selenium-GFAA	1.0	**A**	1000.0	50.0	20.0
Thallium-GFAA	1.0	**A**	1000.0	50.0	20.0

Standard Source		
Supplier	**Dilution**	**Solution**
Inorg Vent.-SPK1 (multi-element std)	1/100	**A**

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Analyst:		Metals Digestion Summary-CT Laboratories Baraboo								Date:	
Prep Batch#	Sample ID#	Matrix*	Prep Method**	Sample Amt gms or mls	Final Volume, mLs	Blk	Dup	MS	MSD	Spike/LCS/ LFB info	Acid ID#

Method Temperature Verification				*So,Sl,ww,gw,fish,tclp,splp,other	Review date/initials
Block Used:		Initial Block Temp (C):		**3005,3010,3020,3050,3060	Digestion Tube Lot #:
Cell #		Final Block Temp (C):		Comments:	

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

CT Laboratories, Inc.
Baraboo Laboratory Division

Title: **Grain Size**

SOP Number: **CC-27**

Prepared by: _____ 1/10/10
Date

Technical Review by: _____ 2/15/10
Date

Reviewed by: _____ 2/11/10
Quality Assurance *Date*

_____ 17-Feb-2010
Laboratory Director *Date*

SOP Manual Control Number: _____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

1.0 Identification of the Test Method

This method is used to determine the particle size distribution of fine and coarse aggregates by sieving.

2.0 Applicable Matrix or Matrices

This method is applicable to soil samples.

3.0 Detection Limits

Not applicable

4.0 Scope and Application

This method is used for determination of particle size and is applicable to most types of solid samples.

5.0 Method Summary

Sample is dried and separated with sieves of different mesh sizes. The sample is passed through the sieves starting with the largest mesh and descending to the smallest in order to determine the percentage of soil passing through each sieve size.

6.0 Definitions

% Passing-The fractional equivalent of soil that passes through a known size of a particular sieve starting with an initial weight of sample and subtracting the weight of remaining sample passing through each sieve.

7.0 Interferences

7.1 Sample aggregate that is not completely dry.

7.2 Sample aggregate that has been oven-dried at too high of a temperature which causes clumping (sample is normally air dried, but oven drying very wet samples to drive off the excess moisture can be done as long as sample is removed before clumping of the sample occurs).

8.0 Safety

Gloves and protective clothing should be worn to protect against unnecessary exposure to possibly hazardous chemicals and contaminants in samples. All activities performed while following this procedure

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

should utilize appropriate laboratory safety systems (see CTI Health and Safety Manual).

9.0 Equipment and Supplies

9.1 Balance; balance sensitive to 0.1 g, Denver Instruments, Model APX-6001 or equivalent

9.2 Sieve series, #4, #10, #40, #60, #80, #100 and #200, #230 with a collection pan, Fisher Scientific-USA Standard Test Sieve or equivalent.

9.3 Mechanical sieve shaker, Humboldt MFG Co.

9.4 Aluminum weighing pan. Fisher Scientific, Cat.# 08-732-103 or equivalent.

9.5 Drying oven at 103-105°C, Fisher Scientific, Isotemp 500 series or equivalent.

9.6 Pestle and mortar (Porcelain), Fisher (CoorsTek) or equivalent.

10.0 Reagents and Materials

Not Applicable

11.0 Sample Collection, Preservation & Storage

11.1 No preservation of the sample is required. Samples are collected in either 4-oz. or 8-oz. jars.

11.2 Samples are stored cooled to 0 - 6º C until analysis.

12.0 Quality Control

This SOP is designed to follow a variety of different project and program requirements. There are no known QC requirements for grain size analysis (i.e. no Duplicate, MS/MSD, or LCS requirements)

13.0 Calibration and Standardization

See SOP (CL-Top Loading Balance Calibration) for balance calibration procedure.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued

14.0 Procedure

14.1 Using a drying pan, thoroughly dry sample by exposing it to room temperature. For best analysis results, use enough sample to ensure at least 100-150 g of dried sample.

14.2 Break up sample aggregate with a pestle and mortar, being careful not to disintegrate sample. Weigh the sample and record the weight on the Grain Size Bench Sheet (Table 1).

14.3 Place the dry/weighed sample into the sieves stacked in series from largest mesh to smallest, and shake sample on mechanical shaker for five to ten minutes.

14.4 After sample is shaken, weigh the portions collected on each sieve and record as weight retained on each of the sieves used.

15.0 Data Analysis and Calculations

Calculate the % Passing through each sieve using the following formula:

Example:

$$\% \text{ Passing \#4} = \frac{(\text{Total weight of Sample}) - (\text{Weight Retained on \#4})}{\text{Total Weight of Sample}} \times 100$$

Note: Calculate each % passing for the remaining sieves used, remembering to subtract the weight retained on each of the previous sieves along with the weight of the sample retained on the sieve of interest.

16.0 Method Performance

Not Applicable

17.0 Pollution Prevention

17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.

17.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

18.0 Data Assessment & Acceptance Criteria for QC Measures

18.1 When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. The analyst will review the data and enter the results into the LIMS system. See checklist (Table 2) for data review guidance.

18.2 After data has been entered into LIMS, it is reviewed by the analyst for accuracy and completeness. Once the analyst has reviewed and approved the data, it is given to a peer or supervisor for review.

18.3 After second review approves the data, the reviewer changes the data to "validated" status in LIMS.

18.4 A paper hard copy of the data is then filed or archived. The package includes the checklist, a copy of the bench sheet, and the LIMS run log.

19.0 Corrective Measures for Out-of-Control Data

Not Applicable

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

Not Applicable

21.0 Waste Management

Samples are routinely held for up to six weeks from analysis date before they enter the waste stream. Waste disposal of samples and standards follows the procedures documented in the Laboratory Waste Disposal SOP (Quality Assurance Section, SOP NO. FO-8 Rev. 4).

22.0 Equipment/Instrument Maintenance, Computer Hardware and Software and Troubleshooting

22.1 All maintenance and troubleshooting is documented in a Maintenance Logbook designated for a particular instrument setup. Documentation shall include problem encountered and corrective action or maintenance performed (including replacement of parts). If outside service is required a copy of the maintenance invoice is to be included in the Maintenance Logbook. Date of maintenance or repair along with analyst initials is also documented.

22.1.1 Check the specific instrument's Maintenance Logbook to determine if the current problem has occurred in the past. If the problem has previously occurred, the workaround or fix should have been documented. Follow the instructions for repairing the problem, document and proceed with the analysis.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

22.1.2 If review of the Maintenance Logbook yields no resolution to the problem, review the specific instrument/software manual for repair/ workaround options. If a solution is presented in the manual, proceed with the repair, document in the Instrument Run/Maintenance logbook and continue with the analysis.

22.1.3 If neither the Maintenance Logbook nor the specific instrument/software manual results in a solution to the problem, contact your supervisor for help in resolving the issue. This may involve contacting the vendor. Refer to the specific instrument/software manual for contact information.

22.2 Troubleshooting – Computers

Computers cannot be diagnosed or repaired in the laboratory. If it has been previously determined that the current problem cannot be resolved with a hardware or software fix, contact your IS representative for repair or replacement. Document the problem resolution in the Instrument Maintenance logbook.

23.0 References

23.1 ASTM C136-84a and ASTM C3390, Modified.

23.2 National Environmental Laboratory Accreditation Program (NELAP), Quality Systems, Chapter 5, June, 2000.

23.3 Model Seven Easy pH meter Operating Instructions, Mettler Toledo GmbH Analytical, 2003, 2004.

23.4 Louisville Chemistry Guideline (LCG), US Army Corps of Engineers-Louisville District, June 2002.

23.5 Louisville DOD Quality Systems Manual Supplement (LS), US Army Corps of Engineers-Louisville District, March 2007.

23.6 Department of Defense, Quality Systems Manual for Environmental Laboratories, DoD Environmental Data Quality Workgroup, Department of Navy, Lead Service, Based on NELAC Voted Revision 5 June 2003, Version 4.1, April 22, 2009.

24.0 Tables, Diagrams, Flow Charts and Validation Data

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

Table 1
Sieve Analysis Bench Sheet

SIEVE ANALYSES

CLIENT: ____ **ANALYSIS DATE:** _____

DATE SAMPLED: ____ **ANALYST:** _____

GRAIN SIZE SIEVE ANALYSIS

SAMPLE ID#: ____ **INITIAL WEIGHT(g):** _____

WEIGHT RETAINED ON #4	_____	% PASSING #4	#DIV/0!
WEIGHT RETAINED ON #10	_____	% PASSING #10	#DIV/0!
WEIGHT RETAINED ON #20	_____	% PASSING #20	#DIV/0!
WEIGHT RETAINED ON #40	_____	% PASSING #40	#DIV/0!
WEIGHT RETAINED ON #60	_____	% PASSING #60	#DIV/0!
WEIGHT RETAINED ON #80	_____	% PASSING #80	#DIV/0!
WEIGHT RETAINED ON #100	_____	% PASSING #100	#DIV/0!
WEIGHT RETAINED ON #200	_____	% PASSING #200	#DIV/0!
WEIGHT RETAINED ON #230	_____	% PASSING #230	#DIV/0!

SIEVE ANALYSIS (ASTMC 3390)

SAMPLE ID#: ____ **INITIAL WEIGHT(g):** _____

WEIGHT RETAINED ON #4	_____	% PASSING #4	#DIV/0!
WEIGHT RETAINED ON #8	_____	% PASSING #8	#DIV/0!
WEIGHT RETAINED ON #16	_____	% PASSING #16	#DIV/0!
WEIGHT RETAINED ON #30	_____	% PASSING #30	#DIV/0!
WEIGHT RETAINED ON #50	_____	% PASSING #50	#DIV/0!
WEIGHT RETAINED ON #100	_____	% PASSING #100	#DIV/0!
WEIGHT RETAINED ON #200	_____	% PASSING #200	#DIV/0!
WEIGHT RETAINED ON #230	_____	% PASSING #230	#DIV/0!

% PASSING #200 SIEVE ANALYSIS

SAMPLE ID# : ____ **INITIAL WEIGHT (g):** _____

WEIGHT RETAINED ON #10 _____ WEIGHT RETAINED ON #200 _____

WEIGHT PASSING #200 _____ % PASSING #200 _____

TARE WEIGHT_____ SAMPLE & TARE WEIGHT _____

Note: All weights in grams.

CHECKED BY:_____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued

Table 2: Data Validation Check List

LIMS #:	Method: Grain Size			
Analysis Date	Analyst / Data Interpreter	Independent Reviewer	Date of Review	Approved
				Yes … No

Instructions: Complete one checklist per *analytical run*. Enter the appropriate response for each question. Each "No" response requires an explanation in the Comments section, and may require the initiation of a Nonconformance Report.

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
1. Was enough sample provided to perform analysis?	Minimum of 100-150 g of dried sample.					
2. Are all samples on the job lists accounted for?						

CT Laboratories
Baraboo Laboratory Division

Title: Total Organic Carbon in Solids

SOP Number:

Prepared by: _____ 1/5/10
Date

Technical Review by: _____ 1/15/10
Date

Reviewed by: _____ 2/16/10
Quality Assurance *Date*

_____ 17-Feb-2010
Laboratory Director *Date*

SOP Manual Control Number: _____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

1.0 Identification of the Test Method

1.1 This test method is used to determine total organic carbon (TOC) in soils following the USEPA Lloyd Khan Method.

2.0 Applicable Matrix or Matrices

2.1 This test method is used to determine the TOC concentration in soils, sludges, sediments, wastes, and other solid matrices.

3.0 Detection Limits

3.1 Method Detection Limits (MDLs) are determined annually and are approximately 1000mg/kg.

4.0 Scope & Application

4.1 The working range for this test is from 0-400000 mg/kg, samples beyond this range must be diluted.

5.0 Method Summary

5.1 Organic carbon is measured using a carbonaceous analyzer. The instrument converts the organic carbon in a sample to carbon dioxide (CO_2) by catalytic combustion. The CO_2 formed is then analyzed by an infrared detector. The amount of CO_2 in a sample is directly proportional to the concentration of carbonaceous material in the sample.

5.2 Carbonate and bicarbonate are inorganic forms of carbon and must be separated from the total organic carbon value. The carbonate and bicarbonate are removed by treatment with phosphoric acid prior to combustion.

6.0 Definitions

6.1 Initial Calibration Verification (ICV): A midrange check standard analyzed after the calibration has been completed, to evaluate calibration curve and or instrument performance. The ICV is from a second source.

6.2 Continuing Calibration Verification (CCV): A check standard analyzed at the beginning of the run, after ten samples and at the end of the analytical run, to evaluate instrument performance. The CCV can be from the same source as the calibration curve.

6.3 Calibration Blank (ICB or CCB): A blank standard analyzed after every ICV or CCV to evaluate instrument contamination or carry over.

6.4 Matrix Replicate (DUP): A separate aliquot of a given sample that is analyzed in triplicate and is taken through all steps of preparation and analysis, exactly like the original sample. The precision of the method is determined by calculating the Relative Standard Deviation (RSD) in percent of the original sample and the three matrix replicates.

6.5 Laboratory Control Standard (LCS): A known concentration obtained from a second source supplier or vendor. The LCS is analyzed exactly like a sample.

6.6 Method Blank (MB): A blank standard, treated like a sample, run with every batch of samples.

6.7 Batch: Group of 20 samples and the corresponding Quality Control samples (QC).

7.0 Interferences

7.1 Carbonate and bicarbonate carbon represent interferences under the terms of this test and must be removed by adding dilute phosphoric acid to the sample prior to analysis.

8.0 Safety

8.1 The toxicity or carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonable achievable.

8.2 Gloves and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.

8.3 The furnace is at 900°C. Use caution when inserting and removing boats from the furnace and when doing any maintenance on the instrument.

9.0 Equipment & Supplies

9.1 Shimadzu TOC: 5000A

9.2 TOC Catalyst: Shimadzu part number 638-92069-01

9.3 Cobalt Oxide Catalyst: Shimadzu part number 630-00566-00 or equivalent.

9.4 Mixed catalyst: Mix 2 containers of Cobalt Oxide Catalyst (9.3) with 1 container of TOC Catalyst (9.2). Make sure this is well homogenized. Use 45g of the mixed catalyst to fill the combustion tube.

9.5 Quartz Wool: Shimadzu part number 630-00557 or equivalent.

9.6 Metal screen for catalyst: Shimadzu part number 638-58102 or equivalent.

9.7 Ceramic fiber: Shimadzu part number 638-60074 or equivalent.

9.8 Combustion tube: Shimadzu part number 638-41325-01or equivalent.

9.9 Shimadzu SSM-5000

9.10 Ceramic weigh boats: Shimadzu or equivalent.

9.11 Analytical Balance: Ohaus, Model AP 2500 or equivalent.

9.12 Drying Oven: Fisher Isotemp Oven p/n 550-50 or equivalent. Set at 75°C.

9.13 Compressed Oxygen: Ultra high purity grade. Praxair p/n UN1072 or equivalent.

10.0 Reagents & Materials

10.1 Reagent water: Milli Q water >10 mega ohms.

10.2 Phosphoric Acid (Fisher catalog number A242SK-212 or equivalent).

10.3 25% Phosphoric Acid: Into a 1L volumetric flask, add 250 ml concentrated phosphoric acid (10.2) and dilute to volume with reagent water (10.1). Store on shelf.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

10.4 Dextrose: Fisher (Cat. #D16-500 or equivalent).

10.5 Potassium Hydrogen Phthalate or an alternate source of Dextrose: E.M. Science (Cat. # DX0145-11).

11.0 Sample Preservation & Storage

11.1 Sampling and storage of samples in glass bottles is preferable but plastic is allowable if it does not contribute to TOC content of sample.

11.2 Samples should be stored at 0-6°C until analysis.

11.3 Hold time for samples is 14 days.

12.0 Quality Control

12.1 This SOP is designed to follow a variety of different projects and programs requirements. Table 1 is designed to illustrate the control steps and provisions required to adequately producing acceptable data.

12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.3 Program Specific Limits: Samples analyzed under the guidance of certain programs; such as the Department of Defense Quality Systems Manual (DoD/QSM) or Louisville Chemistry Guidance (LCG), require their own specified limits. For these samples follow the limits specified in the manuals for that program.

13.0 Calibration & Standardization

13.1 Turn on oxygen to the instrument. Set pressure to 50-60psi.

13.2 Turn on the SSM module. Power button is located on the right side of the SSM.

13.3 Turn on instrument. Power button is located on the left side of the instrument.

13.4 Check to verify that the carrier gas flow rate is 0.5 L/min. Gas flow regulator is located on the right front of the SSM. Open door and adjust to 0.5 ml/min if necessary.

13.5 Check to verify that the pressure is 300 kPa. The pressure regulator is located on the right front of the SSM. Open the door and adjust to 300 kPa if necessary.

13.6 Allow SSM furnace to warm up to 900°C.

13.7 Once the screen powers up, press F1 to go to the main menu.

13.8 Using the arrow keys on the front of the instrument, arrow down to 3 (General Conditions) and press enter. This will take you to the general conditions screen

13.8.1 Under general conditions, make sure the following options are set (for each condition press the enter button after value entry):

13.8.1.1 TC Catalyst should be 1 (normal)

13.8.1.2 Syringe size should be 1 (250ul)

13.8.1.3 Number of Washes should be 4

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

13.8.1.4 Unit of concentration should be 1 (ppm)
13.8.1.5 Auto ranging and injection volume should be 1 (off)
13.8.1.6 Regeneration of IC solution should be 1 (on)
13.8.1.7 Auto printout should be 1 (data only)
13.8.1.8 Furnace on/off should be 3 (TOC and SSM) if you plan on running waters the same day or 4 (SSM) if you only plan on running soils
13.8.1.9 Buzzer should be 2 (not used)
13.8.1.10 Injection speed should be 3 (0.8mm)
13.8.1.11 ESU option should be 2 (not used)
13.8.1.12 Bubble Removal should be 2 (off)
13.8.1.13 Syringe wash should be 1 (std)
13.8.1.14 Cell length should be 1 (std)
13.8.1.15 TOC or SSM should be 2 (SSM)
13.8.1.16 Printer device should be 2 (Internal-New)
13.8.1.17 Page length should have an *
13.8.1.18 Calibration curve form should be 2 (least squares)
13.8.1.19 POC option is 1 (not used)
13.8.1.20 Press F1 to go to the next screen
13.8.1.21 Set measurement interval for TOC/NPOC to 480s
13.8.1.22 Set measurement interval for IC/POC to 360s
13.8.1.23 Press F2 to return to the main menu

13.9 Press 1 on the main menu then press enter. A calibration curve screen will appear.
13.9.1 Type in the curve file name. The instrument will default to the next available number.
13.9.2 Next to the first standard type in 0 for the mg and 40000 for the concentration.
13.9.3 Type in the mg used (should be around 10 mg) for the second standard and 40000 for the concentration.
13.9.4 Type in mg used for the third standard (should be around 25-30mg) and 40000 for the concentration.
13.9.5 Type in mg used for the fourth standard (should be around 50-60mg, but not exceeding 60mg) and 40000 for the concentration.
13.9.6 Type in 30 for the range.

13.10 Press F1 next.
13.11 Insert a clean sample boat for your zero point of the curve and close the cover.
13.12 Press Start.
13.13 Push the sample boat into the furnace as prompted.
13.14 When instructed, pull the boat to the cooling position (about halfway out of the furnace).
13.15 When the instrument says the analysis is complete, pull the boat back completely out of the furnace.
13.16 Press F1to go to the next standard. Sample information should print out automatically.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

13.17 Repeat steps13.10-13.15 with the reaming boats containing your dextrose standards.
13.18 When analyses are complete, press F1 to return to main menu.
13.19 Choose 4: Calibration curve file list.
13.19.1 Highlight the calibration curve number you assigned and press enter to display the curve.
13.19.2 Press F5 to print curve.
13.19.3 Confirm R-value displayed is ≥0.995. If it is not, fix problem and repeat calibration.
13.20 Press F1 to return to the Calibration curve list.
13.21 Press F2 to return to the main menu.

14.0 Procedure

14.1 Ensure system is prepared to run (See Calibration and Standardization 13.1-13.7).
14.2 Place approximately 500 mg of sample in a clean sample boat. Add phosphoric acid (10.3) and heat to 75°C for 20 minutes. Sample triplicates may be prepared at this time.
14.3 After a passing calibration is achieved choose 2 (Sample Measurement) from the main menu screen.
14.3.1 Enter 1 for sample #.
14.3.2 Enter the current curve reference number for Cal Curve #.
14.3.3 Enter 30 for Range.
14.3.4 Enter sample weight (in mg).
14.3.5 Enter 1 for Density.
14.3.6 Sample volume should default to number entered for sample weight.
14.3.7 Units should be 1 (mg), may default to setting in General Conditions (*).
14.4 Press next and place sample boat in SSM for analysis.
14.5 Press Start and follow instrument instructions.
14.6 Push the sample boat into the furnace as prompted.
14.7 When instructed, pull the boat to the cooling position, about halfway out of the furnace.
14.8 When the instrument says the analysis is complete, pull the boat back completely out of the furnace.
14.9 Press F1 next to start the 2nd sample (sample #2).
14.10 Repeat steps 14.4-14.9 with the boats containing your remaining samples.
14.11 When analyses are complete, press F1 to return to main menu.
14.12 If all analyses are acceptable the instrument can be shut down at this time.
14.13 Final results are entered into LIMS by the analyst.

15.0 Calculations

15.1 Dry weight Concentration (mg/kg) = A/B

Where A = instrument reading for sample (ppm)
B= % solids as a decimal

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

15.2 %*RSD* = Percent Relative Standard Deviation (%RSD):

$$\%RSD = \frac{SD \times 100}{Mean}$$

15.2 Instrument correction:
Final result= Instrument result (mg/kg) x10

16.0 Method Performance

16.1 Certified standard solutions and chemicals, properly used instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies. Internal blind spikes are also utilized to check analyst performance.

16.2 Initial demonstration of capability (IDC) is another technique used to ensure acceptable method performance. An analyst must demonstrate initial precision and accuracy through the analysis of 4-5 laboratory control spikes for each matrix and sample type. After analysis, the analyst calculates the average recovery (AR) and the relative standard deviation (RSD) of the recoveries for each analyte. In the absence of specific criteria found in the EPA methods or project specific limits, the default criteria of 70-130% recovery and 20 % RSD are used until internal limits are generated.

16.3 Proper instrument maintenance is another means to ensure adequate method performance. Refer the Shimadzu TOC 500A Instruction Manual or the Shimadzu Solid Sample Module Instruction Manual as needed.

17.0 Pollution Prevention

17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.

17.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18.0 Data Assessment & Acceptance Criteria for QC Measures

18.1 When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. The analyst will review the data to ensure QC is acceptable and that exceedances are addressed. Acceptable data is then entered into the LIMS system.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

18.2 After data has been entered into LIMS, it is reviewed by the analyst for accuracy and completeness. See checklist (Table 2) for data review guidance.

18.3 Once the analyst has reviewed and approved the data, it is given to a peer or supervisor for review.

18.4 After the second reviewer approves the data, the reviewer sends the data to "validated" status in LIMS.

18.5 A paper hard copy of the data is then filed or archived. The package includes the checklist, the sequence run log, and a copy of the bench sheet (if applicable), the LIMS run log, and verification of calibration data.

19.0 Corrective Measures for Handling Out-of-Control Data

19.1 When data is out of control, a number of corrective actions may need implementing. If the nonconformities involve failing QC within the analytical sequence batch, then reanalysis of samples may eliminate any out of control data. If the out of control data is the result of instrument malfunctions, then maintenance or repair of the downed instrument followed by reanalysis of affected data may correct the problem. If sample matrix affect or contamination is the reason for poor data, the instrument may need cleaning and decontamination. In all cases, when out of control data presents itself, the appropriate corrective measures need to be enacted to eliminate unusable data. The Quality Control Requirements chart can be used as a guide as to which corrective actions should be taken for different QC-type failures or nonconformities (Table 1).

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 Due to limited sample volume, expiration of hold times, downed instrumentation, and analyst error, the sample data may be out of control or unacceptable to report. Since these potential instances can arise, contingency plans need to be in place to prevent and/or minimize their affect on data.

20.1.1 The first thing addressed is prevention of producing unacceptable data. When limited sample volume is the issue, the analyst should determine if splitting the sample into lesser volumes or weights is an option. To avoid sample hold time issues, the analyst's first responsibility is to plan accordingly. The analyst is responsible for budgeting enough time for sample analysis, so if a problem arises, reanalysis is an option. Analyst error is prevented by a second analyst confirmation and validation. If the initial analyst makes an analysis error or inadvertently reports unacceptable data, the second analyst is responsible for finding and/or correcting those errors.

20.1.2 When out of control or unacceptable data is produced and it is too late for corrective measures, a number of actions can be taken. The first and foremost is alerting the client service personnel of the

UNCONTROLLED CT Laboratories SOP Updates and revisions will not be issued

problem. Client services will inform the client and/or responsible parties. In some instances, more samples can be made available or re-sampling can occur, so it is important to alert the appropriate personnel as soon as possible.

20.1.2.1 If the out of control data affects only specific analytes, it is important to let the appropriate person(s) know in case his or her site assessment is based on a specific target analyte list.

20.1.2.2 In all instances, if results are reported from data that is out of control or unacceptable, that data should be qualified accordingly. Once the client has been notified and he or she instructs us to report the data, flag the data indicating what type of nonconformity has occurred.

20.1.2.3 Out of control data is still retained by the laboratory and filed and archived along with acceptable data. The file folder should be labeled as such, indicating that the data is out of control.

20.1.2.4 A non-conformance/corrective action report (CAR) form must be filled out whenever these types of events occur. The information on the report includes the problem encountered, planned corrective actions, and corrective action follow-up. The form is then discussed with and signed by the analyst, the client representative, the QA officer, and the laboratory manager. The purpose of the form is to document problems in order to eliminate the possibility of repeating nonconformance and to ensure that the proper corrective actions are employed.

21.0 Waste Management

21.1 Samples are routinely held for up to six weeks from analysis date before they enter the waste stream. Waste disposal of samples and standards follows the procedures documented in the Laboratory Waste Disposal SOP (Quality Assurance Section, SOP NO. FO-8, Rev. 4).

22.0 References

22.1 Determination of Total Organic Carbon in Sediment (Lloyd Kahn Method),USEPA, July 27, 1988.

22.2 Shimadzu Instruction Manual Total Organic Carbon Analyzer Model TOC- 5000A.

22.3 Shimadzu Solid Sample Module SSM-5000 for TOC-5000/5050 Total Organic Carbon Analyzer Instruction Manual. 1993.

22.4 National Environmental Laboratory Accreditation Program (NELAP), Quality Systems, Chapter 5, June, 2000.

22.5 Department of Defense, Quality Systems Manual for Environmental Laboratories, DoD Environmental Data Quality Workgroup, Department

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

of Navy, Lead Service, Based on NELAC Voted Revision 5 June 2003, Version 4.1, April 22, 2009.

22.6 Louisville Chemistry Guideline (LCG), US Army Corps of Engineers-Louisville District, June 2002.

22.7 Louisville DOD Quality Systems Manual Supplement (LS), US Army Corps of Engineers-Louisville District, March 2007

Table 1.
SUMMARY OF QUALITY CONTROL REQUIREMENTS

Procedure	Frequency of Procedure	Acceptance Criteria	Corrective Action if Unacceptable
4 point curve (3 standards and a blank)	Initially and as needed	r ≥ 0.995 for each regression line	Repeat until acceptable
Initial calibration verification (ICV)	Second source standard run after each ICAL and daily prior to sample analysis	%R: 90-110%	Reanalyze ICV standard, if still unacceptable repeat ICAL
Initial calibration blank (ICB)	After each ICV, prior to sample analysis	< RL	Remake and reanalyze CB once, if still unacceptable investigate and correct problem or flag results less than 20 X's the ICB with a 'B' qualifier
Continuing calibration verification (CCV)	Daily, prior to sample analysis, after every 10 analyses, and at end of run	%R: 90-110%	Remake and reanalyze CCV, if still unacceptable investigate and correct problem. Reanalyze all samples after last acceptable CCV.
Continuing calibration blank (CCB)	After each CCV	<RL or <20 times less than the lowest sample result	Remake and reanalyze CB once, if still unacceptable investigate and correct problem then reanalyze all samples after the last acceptable CCB or flag results less than 20 X's the CCB with a 'B' qualifier
Laboratory Control Standard (LCS)	Analyzed with each batch of samples (or at project/program specified frequencies)	With in-house limits Default 80-120 %R.) or within project/program specified limits	Remake and reanalyze LCS once, if still unacceptable investigate and correct problem. Reanalyze all samples associated with failing LCS. IF reanalysis is not possible samples must be "Q" qualified.
Method Blank (MB)	Analyzed with each batch of samples (or at project/program specified frequencies)	< MDL or project/program specified limit. < ½ RL for DoD-QSM	If unacceptable, all associated samples that have detects ≤ 20 times (or project specific) the blank detection and are greater than the MDL must be reanalyzed or 'B' qualified
Matrix Replicate (DUP)	Sample + 3 reps / 20 samples per solids matrix or at project / program frequencies	% RSD within in house limits (Default ±30%) or project/program specified limits	Qualify results with 'Y' flag
Capability demonstration sample (IDC)	Four (4) prepared samples analyzed one time prior to any sample analyses and one blind sample	Within in house limits. Default 70-130% Recovery ±20% RSD or within project/program specified limits	Repeat until acceptable

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

CT Laboratories

Table 2. Data Validation Checklist

LIMS #:	Method: Total Organic Carbon: Lloyd Khan Method			
Analysis Date	Analyst / Data Interpreter	Independent Reviewer	Date of Review	Approved
				Yes … No

Instructions: Complete one checklist per *analytical run*. Enter the appropriate response for each question. Each "No" response requires an explanation in the Comments section, and may require the initiation of a Nonconformance Report.

Requirement:	Acceptance	Analyst Review		Independent Review		Comments:
	Criteria	Yes	No	Yes	No	(indicate reference to an attachment if necessary)
1. Were the samples acidified prior to analysis?	No effervescence					
2. Was a calibration curve performed using the required number of standards?	3 standard levels and 1 blank					
3. Was the correlation coefficient acceptable?	>= 0.995					
4. Was the ICV standard run at the beginning of the run prior to sample analysis?	---					
5. Was the ICV recovery acceptable?	90 – 110 %					
6. Was the ICB result acceptable?	< LOD					
7. Were the CCV's and the CCB's analyzed at the required frequency?	1 per 10 analyses					
8. Were the CCV recoveries acceptable?	90 – 110 %					
9. Were the CCB results acceptable?	< LOD					
10. Were all standards used before the indicated expiration date?	---					
11. Were all positive results that were reported within the calibration's range?	---					
12. Was the LCS recovery acceptable?	Within in-house or project/program specific limits					
14. Was the MB result acceptable?	< LOD or project/program specific					
13. Were the appropriate numbers of samples analyzed in quadruplicate?	1 per 20 samples					
13. Was the %RSD on the replicated sample acceptable?	±30 % or project/program specific					

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

/RS 2/21/05

5/8/07
1/18/08
2/1/09
1/26/10

CT Laboratories
Baraboo Laboratory Divison

Title: **TCLP and SPLP Extraction for Non-Volatile Parameters**

SOP Number: **CL-8B**

Prepared by: Kara Ruckaghe 9/2/04
Date

Technical Review by: Greg Edens 9/2/04
Date

Reviewed by: [signature] 10/5/04
Quality Assurance ***Date***

[signature] 6-Oct-2004
Laboratory Director ***Date***

SOP Manual Control Number:_____

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

1.0 SCOPE AND APPLICATION

1.1 The Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) are designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

1.2 The following procedure will be used for performing the metals and semi-volatile extraction.

2.0 METHOD SUMMARY

2.1 TCLP

2.1.1 For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the TCLP extract.

2.1.2 For wastes containing greater than or equal to 0.5% solids, the liquid, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

2.1.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

2.2 SPLP

2.2.1 For liquid samples (i.e., those containing less than 0.5 % dry solid material), the sample, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the SPLP extract.

2.2.2 For samples containing greater than 0.5 % solids, the liquid phase, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the region of the country where the sample site is located if the sample is a soil. If the sample is a waste or wastewater, the extraction fluid employed is a pH 4.2 solution. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

2.2.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are

analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

3.0 **DEFINITIONS**

3.1 Batch - A batch consists of a maximum of 20 samples of similar matrix which are prepared and analyzed in the same manner. Each batch is given a unique prep batch number for tracking purposes.

3.2 PB or MB (Prep Blank/ Method Blank) - A Reagent Blank which is carried through the entire preparation and analytical method. The method blank is used to detect possible contamination that may occur prior to or during the sample preparation. A minimum of one MB is prepared per batch, and is analyzed at the beginning of an analytical batch.

3.3 MS (Matrix Spike): - A separate sample aliquot to which a known concentration of analyte has been added which is carried through the entire preparation and analytical procedure. The purpose of a matrix spike is to reveal any matrix effect from the sample on the recovery of the analyte by the method being used. One MS is prepared for each waste type in a given batch of samples. Failure to meet criteria may be due to poor recovery during the preparation method or due to matrix interference within the sample.

4.0 HEALTH AND SAFETY

4.1 Gloves and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.

5.0 **CAUTIONS**

There are no cautions

6.0 **INTERFERENCES**

Refer to the sample analytical methods for interferences.

7.0 PERSONNEL QUALIFICATIONS

7.1 All personnel performing this analysis should be instructed in the use of personal protective equipment prior to beginning analysis.

7.2 Personnel should know how to read a meniscus and how to use a balance correctly.

8.0 **APPARATUS AND MATERIALS**

8.1 Rotator apparatus capable of turning at 30 +/- 2 rpm.

8.2 2 liter glass extraction jars.

8.3 2 liter polyethylene extraction containers.

8.4 Millipore pressure filtration apparatus. Note: The interior surface of the pressure filtration apparatus should be free smooth and free of scratches. Clean using only a very soft bristled brush if necessary. Also, the screen

UNCONTROLLED: Laboratories SOP updates and revisions will not be issued

on which the filter is placed should be clean of debris. If any of the holes are clogged they can be cleaned by sonicating for 15 minutes.

8.5 Glass fiber filters 0.7 micron: Environmental Express TCLP filters or equivalent.

8.6 Ceramic filtration funnel, 15 cm.

8.7 2 liter filtration flask.

8.8 pH meter.

8.9 Top-loading balance, 0.01 g capacity.

8.10 Hotplate.

8.11 Magnetic stirrer.

8.12 100 mL graduated cylinder.

8.13 5 mL oxford pipette.

8.14 Thermometer, 100^0C.

8.15 Reagents:

8.15.1 De-ionized water: Milli-Q type II

8.15.2 Hydrochloric acid 1N: Prepare in hood. Into a 1 liter volumetric flask, add 900 mL of D.I. H2O. Carefully add 83 mL ACS reagent grade conc. HCl. Dilute to volume with D.I. H2O and mix well.

8.15.3 Glacial acetic acid, conc. ACS reagent grade.

8.15.4 Sodium Hydroxide 10N: Into a 1 liter volumetric flask, add 500 mL of D.I. H2O. Dissolve 400g. ACS reagent grade NaOH pellets (caution: mixture will become very hot). When cool, dilute to volume with D.I. H2O and mix well.

8.15.5 SPLP extraction fluid acid mixture: To a 100 mL volumetric flask, add 50 mL D.I. H2O. Carefully add 6 g. Conc. H2SO4 and 4 g. Conc. HNO3. Mix by swirling and dilute to volume with D.I. H2O.

8.16 EXTRACTION FLIUDS

8.16.1 TCLP extraction fluid #1: (To prepare a 20 liter quantity): Fill a 20 L carboy with 19 L Of D.I. H_2O. Add 114 mL glacial acetic acid and 128.6 mL 10N NaOH. Dilute to 20 L With D.I. H_2O and mix by stirring. When correctly prepared, the pH of this fluid will be 4.93 +/- 0.05.

8.16.2 TCLP extraction fluid #2: (To prepare a 20 liter quantity): Fill a 20 L Carboy with 19 L of D.I. H_2O. Add 114 mL glacial acetic acid. Dilute to 20 L and mix by stirring. When correctly prepared, the pH of this fluid will be 2.88 +/- .05.

8.16.3 SPLP extraction fluid #1: To be used for sites that are east of the Mississippi River. Prepare a sufficient quantity of extraction fluid by adding the SPLP acid mixture (see step 8.15.5 of this SOP) to D.I. H_2O to obtain a pH of 4.20 +/- 0.05. Note: solutions are unbuffered and the exact pH may not be obtained.

8.16.4 SPLP extraction fluid #2: To be used for sites that are west of the Mississippi River. Prepare a sufficient quantity of extraction fluid by adding the SPLP acid mixture (see step 8.15.5 of this SOP) to

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

D.I. H_2O to obtain a pH of 5.00 +/- 0.05. Note: solutions are unbuffered and the exact pH may not be obtained.

9.0 INSTRUMENT OR METHOD CALIBRATION

No calibration is necessary.

10.0 SAMPLE COLLECTION, HANDLING AND PRESERVATION

10.1 Preservatives shall not be added to samples before extraction. Extracts to be analyzed for metals shall be preserved following filtration with conc. HNO_3. Extracts to be analyzed for Semivolatile organic compounds (SVOCs) shall not be preserved following filtration. Extracts to be analyzed for Phenolics shall be preserved following filtration with conc. sulfuric acid.

10.2 Sample hold times are as follows (days):

	SVOCs	Mercury	Metals	Phenolics
From sample date to TCLP extraction:	14	28	180	28
From TCLP extraction to preparative extraction:	7	n/a	n/a	n/a
From preparative extraction to analysis:	40	28	180	28

See TCLP method 1311 sec. 6.0 and SPLP method 1312 sec. 6.0 for a detailed description of sample handling.

11.0 SAMPLE PREPARATION AND ANALYSIS

11.1 See appropriate SOP for sample analysis following extraction with this mehod.

11.2 DETERMINE SAMPLE % SOLIDS

11.2.1 For solid samples which contain no free liquids, proceed to sec. 11.3.2.

11.2.2 For samples which are liquid, contain free liquids, or are multi-phasic, filtration or liquid/solid separation is required as follows:

11.2.2.1 Preweigh a GFF filter and record the weight.

11.2.2.2 Preweigh a receiving beaker and record the weight.

11.2.2.3 Preweigh a transfer beaker and record the weight.

11.2.2.4 Assemble the pressure filtration device with the GFF filter, and place the receiving beaker beneath the outlet.

11.2.2.5 Weigh out a subsample of the waste (100g. minimum) and record the weight. An additional minimum 100g. will be needed for the extraction.

11.2.2.6 Transfer the waste to the filtration device and secure the top.

11.2.2.7 Re-weigh the empty transfer beaker and record the weight.

11.2.2.8 Slowly apply air pressure to the filtration device in 10 psi increments up to 50 psi. or until air passes through

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

the filter. Hold at each increment for 2 minutes before proceeding to the next higher increment.
*Note: Some wastes, such as oily wastes and some paint wastes will contain material that appears to be a liquid. Even after applying pressure to 50 psi, this material may not filter. In this case, the material in the filter holder is defined as the solid phase and is carried through the extraction as a solid. Proceed to sec. 11.4.

11.2.2.9 Weigh the receiving beaker and record the weight.

11.2.2.10 The material in the filter holder is defined as the solid phase of the waste, and the material in the receiving beaker is defined as the liquid phase.
*Note: This subsample is not to be used for the extraction procedure.

11.2.2.11 Determine and record the weight of the liquid phase.

11.2.2.12 Determine the weight of the solid phase by subtracting the weight of the liquid phase from the total weight of the waste.

11.2.2.13 Calculate the % solids as follows:

$$\% \text{ solids} = \frac{\text{weight of solid phase}}{\text{total weight of waste}} \times 100$$

11.3 EVALUATION OF % SOLIDS

11.3.1 If the % solids is <0.5%, the filtrate is defined as the TCLP extract. Proceed to section 11.5 to prepare the extract for analysis.

11.3.2 If the % solids is significantly >0.5%, the solid portion must have a particle size which is smaller than 1cm. or have a surface area >3.1 cm^2 /g. (paper, cloth, etc.).If the above is not met, the material must be reduced to particles of the appropriate size by cutting, crushing, or grinding.

11.3.3 If the % solids is ≥0.5% or is very close, and it is noticed that the solid material is entrained in the filter, dry the filter at 80-120C until two successive weighings agree within +/- 1%. Determine the % dry solids. If the % dry solids is <0.5%, the filtrate is defined as the TCLP extract. Proceed to section 11.5 . If the % dry solids is >0.5%, see note below.
*Note: there must be a significant level of % solids such that a minimum of 25-50g of solids can be generated for the extraction. This minimum amount of solids will yield 500-1000 mL of extract.

11.4 DETERMINE THE APPROPRIATE EXTRACTION FLUID

11.4.1 TCLP

11.4.1.1 Transfer 5.0 g. of a representative subsample of the waste to a clean 250 mL beaker.

11.4.1.2 Add 96.5 mL D.I. H2O and cover with a

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

watchglass.

11.4.1.3 Stir vigorously for 5 min.

11.4.1.4 Measure and record the pH.

*Note: Accurate pH measurement is critical; calibrate the pH meter daily with fresh buffer solutions.

11.4.1.5 If the pH is <5.0, use extraction fluid #1.

11.4.1.6 If the pH is >5.0, add 3.5 mL of 1N HCl, cover with a watchglass, and heat on a hotplate to 50^0 C. Hold at 50^0 C for 10 min. Cool to room temperature, measure and record the pH. If the pH is < 5.0, use extraction fluid #1. If the pH is > 5.0, use extraction fluid #2.

11.4.2 SPLP

11.4.2.1 For samples collected from sites east of the Mississippi River, use extraction fluid #1.

11.4.2.2 For samples collected from sites west of the Mississippi River, use extraction fluid #2.

11.5 EXTRACTION PREPARATION

11.5.1 For samples that are 100% total solids

11.5.1.1 Perform particle size reduction if necessary.

11.5.1.2 Weigh **at least** 100 g of sample directly into the extraction vessel and record the weight. (For SVOC and phenolics analysis, a glass container must be used. For metals analysis, a glass or plastic container may be used.)

11.5.1.3 Record the number of the vessel being used and also check it off on the vessel usage sheet in front of the TCLP extraction log. A blank must be run on each container at a minimum of every 20th use.

11.5.1.4 Determine the amount of extraction fluid to add to the extraction container as follows:
Volume of extraction Fluid (mL) = 20 x mass of sample (g)

11.5.1.5 Measure and record the pH of the extraction fluid immediately prior to use.

11.5.1.6 Add the appropriate amount of extraction fluid.

11.5.1.7 Measure and record the initial pH.

11.5.1.8 Tightly cap the extraction container. The sample is now ready for extraction. Proceed to sec. 11.6.

11.5.2 For samples which are liquid, contain free liquids, or are multi-phasic, filtration or liquid/solid separation is required on a new portion of the waste:

11.5.2.1 Preweigh a GFF filter and record the weight. Filters should be prewashed with 1N HNO_3 followed by D.I. H_2O if metals are to be analyzed.

11.5.2.2 Preweigh a receiving beaker and record the weight.

11.5.2.3 Preweigh a transfer beaker and record the weight.

11.5.2.4 Assemble the pressure filtration device with the GFF filter, and place the receiving beaker underneath.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

11.5.2.5 Weigh out at least 100 g of waste and record the weight. Ideally, enough sample should be filtered to allow for 100 g of solids to remain.

11.5.2.6 Transfer the waste to the filtration device and secure the top.

11.5.2.7 Re-weigh the empty transfer beaker and record the weight.

11.5.2.8 Slowly apply air pressure to the filtration device in 10 psi increments up to 50 psi. or until air passes through the filter. Hold at each increment for 2 minutes before proceeding to the next higher increment.

11.5.2.9 Weigh the receiving beaker and record the weight.

11.5.2.10 The material in the filter holder is defined as the solid phase of the waste, and the material in the receiving beaker is defined as the liquid phase.

11.5.2.11 Measure and record the weight and volume of the liquid phase.

11.5.2.12 Using a transfer pipette and a small beaker, add a few drops of the liquid phase to a small quantity of D.I. H_2O.

11.5.2.13 If the two phases are miscible, save the liquid phase for addition back to the filtered TCLP or SPLP extract. Store at 4° C in an appropriate container until the extraction is complete. If the two phases do not mix, the liquid phase will need to be analyzed separately and the results mathematically combined with the results from the extract.

Calculation:

Final analyte concentration = $\frac{(V1)(C1) + (V2)(C2)}{V1 + V2}$

V1 = volume of the first phase liquid
C1 = concentration of the first phase in mg/L
V2 = volume of the second phase liquid
C2 = concentration of the second phase in mg/L

11.5.2.14 Disassemble the filtration apparatus and carefully remove the filter and waste. Perform particle size reduction if necessary. Quantitatively transfer the filter and waste into the appropriate extraction container.

11.5.2.15 Determine the amount of extraction fluid to add to the extraction container as follows:

Volume of extraction Fluid (mL) = 20 x mass of sample (g)

11.5.2.16 Add the appropriate amount of extraction fluid.

11.5.2.17 Measure and record the initial pH.

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued

11.5.2.18 Tightly cap the extraction container. The sample is now ready for extraction.

11.6 EXTRACTION

11.6.1 Secure the samples in the rotation apparatus which is located in the BOD incubator

11.6.2 Rotate for 18 +/- 2 hours. A room temperature of 23 +/- 2^{0}C must be maintained during the extraction period. This can be checked in the electronic temperature data logger.

11.6.3 Begin rotating. Record the time.

11.7 FILTRATION FOLLOWING EXTRACTION

11.7.1 Record the time and temperature at the end of the extraction period, as well as the minimum and maximum temperatures.

11.7.2 Following the rotation period, measure and record the pH of each bottle

11.7.3 Assemble the 2 L vacuum flask and ceramic filtration funnel.

11.7.4 Obtain the necessary sample containers and pH paper.

11.7.5 Place a 0.7 micron glass fiber filter (Environmental Express TCLP filters) in the filtration funnel. Record the lot # of filter that is used.

11.7.6 Filter the extract.

11.7.7 Transfer a suitable quantity of the filtrate to the appropriate sample containers:

Metals: 250 mL in polyethylene with HNO_3 preservative.
Semi-volatiles and phenolics: 1 L in amber glass jar.

11.7.8 For metals analysis, preserve the sample to pH <2 with conc. HNO_3.

11.7.9 For semi-volatile analysis, preservative is not added. Store at 4 ^{o}C.

11.7.10 For phenolics analysis, preserve the sample to pH<2 with conc. H_2SO_4.

12.0 TROUBLESHOOTING AND MAINTENANCE

12.1 There is no troubleshooting or maintenance for this method.

13.0 DATA ACQUISITION, CALCULATION AND REDUCTION

13.1 See section 11.0 for any applicable calcuations.

14.0 COMPUTER HARDWARE AND SOFTWARE

14.1 Computer with StarLIMS

15.0 DATA MANAGEMENT AND RECORD MANAGEMENT

15.1 Data is recorded in the TCLP/SPLP extraction log.

15.2 Prep data is entered into LIMS, and then the batch sheet is given to the metals prep analyst or the semi-volatile prep analyst.

16.0 QUALITY CONTROL/QUALITY ASSURANCE

UNCONTROLLED CT Laboratories SOP. Updates and revisions will not be issued.

16.1 A minimum of one blank, using the same extraction fluid as used for the samples, is required for every extraction batch. Also, a blank must be performed every 20th time an extractions is performed in a particular container to check for contamination.

16.2 A matrix spike is required for each waste type, with a minimum of one matrix spike per extraction batch. Matrix spikes are prepared at the time of digestion/analysis.

17.0 REFERENCES

17.1 *Test Methods for Evaluating Solid Waste*,. EPA-SW-846. September, 1994. Method 1311.

17.2 *Test Methods for Evaluating Solid Waste*,. EPA-SW-846. September, 1994. Method 1312.

UNCONTROLLED CT Laboratories SOP . Updates and revisions will not be issued

TITLE: Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment

Approved By:

QA Officer: _____ Date: 11/11/10

Technical Director: _____ Date: 11/11/10

Revision History:

Revision Number	Changes	Revised By	Date
0	Preparation of SOP	R. Foster	03/06
1	Review and Update	R. Foster	06/08
2	Review	R. Foster	02/10
3	Reformat and addition of DOD support	K. Hudson	04/10

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment

1.0 Purpose and Applicability

1.1 This method describes procedures for the determination of acid volatile sulfides (AVS) and for selected metals that are solubilized during the acidification step (simultaneously extracted metal, SEM) in sediments. As a precipitant of toxic heavy metals, sulfide is important in controlling the bioavailability of metals in anoxic sediments (1). Research has established that the relative amounts of SEM and AVS are important in the prediction of potential metal bioavilability; if the molar ratio of SEM for bivalent metals to AVS exceeds one, the toxic heave metals in that sample are potentially bioavailable. This method uses the same conditions for release of both sulfide and metal from the sediment and thus provides the most predictive means of assessing the amount of metal associated with sulfide.

1.2 The AVS in the sample is first converted to hydrogen sulfide (H_2S) by acidification with hydrochloric acid at room temperature. The H_2S is then purged from the sample and trapped in aqueous solution. The amount of sulfide that has been trapped is then determined. The SEM are selected metals liberated from the sediment during the acidification. These are determined after filtration of the sample.

1.3 Two types of apparatus for sample purging and trapping of H_2S are described. One uses a series of Erlenmeyer flasks while the other uses flasks and traps with ground glass stoppers. The former is less costly. The latter is less prone to leakage that causes low recovery of AVS. The latter is recommended when higher degrees of precision are desired and for samples containing low levels of AVS.

1.4 Three means of quantifying the H_2S released by acidifying the sample are provided. The colorimetric method is generally preferred. In the gravimetric procedure, the H_2S is trapped in silver nitrate. The silver sulfide that is formed is determined by weighing (1,2). This procedure can be used for samples with moderate or high AVS concentrations. Below 10 µmoles AVS/gram dry sediment, accuracy may be affected by incomplete recovery of precipitate and by weighing errors. In the colorimetric method, the H_2S is trapped in sodium hydroxide. The sulfide reacts with N-N-dimethy-p-phenylenediamine to form methylene blue that is measured. This procedure is capable of determining AVS concentrations as low as 0.01 µmoles/gram dry weight of sediment. By appropriate sample dilution, the maximum concentration of AVS which can be determined is at least 1000 µmoles/gram dry sediment. In an alternative procedure the H_2S is trapped in an antioxidant buffer before using an ion-selective electrode.

1.5 After release of the H_2S, the acidified sediment sample is membrane filtered before determination of the SEM by atomic spectrometic methods.

2.0 Definitions -

AVS = Acid volatile sulfide is operationally defined as sulfides that form hydrogen sulfide under the conditions of this test.

SEM = Simultaneously extracted metals are operationally defined as metals, commonly cadmium, copper, lead, mercury, nickel and zinc, that form less soluble sulfides than do iron or

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

manganese, and which are at least partially soluble under the conditions of this test.

MDL = The method detection limit is the minimum concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

LRB = The laboratory reagent blank is an aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, and reagents that are used with samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents or apparatus.

LFB = A laboratory fortified blank (also a laboratory control sample, LCS) is an aliquot of reagents to which a known quantity of the method analyte is added in the laboratory. The LFB is analyzed exactly like a sample. Its purpose is to determine whether the method is within accepted control limits.

LFM = The laboratory fortified sample matrix (also spiked sample) is an environmental sample to which a known quantity of the method analyte is added in the laboratory. The LFM is analyzed exactly like a sample.

CCV = Continuing calibration verification

ICV = Initial calibration verification

CCB = Continuing calibration blank

ICB = Initial calibration blank

SAOB = Sulfide anti-oxidant buffer solution

Stock Standard Solution = A concentrated solution of the analyte prepared in the laboratory using assayed reference compounds or purchased from a reputable commercial source.

Calibration Standards = Solutions prepared from the stock standard solution that is used to calibrate the method response with respect to analyte concentration.

3.0 Applicable Documents/References

Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment, US EPA-821-R-91-100 December 2, 1991.

Method for Determination of Acid Volatile Sulfide in Sediment. R.D. Foster 01/92.

APHA. *Standard Methods for the Examination of Water and Wastewater.* 20th . Edition. 1998. 4500-S^{2-} F.

Supplemental References

1. DiToro, D.M., J.D. Mahony, D.J. Hansen, K.J. Scott, M.B. Hicks, S.M. Mayr and M.S. Redmond, "Toxicity of Cadmium in Sediments: The Role of Acid Volatile Sulfide", *Environmental Toxicology and Chemistry,* 1990, 9, 1487-1502.

2. Morse, J.W., F.J. Millero, J.C. Cornwell and D. Rickard, "The Chemistry of the Hydrogen Sulfide and Iron Sulfide System in Natural Waters", *Earth Science Review,* 1987, 24, 1-42.

3. Allen, H.E., G. Fu and B. Deng, "Determination of Acid Volatile Sulfide (AVS) in Sediment", Report to the Environmental Protection Agency Office of Water Regulations and Standards, Washington, December 1990, 26 pages; Allen, H.E., G. Fu and B. Deng, "Determination of

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

Acid Volatile Sulfide (AVS) and Simultaneously Extracted Metals (SEM) in Sediments", presented at the "12th Annual Meeting of the Society of Environmental Toxicology and Chemistry", Seattle, 1991.

4. Boothman, W.S., "Acid-volatile Sulfide Determination in Sediments Using Sulfide-specific Electrode Detection" , U.S. Protection Agency Environmental Research Laboratory, Narragansett, R.I., undated, 8 pages.

5. Baumann, E.W., "Determination of Parts Per Billion Sulfide in Water with the Sulfide-Selective Electrode", *Analytical Chemistry*, 1974, 46, 1345-1347.

6. U.S. Environmental Protection Agency. "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, revised March 1983.

7. "Standard Methods for the Examination of Water and Wastewater", 17th edition, APHA, AWWA, WPCF, 1989.

8. Cornwell, J.C., and J.W. Morse, "The Characterization of Iron Sulfide Minerals in Anoxic Marine Sediments", *Marine Chemistry,* 1987, 22, 193-206.

9. Sax, N.L. and R.L. Lewis, Sr. "Dangerous Properties of Industrial Materials, 5th ed., Van Nostrand Reinhold, New York, 1989.

10. Code of Federal Regulations 40, Ch.1, Pt. 136, Appendix B.

4.0 Materials and Apparatus

Hydrochloric Acid, HCl, 6*N*
Standard Iodine solution, 0.025*N* (KI, iodine)
Standard sodium thiosulfate solution, 0.025*N* ($Na_2S_2O_3$ - $5H_2O$, NaOH -6*N* or solid)
Standard Bi-iodate solution ($KH(IO_3)_2$)
Starch solution (soluble starch, salicylic acid)
Sulfide standard (1.00 mg S^{2-} /1.00 mL) - buy prepared or prepare fresh from NaS2
Intermediate Standard : Dilute 10 mL stock to 1 L water. Prepare fresh daily. Standardize 1mL ≈ 0.01 mg S^{2-}
Working standards: Dilute 50 mL intermediate to 500 mL with 0.01N NaOH. Prepare fresh daily. 1.00 mL ≈ 0.001 mg S^{2-}
Source of ultrapure Nitrogen at 1-3 PSI
Diffusion chamber 500mL/50 mL glass/Teflon with luerlok inlet and vent
Gas evolution/trapping train, glass and teflon
Oscillating extractor for use a 60-120 oscillations per minute may be temperature controlled to 20 C +/- 2 C.
Spectrophotometer for measurement of absorbance at 520 nm
Spectrophotometer cells
Evaporating dishes, porcelain, 100 mL
Assorted calibrated pipettes and volumetric flasks
Drying Oven - capable of maintaining a constant temperature in the range of 103-105°C

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

Analytical balance - capable of weighing to 0.0001 g.
Magnetic stirrer, thermally insulated, and Teflon-coated stirring bar
Filtering Flask
Filter Holder for 47 mm filter
Electrometer
pH meter or ion-selective meter
Sulfide selective electrode
Double-junction reference electrode
High purity nitrogen or argon
Atomic absorption/fluorescence spectrometer and/or inductive couple plasma mass spectrometer

4.1 The above lists general materials and apparatus requirements. There are two variations for the performance of this method depending on the application desired. The additional materials and apparatus for each follow.

4.1.1 AVS Evolution and H_2S Trapping -

4.1.1.1 For each H2S evolution and trapping analytical train, a gas washing bottle or oxygen trap, one 250mL round bottom flask with a septum, 2 50 mL impingers. The round bottom flask contains the sediment and acid is introduced to it by a syringe inserted through a septum or valved inlet. The flasks are connected by glss and teflon tubing. The apparatus is assembled as shown in Figure 1 and more than one analytical train can be connected to a single source of nitrogen or argon if flow controllers are installed in the line.

4.1.1.2 Alternate apparatus - Diffusion apparatus, 250 or 500 mL, glass wide mouth fitted with internal 50 mL adsorption solution reservoir. The apparatus has a teflon screw cap cover with luer-lock valved inlet and outlet. One apparatus is substituted for each of the round bottom flask and impingers. Because sulfide may react with tubing, stoppers and other surfaces in the evolution and trapping train, the minimum exposure of this apparatus may improve sulfide recovery. The analyst should pay particular attention to the recovery of sulfide from standards in evaluating the apparatus.

5.0 Methods/Procedures

5.1 Reagents:

All water and reagents used in this method must be free of dissolved oxygen and sulfide. Freshly prepare and use deaerated, deionized water by removing dissolved oxygen from the deionized water by vigorously bubbling with oxygen-free nitrogen or argon for approximately one hour. Deaerate reagents immediately before use by deaerating with oxygen-free nitrogen or argon.

5.2 Sodium sulfide standard - Required to quality assurance and calibration

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

5.2.1 Sulfide stock standard solution, approximately 0.05M or 50 µmoles/mL (1600mg/L)

5.2.1.1 Weigh about 1.2 grams of $Na_2S{\cdot}9H_2O$ and dissolve it in 100.0 mL of deionized water. Store in a brown bottle. To prevent air oxidation, the sulfide solution should be maintained under oxygen-free nitrogen or argon.

5.2.1.2 Standardize against thiosulfate solution.

5.2.1.2.1 Pipette 10.00 mL of 0.025N standard iodine solution into each of two 125 mL Erlenmeyer flasks.

5.2.1.2.2 Pipette 2.00mL of sulfide stock standard solution into one flask. Pipette 2.00 mL of deionized water, as a laboratory reagent blank, into the other flask.

5.2.1.2.3 Add 5.0 mL of 6M HCl into each flask, swirl slightly, then cover and place in the dark for 5 minutes.

5.2.1.2.4 Titrate each with 0.025N thiosulfate until the yellow iodine color fades to a pale straw. Just before all the iodine has been titrated, add starch indicator dropwise to form a pale blue color. Continue the titration with the thiosulfate. The end point is reached when the blue color first disappears.

5.2.1.2.5 Calculate the sulfide concentration as follows:

$$\text{Sulfide } (\mu\text{mol/mL}) = \frac{(T_{blank} - T_{sample}) \text{ X N (thio)}}{V_{sample}} \text{ X } \frac{1 \text{ mole } S^{2-}}{2 \text{ equiv } S^{2-}} \text{ X } \frac{1000 \ \mu\text{moles}}{1\text{mmole}}$$

where: T = volume of titrant used for the blank and sample (mL)
N (thio) = concentration of thiosulfate titrant
V = volume of standard used (mL), 2.00 mL recommended

5.2.2 Standard Iodine solution, 0.025*N*: Dissolve 20 - 25 g KI in 10 -20 mL water and add 3.2 g iodine. After iodine has dissolved, dilute to 1000 mL and standardize against 0.025*N* $Na_2S_2O_3$, using starch solution as indicator.

5.2.3 Standard thiosulfate solution, 0.025*N*: Dissolve 6.205 g $Na_2S_2O_3$ - $5H_2O$ in distilled water. Add 1.5 mL 6*N* NaOH or 0.4 g solid NaOH and dilute to 1000 mL. Standardize with bi-iodate solution.

5.2.5 Standard Potassium bi-iodate solution, 0.0021 *M*: Dissolve 812.4 mg $KH(IO_3)_2$ in distilled water and dilute to 1000 mL.

5.2.6 Standardization: Dissolve approximately 2 g KI, free from iodate, in an Erlenmeyer flask with 100 to 150 mL distilled water. Add 1 mL 6*N* H_2SO_4 or a few drops of

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

concentrated H_2SO_4 and 20.00 mL standard bi-iodate solution. Dilute to 200 mL and titrate liberated iodine with thiosulfate titrant, adding starch toward end of titration, when a pale straw-yellow color is reached. When the solutions are of equal strength, 20.00 mL 0.025*M* $Na_2S_2O_3$ should be required. If not, adjust the $Na_2S_2O_3$ solution to 0.025*M*.

5.2.7 Starch solution: Dissolve 2 g laboratory grade soluble starch (optionally add 0.2 g salicylic acid, as a preservative) in 100 mL hot distilled water.

5.2.8 Sulfide working standards
Prepare sulfide working standards using the sulfide stock standard solution in 5.1.1. The concentrations of the following standards will depend on the exact concentration of the sulfide stock standard determined above. Correct concentrations of the standards in the following part of this section and the amount of the sulfide in standards used in the colorimetric method in Section 5.3.3 by multiplying by a factor of the concentration determined in Section divi 5.2.1.2.5 divided by 50 µmoles/mL.

Prepare sulfide working standard A by diluting 1.00 mL of sulfide stock standard to 100.0 mL. This solution contains 0.5 µmole sulfide/mL, if the concentration of the sulfide stock standard is exactly 0.05M.

5.3 Procedure:

5.3.1 AVS evolution

Hydrochloric acid 6M - Dilute 500 mL of concentrated hydrochloric acid (sp.gr.1.19) to 1L with deionized water. Deaeration of this solution is most important.

Nitrogen or argon gas, oxygen free, with regulator and flow controller. An oxygen gas scrubber may be required and is available commercially or deoxygenating solutions may be placed in the first flask or gas washing bottle in the analytical train.

Glass or plastic hypodermic syringe, 30 mL.

5.3.2 Gravimetric method

Potassium acid phthalate, 0.05M - Dissolve 10.2 g of potassium acid phthalate, $KHC_3H_4O_4$, in deionized water and dilute to 1L.

Silver nitrate, 0.1M - Dissolve 17 g of silver nitrate, $AgNO_3$, in deionized water and dilute to 1L. Store in a dark bottle.

Glass fiber filters, 1.2 micron - Rinse with deionized water, then pre dry filters at 103-105°C.

5.3.3 Colorimetric method

Sodium hydroxide solution, 1M - Dissolve 40 g sodium hydroxide in 1000 mL

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

deionized water.

Sodium hydroxide solution, 0.5M - Dissolve 20 g sodium hydroxide in 1000 mL deionized water.

Mixed diamine reagent, MDR

5.3.3.1 Component A - Add 660 mL concentrated sulfuric acid to 340 mL of deionized water. After solution cools, dissolve 2.25 g N-N-dimethy-p-phenylenediamine oxalate in it.

5.3.3.2 Component B - Dissolve 5.4 g ferric chloride hexahydrate ($FeCl_3 \cdot 6H_2O$) in 100 mL concentrated hydrochloric acid and dilute to 200mL with deionized water.

5.3.3.3 Mixed diamine reagent, MDR - Mix components A and B

5.3.4 Sulfuric acid solution, 1.0M - Dilute 56 mL concentrated sulfuric acid (H_2SO_4) to 1L with deionized water.

5.4 Ion-selective electrode method

5.4.1 Sodium hydroxide solution - Dissolve 80 g of sodium hydroxide in 700 mL of deionized water with caution. Cool to room temperature.

5.4.2 Sulfide anti-oxidant buffer (SAOB) - To the sodium hydroxide solution in 5.3.1 add and dissolve 74.45 g of disodium ethylenediaminetetraacetic acid and 35.23 g of ascorbic acid. Dilute to 1L with deionized water.

6.0 Sample Collection, Preservation and Storage

6.1 Samples should be collected in the field in wide mouth Teflon seal glass containers with a minimum of air space above the sediment. If possible, the head space should be filled with oxygen free nitrogen or argon.

6.2 Samples should be cooled to 4°C as soon as possible after collection, held and shipped at 4°C. Laboratory storage is refrigeration at 4°C. Samples maintained at 4°C have been found to have no significant loss of AVS for storage periods up to 3 weeks. Holding time for samples should not exceed 21 days.

7.0 Calibration and Standardization

7.1 Calibrate the photometer with a minimum of four standards and a blank that cover the expected range of the samples. Prepare a calibration graph relating absorbance to the µmoles of sulfide taken.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

7.2 Calibrate the sulfide electrode system with a minimum of three standards that cover the expected range of the samples. Standards must be made up in SAOB diluted 1+1 with deionized water. Follow the manufacturer's instructions for use of the electrode.

7.3 Overall sulfide recovery is determined by analysis of a known amount of sodium sulfide standard added to deionized water from which the sulfide is liberated in the analysis train (LFB). Recoveries of 95%± 10% are expected.

8.0 Quality Control

8.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirement of this program consists of an initial demonstration of laboratory capability, and the analysis of laboratory reagent blanks, fortified blanks and fortified samples as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of data thus generated.

8.2 Initial Demonstration of Performance

8.2.1 The initial demonstration of performance is used to characterize instrument performance, method detection limits and linear calibration ranges.

8.2.2 Method detection limit (MDL) - The method detection limit should be established for the analyte, using deionized water (blank) fortified at a concentration two to five times the estimated detection limit (10). To determine MDL values, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = t \times s$$

where t = students' t value for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom (t=3.14 for seven replicates), and s = standard deviation of the replicate analyses.

Method detection limits should be determined every six months or whenever a significant change in background or instrument response is expected.

8.2.3 Linear calibration ranges - The upper limit of the linear calibration range should be established by determining the signal responses from a minimum of four different concentration standards covering the expected range, one of which is close to the upper limit. The linear calibration range that may be used for the analysis of samples should be judged by the analyst from resulting data. Linear calibration ranges should be determined every six months or whenever a significant change in instrument response may be expected.

8.3 Assessing Laboratory Performance - Reagent and Fortified Blanks

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

8.3.1 Laboratory reagent blank (LRB) - The laboratory must analyze at least one laboratory reagent blank (Section 2.0) with each set of samples. Reagent blank data are used to assess contamination from the laboratory environment and reagents. If an analyte value in the reagent blank exceeds its determined MDL, then laboratory or reagent contamination should be suspected. Any determined source of contamination should be corrected and the samples reanalyzed.

8.3.2 Laboratory fortified blank (LFB) - The laboratory must analyze at least one laboratory fortified blanks (Section 2.0) with each set of 20 samples. Calculate accuracy as percent recovery. If the recovery of the analyte falls outside the control limits (Section 8.3.3), the analyte is judged to be out of control, and the source of the problem should be identified and resolved before continuing analyses.

8.3.3 Until sufficient data become available from within their own laboratory (usually a minimum of twenty to thirty analyses), the laboratory should assess laboratory performance against recovery limits of 85-105%. When sufficient internal performance data becomes available, develop control limits from the mean recovery (x) and the standard deviation (s) of the mean recovery. These data are used to establish upper and lower control limits as follows:

UPPER CONTROL LIMIT = x + 3s
LOWER CONTROL LIMIT = x - 3s

After each five to ten new recovery measurements, new control limits should be calculated using only the most recent twenty to thirty data points.

8.4 Assessing the Analyte recovery - Laboratory Fortified Sample Matrix

8.4.1 The laboratory must fortify a minimum of 10% of the routine samples or one fortified sample per set of 20 samples, whichever is greater. At least one sample from each source should be fortified. Ideally, the concentration should at least double the background concentration. Over time, samples from all routine sample sources should be fortified.

8.4.2 Calculate the percent recovery for the analyte, corrected for background concentrations measured in the unfortified sample, and compare these values to the control limits established in Section 8.3.3 for the analyses of LFBs. Spike recovery calculations are not required if the spike concentration is less than 10% of the sample background concentration. Percent recovery may be calculated in units appropriate to the matrix, using the following equation:

$$R = \frac{(C_s - C_b)}{S} \times 100$$

where

R = percent recovery,

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

C_s= fortified sample concentration,
C_b= sample background concentration, and
S = concentration equivalent of the fortified sample.

8.4.3 If the recovery of the analyte in the fortified sample falls outside the designated range, and the laboratory performance on the LFB for the analyte is shown to be in control (Section 8.3) the recovery problem encountered with the fortified sample is judged to be matrix related, not system related.

8.5 Interferences -
Contact with oxygen must be avoided in all stages from sampling to analysis. Consequently, the samples and standards should be protected from air from the time of sampling through coupled plasma spectrometric methods (6,7).the analytical procedure. This can be achieved by deaerating and maintaining the samples under nitrogen or argon at all times.

9. Generation of H2S

9.1 Assemble glassware according to the detection method to be used. The setup in Figure 1 should be followed as a general guide. In all cases a flask or gas washing bottle containing a deoxygenating solution may be placed in the sample train between the nitrogen or argon tank and the first flask. Glassware is specified in Section 4.0. It is recommended that nitrogen or argon be controlled by a flow controller, but an equivalent flow rate may be regulated by a clamp and bubble rate determined. In all cases the glassware will minimally consist of a H_2S generating flask and a series of traps.

9.1.1 Gravimetric method - The first flask contains the sediment sample or standard. The second flask contains 175-200 mL of potassium hydrogen phthalate reagent 5.1.5 as an HCL trap. The third and forth flasks contain 175-200 mL of silver nitrate reagent 5.2.2. If glassware specified in Section 4.0. is used, the second flask is a gas washing bottle and the third and forth flasks are impingers.

9.1.2 Colorimetric method - The first flask contains the sediment sample or standard. The impingers contain 50 mL of 0.5 NaOH reagent.
If the diffusion apparatus is used, 20 to 40 mL 0.5 N NaOH is added to the adsorption reservoir.

9.1.3 Ion-selective method - The first flask contains the sediment sample or standard. The impingers contain an absorbant of 30 mL SAOB reagent 5.3.2 and 20 mL deionized water.

9.2 Fifty milliliters (50 mL) of deionized water are added to the flask that will contain the sediment. The total volume of deionized water plus water contained in the wet sediment sample should not exceed 60 mL to minimize differences in acid concentration among samples. For the computation of the volume of water contained in the wet sediment see Section 11.3. The traps are filled and deaerated by bubbling nitrogen or argon for 10 minutes at a flowrate of 100 cm^3/min. Reduce flow to 40 cm^3/min.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

9.3 Weigh up to 10 g of wet sediment on an analytical balance. Record weight to the nearest milligram. If AVS concentration is high, a smaller amount of sediment may be required; use of sediment samples smaller than 1-2 grams is not recommended due to sulfide oxidation and sample heterogeneity. Use of large sediment samples is not recommended because significant amounts of acid may be neutralized. Place sediment in the flask. Rinsing the sample into the flask is not recommended. Purge the sample for 10 minutes with nitrogen or argon at a flowrate of 40 cm^3/min. Stop flow of gas.

9.4 Using a 30 mL syringe, inject 10 mL of 6M HCl, which has been bubbled with nitrogen or argon gas for 30 minutes, into the reactor. Bubble nitrogen or argon through the evolution and trapping train for 1 hour at a flowrate of 20 cm^3/min while agitating at the same time. If the diffusion apparatus is used, seal, and agitate the diffusion apparatus for I hour.

9.5 Analyze sulfide contained in sulfide trap by the appropriate analytical procedure in Section 10.

10. Analysis of Sulfide

10.1 Gravimetric method

10.1.1 Insure that the final trap, the second silver nitrate trap, contains no precipitate.

10.1.2 Filter the silver sulfide contained in the first sulfide trap through a preweighed 1.2 micron filter. Rinse filter with deionized water. Dry at 103-105°C and weigh.

10.1.3 Calculate the amount of silver sulfide as the difference between the weight of silver sulfide and the filter and the weight of the predried filter.

10.1.4 Calculate the amount of sulfide in the sample:

$$\text{Sulfide in wet sediment (}\mu\text{moles)} = \frac{gAg_2S}{247.8} \times 10^6$$

10.2 Colorimetric method

10.2.1 If the AVS concentration is low so that the sulfide contained in the tube trap is less than 15 µmoles, analyze the adsorption solution directly. Combine the scrubber solution and bring to 100 mL with deionized water. If the sulfide contained in the NaOH exceeds dilute to an appropriate volume with NaOH. An appropriate volume aliquot of this solution is used for the analysis. Use of small sediment samples is not recommended due to sulfide oxidation and sample heterogeneity. Add 1.00 mL MDR and 1.00 mL deionized water to 8.00 mL of adsorption solution or diluted adsorption solution. Mix.

10.2.2 After 30 minutes, but before two hours have elapsed, measure the absorbance of light at 670 nm.

10.2.3 If the abosorbance of the sample is greater than 0.6, dilute 10-fold with 1.0M H_2SO_4

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

and compare to the high range calibration curve.

10.2.4 Normally, the sulfide concentration in the second trap tube is close to the blank value in this procedure and is not significant in calculating the concentration of sulfide and the first impinger solution may be analyzed directly for improved sensitivity. If a significant color is developed, the flow rate and amount of sulfide in the standard or sediment should be checked.

10.2.5 Preparation of calibration curve - The indicated amounts of sulfide are based on a 0.05M concentration of the sulfide stock standard solution. The procedure below may be used to calculate the exact amount of sulfide in each of the standards.

10.2.5.1 Low range calibration curve - 0.0 - 2.5 µmoles S^{2-} (0.0 - 80 µg S^{2-})

Add 80 mL 0.5N sodium hydroxide to each of a series of 100 mL of flasks and add 0.00, 1.00, 2.00, 3.00, 4.00, and 5.00 mL of sulfide working standard A to these flasks. These samples contain 0.00,0.50, 1.00, 1.50, 2.00, and 2.50 µmoles sulfide, respectively, Add 10.0 mL of MDR to each and dilute to 100.00 mL with deionized water. After 30 minutes, measure the absorbance at 670 nm.

10.2.3.2 High range calibration curve - 0.0 - 20.0 µmoles sulfide

(0.0 - 640 µg S^{2-})

Add 80 mL 0.5M sodium hydroxide in 100 mL flasks and add 0.0, 1.0, 2.0, 3.0, and 4.0 mL of sulfide working standard B to these flasks. These samples contain 0.0, 5.00, 10.00, 15.00, and 20.00 µmoles S^{2-}, respectively. Add 10.0 mL of MDR and dilute to 100.00 mL with deionized water. After 30 minutes, dilute the solution 10-fold with 1.0M H_2SO_4, and measure the absorbance at 670nm.

10.2.6 Calculate the amount of sulfide (µmoles) in the sample from the calibration curve. If the total volume of NaOH in the trap was not used in the analysis, account for the portion tested.

10.3 Ion-selective electrode method

10.3.1 Calibrate the sulfide electrode and meter according to manufacturer's recommendations, using sulfide standards prepared in SAOB reagent Section 5.4.2 diluted 1:1 with deionized water.

10.3.2 Transfer the contents of each sulfide trap into a 100-mL volumetric flask. Rinse the trap with deionized water.

10.3.3 Pour contents of volumetric flask into a 150-mL beaker, add a stirring bar and place on stirrer. Begin stirring with minimum agitation to avoid entrainment of are into the solution and minimize oxidation of the sample during the measurement.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

10.3.4 Rinse sulfide and reference electrodes into waste container and blot dry with absorbant tissue. Immerse electrodes in sample solution.

10.3.5 All electrode response to stabilize (8-10 minutes), then take measurement of sulfide concentration. Depending on the meter used, the reading may be directly in concentration units if the meter is in the concentration mode and a 2-point calibration has been performed. If the readings are in millivolts, convert millivolts to concentration using the calibration curve obtained from standard solutions.

10.3.6 Calculate the amount of sulfide (µmoles) in the sample.

11. Calculation of AVS Concentration in Sediments

11.1 The sediment dry weight/wet weight ratio (R) must be determined separately. Acid volatile sulfide can be oxidized or altered to non-volatile forms during drying.

11.2 Transfer an aliquot of the sediment to a tared 100-mL evaporating dish. Weigh the dish plus the wet sediment. Calculate the wet weight of the sample. Dry the sediment at 103-105°C and weigh. Calculate the dry weight of sediment.

11.3 Determine the ratio of dry weight to wet weight for the sediment sample:

$$R = \frac{W_d}{W_w}$$

where: R = ratio of dry weight to wet weight,
W_d = dry weight of sediment sample (g), and
W_s = wet weight of sediment sample (g).

Also, the weight of water, W_{water} taken in a sample of AVS analysis can be calculated. If the weight of the wet sediment sample taken for the AVS analysis is W_{s+w}, the weight of water contained in the sediment sample would be

$$W_{water} = W_{s+w} - ® \times W_{s+w})$$

The volume of water in the sample equals the weight of water, assuming the density is near unity.

11.4 Compare the sulfide concentration per gram dry weight of sediment:

$$\text{AVS } (\mu\text{moles/g}) = \frac{S}{R \times W_w}$$

Where: S = the amount of AVS in sediment (µmoles) from Section 10.1.4, 10.2.6, or 10.3.6, as appropriate,
R = ratio of dry weight to wet weight from section 11.3, and

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

W_w = wet weight of sediment (g) taken for AVS analysis.

11.5 The QC data obtained during the analysis provides an indication of the quality of the sample data and should be provided with the sample results.

12. Determination of Simultaneously Extracted Metals (SEM)

12.1 After the generation of sulfide has been completed, verify that the pH has remained below 2. Filter the sediment suspension remaining in the H_sS generation flask through a 0.2 µ membrane filter resistant to attack by acid. The filtering apparatus should be soaked in 0.1M HNO3, then rinsed with deionized water prior to use.

12.2 Transfer the filtrate to a polyethylene or teflon container. Samples should be analyzed within 2 weeks.

12.3 Determine the concentrations of metals of interest using appropriate atomic spectrometric methods. Metals which may typically be included in SEM are cadmium, copper, lead, mercury, nickel and zinc.

[Optionally add those elements which, on a molar basis, are present at more than 1 percent of the AVS concentration. Do not include iron and manganese whose sulfides are less stable than are the sulfides of many trace metals . In addition, antimony bismuth and chromium, among others, form insoluble sulfides. If significant concentrations of these or other metals forming insoluble sulfides are present, their concentrations should be taken into account in the computation of SEM. However, if these or other metals which are not divalent are present in significant concentrations, the computation in Section 12.5 may need to be modified to account for the stoichiometry.]

Convert µg/L concentration values to µmoles/L. Multiply the µmoles/L by the solution volume to obtain the µmoles of metal.

12.4 Report the concentrations of each of the metals in the sediment on a µmole per gram dry sediment (µmoles/g) basis.

12.5 Optionally Calculate the ratio of SEM to AVS:

$$\frac{SEM}{AVS} = \frac{\Sigma[metal]}{AVS}$$

where: SEM is the sum of the concentrations of metals, Σ[Metal], for the metals (e.g., cadmium, copper, lead, mercury, nickel and zinc) in Section 12.4 and AVS is the acid volatile sulfide concentration determined in Section 11.4.

Both SEM and AVS are expressed on a (µmoles/g) basis. Because metals present in the pore will be included in the analysis, the ratio could be less than that if correction were made for this contribution. This will lead to a conservative estimation of potential bioavilability (1).

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

13.0 Corrective Actions

13.1 Data Qualification

In the event that a QC element is outside acceptance limits, it may be necessary to qualify data using the appropriate qualification code and explanation. Qualification of sample data is dependent upon the needs of each particular client, and may not always be appropriate. IS outside limits - qualify associated sample result as estimated(J).

ICV/CCV outside limits - qualify associated sample result as estimated(J).

ICB/CCB outside limits - qualify associated sample results less than five times the as affected (B).

LCS/LCSD outside limits - qualify associated samples result as estimated (J).

MS/MSD outside limits - qualify spiked sample result as estimated (J).

Sample Duplicate outside limits - qualify sample result as estimated (J).

14.0 Health and Safety

14.1 As with all samples, gloves and safety glasses should be worn when handling samples and chemicals. It is advisable to wear a lab coat to protect clothing.

14.2 Analysts should familiarize themselves with any chemical substances which are named along with their corresponding MSDS sheets.

15.0 Responsibilities

15.1 It is the Lab Manager's responsibility to ensure analysts performing this procedure are properly trained and the training is documented in their training file. The analyst is responsible for following the procedures outlined in this SOP.

15.2 Prior to any staff member working unsupervised on a testing procedure, they must be certified by the Laboratory Manager. Certification will include reading this and associated SOPs, review of the primary literature and participation in similar procedures under the direct supervision of a trained staff member. Certification will be based upon a review of the persons' demonstrated abilities.

16.0 Pollution Prevention

Minimize reagent use. Prepare reagents in amounts that will be used before expiration. Dispose of

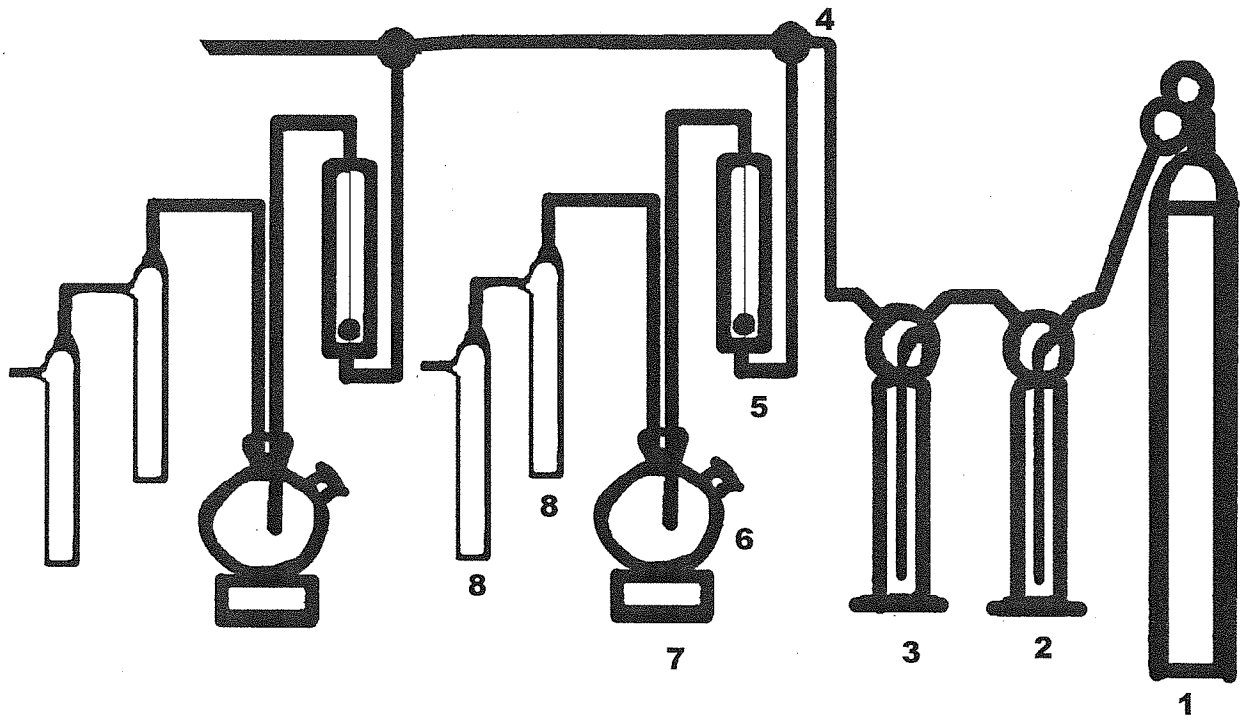
This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

samples, reagents, and wastes in accordance with ESI policy and state and federal regulation.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

17. Figures

Figure 1. Evolution and Trapping Train for AVS Determinations



Notes:

1. Nitrogen or Argon Gas Cylinder
2. Gas Washing Bottle, oxygen scrubbing solution or oxygen trap
3. Gas Washing Bottle, Deionized Water
4. Three-way valve
5. Flow Controller
6. Reaction Flask
7. Magnetic Stirrer
8. Impingers

Drawing from US EPA -821-R-91-100, modified

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry

Approved By:

QA Officer: Megan Scott (LCB) Date: 11/4/10

President: Date: 11/20/10

Revision History:

Revision Number	Changes	Revised By	Date
0	Preparation of SOP	M. Folsom	10/06
1	Review and Update	M. Scott	12/09

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry

1.0 Purpose and Applicability

This method is for the determination of mercury (Hg) in water by cold vapor atomic fluorescence spectrometry. It is applicable to drinking water, surface and ground waters, marine water, industrial and municipal wastewater, aqueous samples, ranging from marine water to effluent.

The samples are processed by treatment with a Bromate/Bromide solution followed by a Hydroxylamine solution just prior to analysis. The mercury levels are determined by running the samples through a PSA mercury fluorescence system and then evaluated against calibration and quality control samples. This method is used with a range of 10ng/L to 150ng/L. Samples are acid preserved to a pH<2 and have a holding time of 28 days.

2.0 Definitions

3.0 Applicable Documents/References

Method 245.7 Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry. Revision 2.0 February 2005. EPA-821-R-05-001.

4.0 Materials and Apparatus

4.1

CVAFS System
40mL glass vials
Milli Q
Adjustable pipettes
Volumetric Flasks
Air - low in particulate and gaseous mercury
Argon Gas - high purity (99.998%)
Hydrochloric Acid
Sulfuric Acid
Potassium Bromate
Potassium Bromide
Hydroxylamine Hydrochloride
Stannous Chloride
Stock Mercury Standard - 1,000ppm NIST traceable.
Secondary Mercury Standard- 1.000ppm NIST traceable

4.2 Reagent and Standard Preparation

4.2.1 Hydrochloric Acid Solution - add concentrated HCl to Milli-Q in a 1:1 ratio. Prepare as needed.

4.2.2 Hydroxylamine Solution - Dissolve 2.4g of Hydroxylamine Hydrochloride in 20mL of Milli Q. Prepare weekly.

4.2.3 Sulfuric Acid Solution - add 100mL of concentrated sulfuric acid to Milli-Q for a final

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

volume of 4L. Prepare as needed.

4.2.4 Stannous Chloride Solution - Dissolve 20.0g of stannous chloride into 2L of the Sulfuric acid solution or dissolve into 2L of Milli-Q with 20mL of concentrated HCl. Prepare before each analytical session.

4.2.5 Bromate/Bromide Solution - Dissolve .167g of Potassium Bromate and .714g of Potassium Bromide in 30mL of Milli-Q. Prepare as needed.

4.2.6 Mercury Standard - Add about 50mL of Milli-Q, .5mL of the Bromate/Bromide solution, and .25mL of the HCl solution to a 100mL volumetric flask. Add .100mL of the stock mercury standard and dilute to 100mL. Transfer to a glass bottle, this standard contains 1.00mg/L. Stable until expiration date given for stock mercury standard.

4.2.7 Check Mercury Standard - Add about 50mL of Milli-Q, .5mL of the Bromate/Bromide solution, and .25mL of the HCl solution to a 100mL volumetric flask. Add .100mL of the secondary mercury standard and dilute to 100mL. Transfer to a glass bottle, this standard contains 1.00mg/L. Stable until expiration date given for stock mercury standard.

4.2.8 Working Mercury Standard - Dilute .2mL of the Mercury standard to 100mL in a volumetric flask with Milli Q. This solution contains 2000ng/L and should be made new with each use.

4.2.9 ICV Mercury Standard - Dilute .2mL of the Check Mercury standard to 100mL in a volumetric flask with Milli Q. This solution contains 2000ng/L and should be made new with each use.

5.0 Methods/Procedures

5.1 Sample Preparation

Mercury samples are to be collected in 40mL glass or fluoropolymer vials with fluoroploymer lined caps and preserved with concentrated HCl (5mL/L).

Samples are prepared by first treating 40mL vials with 2.25mL of HCl Solution and .45mL of the Bromate/Bromide solution (a dark yellow color should result). Then 20mL of each sample is transfered into a treated 40mL vial. The sample should be shaken and allow to digest for at least 30 minutes. If the yellow color does not remain more Bromate/Bromide should be added until a permanent yellow color is obtained.

After the samples are allowed to digest the caps are removed and 25uL of the Hydroxylamine solution is added to each vial, recapped swirled occasionally over a 5 minute period. The addition of the Hydroxylamine should cause the yellow color to disappear. The hydroxylamine should be added at a time the coincides with the start of sample analysis.

5.2 Calibration Preparation

The curve, ICV, ICB, CCV, and CCB are prepared at the same time and in the same manner as the samples. The curve points are 10, 25,50,100,150ng/L. The ICV and CCV are prepared at 25ng/L. The CCB and ICB consist of 20mL of Milli-Q added to the pretreated vials. The following amounts of the Working Mercury Standard are brought to a final volume of 20mL in pill cups before being added to the pretreated 40mL vials.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

Concentration (ng/L)	Volume added (mL)	Std. Source
10	.100	Working Hg Std.
25	.250	Working Hg Std.
50	.500	Working Hg Std.
100	1.00	Working Hg Std.
150	1.50	Working Hg Std.
CCV25	.250	Working Hg Std.
ICV25	.250	ICV Hg Std.

The curve, ICV, ICB, CCV, and CCB are also allowed to digest for at least 30 minutes and then have 25uL of hydroxylamine solution added to them just prior to analysis.

5.3 Instrument Operation
Turn on the CVAFS system, air, and argon. Set the Argon to 350 cc/mn, the air to 2.5 L/mn, and the flow valve to .8 L/mn. Allow the instrument to warm up for 20 minutes with Milli-Q running through the reagent and sample lines. When ready to begin analysis place the reagent line in the Stannous Chloride solution and the sample line into the Sulfuric Acid solution and allow to flow through.

Analyze an instrument blank to verify no contamination is present, then run the curve, ICV, ICB. If the curve and initial calibration standards are acceptable proceed with batch analysis with CCV's and CCB's being run every 10 samples. The sample line is to be in the sample when the program is during its "rise" and "analysis" cycles and in the sulfuric acid solution at all other times.

When ready to shut down allow water to flush through the lines for at least 10 minutes. Then shut off the argon, air, and CVAFS system.

6.0 Quality Control Requirements

6.1 Detection Limit
The detection limit of this method is 10.0ng/L with an MDL of 4.0ng/L that is verified annually through an MDL study.

6.2 Interferences
Gold, silver, and iodine are known interferences. The bromate/bromide digestion reagent overcomes many chloride, sulfide, and molecular absorption interferences.

6.3 Quality Control Requirements

6.3.1 Calibration Curve -

The calibration curve must contain at least 5 non-zero points, result in a %RSD of less than or equal to 15% and the % recovery of the low point in the curve must lie in the

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

range of 75 - 125%. If these criteria are not met the curve must be redone.

6.3.2 ICV/ICB-

The ICV must be ±15% of the true value and the ICB must be below the detection limit. An ICV and ICB must be run after the curve and before samples during analysis.

6.3.3 CCV/CCB and PB/LCS-

All CCV's and LCS's must have a % recovery between 76 - 113%R. All CCB's and PB's must be below the detection limit. Prep Blanks and Laboratory Control Samples must be prepared for every batch of no more than 20 samples. CCV's and CCB's are run every ten samples during analysis and at the end of an analytical session. CCV's and LCS's are prepared at 25ng/L with the Working Mercury Standard.

6.3.4 MS/MSD-

Matrix Spikes and Matrix Spike Duplicates are prepared every ten samples and are spiked at 25ng/L with the Working Mercury Standard. MS/MSD's must have a % recovery of 63 - 111% and a relative percent difference (RPD) less than or equal to 18%.

7.0 Calculations/Reporting

The signal datum provided by the CVAFS system is entered into the Standard Curves program. An appropriate model for the curve is chosen and the entire run is entered under "samples" including any dilutions used. This program converts the signal to an answer in ng/L and then the results can be entered into BigDB or QCDB in ug/L. The curve and samples pages are printed from Standard Curves and kept on file along with being saved on the L drive.

All results are reported to two significant figures.

8.0 Corrective Actions

8.1 If the curve, ICV, or ICB does not meet acceptance criteria then sample analysis may not commence until the problem is identified and reanalysis or redigestion results in acceptance.

8.2 If a CCV or CCB fails all samples run prior must be reanalyzed until an acceptable CCV and CCB are obtained.

8.3 If a prep blank does not pass acceptance criteria either redigestion of the entire batch or qualification of samples with a B must occur. Samples need only be qualified with a B if the result is less than 5 times of the value observed in the blank.

8.4 If an LCS does not pass acceptance criteria redigestion of the entire batch or qualification of the entire batch with a J must occur.

8.5 If a MS/MSD does not pass acceptance criteria then that sample must be qualified with a J. Redigestion of the entire batch is not necessary.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

9.0 Health and Safety

Only analysts and technicians who are qualified and experienced with this method may perform this procedure. Gloves should be worn during the handling of any samples or chemicals. Analysts are advised to wear goggles and a lab coat during sample preparation and analysis. Each analyst should familiarize themselves with the reagents and standards used in this analysis. MSDS sheets are available, in the 2nd floor main hallway, for all reagents used in analysis.

Acids are corrosive and should be used with due caution, under a fume hood.
Mercury is very toxic and should be used with extreme care and at the lowest possible concentrations.

10.0 Waste Management

Samples and reagents are disposed of in the dilute metals and acids wastes containers. These containers must be properly labeled. It is the responsibility of the analyst to ensure that all waste is disposed of according to ESI protocol, as well as state and federal law.

11.0 Responsibilities

11.1 It is the Analytical Technical Director's responsibility to ensure analysts performing this procedure are properly trained and the training is documented in their training file. The analyst is responsible for following the procedures outlined in this SOP.

11.2 Prior to any staff member working unsupervised on a testing procedure, they must be certified by the Laboratory Manager. Certification will include reading this and associated SOPs, review of the primary literature and participation in similar procedures under the direct supervision of a trained staff member. Certification will be based upon a review of the analyst's demonstrated abilities.

12.0 Pollution Prevention

Minimize reagent use. Prepare reagents in amounts that will be used before expiration. Dispose of samples, reagents, and wastes in accordance with ESI policy and state and federal regulation.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Determination of Trace Metals by ICP-MS Analysis

Approved By:

Technical Director: _____ Date: 11/11/10

QA Officer: Megan Scott (LCB) Date: 11/11/10

Revision History:

Revision Number	Changes	Revised By	Date
0	Draft Preparation	RDF	11/07
1	Edits and Revisions	DAS	12/07
2	Edit	MES	05/08
3	Review and update	M. Scott	12/09

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Determination of Trace Metals by ICP-MS Analysis

1.0 Purpose and Applicability

This SOP describes the method for determining concentrations of trace metals in aqueous or extracted samples; calcium and magnesium concentrations are determined for the calculation of hardness values (See SOP QA-1309: Hardness by Calculation).

Inductively Coupled Plasma (ICP-MS) instrumentation is used to determine the concentration of trace metals, *METHOD 200.8 DETERMINATION OF TRACE ELEMENTS IN WATERS AND WASTES BY INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY Revision 5.4 EMMC Version.* The applicable range for this method varies by element, and is responsive to the requirements of the method and regulatory agencies.

Samples are preserved to pH <2.0 with HNO_3, and held at ambient temperature until analysis. Sample holding time is 180 days. Samples may be digested prior to analysis (See SOP QA-1323: Trace Metals Sample Preparation). The ICP makes multi-element determinations by measuring the electron multiplier ion intensities at characteristic atomic masses. The characteristic atomic masses are passed by a mass spectrometer sampling an argon plasma. Samples are aerosolized and applied to the plasma torch. Sample intensity is evaluated against both linear calibrations and quality control samples.

2.0 Definitions

2.1 Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument and the analytical calibration curve (Section 7.6.1).

2.2 Calibration Standard (CAL) - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration (Section 7.4).

2.3 Dissolved Analyte - The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification (Section 11.1).

2.4 Field Reagent Blank (FRB) - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if method analytes or other interferences are present in the field environment .

2.5 Instrument Detection Limit (IDL) - The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of 7 replicate measurements of the calibration blank signal at the selected analytical masses.

2.6 Internal Standard - Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

is not a sample component .

2.7 Laboratory Duplicates (LD1 and LD2) - Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

2.8 Laboratory Fortified Blank (LFB) - An aliquot of LRB to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements

2.9 Laboratory Fortified Sample Matrix (LFM) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations .

2.10 Laboratory Reagent Blank (LRB) - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, reagents, apparatus or other parts of the sample preparation procedure.

2.11 Linear Dynamic Range (LDR) - The concentration range over which an analyte's relative response is within 10% of the initial calibration concentration .

2.12 Quality Control Sample (QCS) - A solution of method analytes of known concentrations which is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.

2.13 Solid Sample - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

2.14 Stock Standard Solution - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

2.15 Total Recoverable Analyte - The concentration of analyte determined either by "direct analysis" of an unfiltered acid preserved drinking water sample with turbidity of <1 NTU , or by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method .

2.16 Tuning Solution - A solution which is used to determine acceptable instrument performance prior to calibration and sample analyses .

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

2.17 Water Sample - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

2.18 LCS - Laboratory Control Sample, also called a laboratory fortified blank, is prepared by fortifying an aliquot of the laboratory reagent blank with all analytes to a suitable concentration. The LCS must be carried through the same entire preparation scheme as the samples. Calibration standards or a pre-made mixture of analytes from a second source may be used to make the LCS.

2.19 LCSD - Laboratory Control Sample Duplicate, the LCS run as a duplicate sample using the same preparation as the LCS.

2.20 Prep Blank - Shall be performed at a frequency of one per batch of samples (20) per matrix per sample extraction or preparation method. The results of this analysis shall be one of the QC measures to be used to assess batch acceptance. The method blank is a solution of 5% Nitric acid in Milli-Q® water and carried through all preparation procedures.

2.21 Method Detection Limit (MDL) - MDL's must be established for each element using reagent water fortified at a concentration of one to three times the estimated instrument detection limit. To determine MDL values, seven replicate aliquots of the fortified reagent water are processed through the entire analytical method.Calculate MDL using the following equation:

MDL = 3.14 X (Standard Deviation of 7 replicates)

2.22 Matrix Spike (MS) - An aliquot of a 'real world' sample fortified with a known concentration of analytes. Matrix spikes must be carried through the same preparation steps as the rest of the laboratory samples.

2.23 Matrix Spike Duplicate (MSD) - MS duplicate that is prepared and run with an identical procedure, but analyzed separately.

2.24 Instrument Calibration Verification (ICV) - Instrument checks must be analyzed to verify instrument performance. The ICV must be obtained from an outside source different from the standard stock solutions and prepared in the same acid mixture as the calibration standards. The ICV is prepared at the same concentration as the Calibration Slope Standard.

2.25 Protocol Required Reporting Limit (PRRL) Solution. Laboratory reagent water fortified with analyte a the reporting limit. Required for some protocols.

3.0 Applicable Documents/References

Agilent 7500 ICP-MS Operator's Manual and Hardware manual

200.8 Determination of trace elements in waters and wastes by inductively coupled plasma - mass spectrometry 1994.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Determination of Trace Metals by ICP-MS Analysis

Method 6020 *Inductively Coupled plasma Mass Spectrometry*. 1996.

SOP QA-1323: Trace Metals Sample Preparation

SOP QA-1324: Preparation of Glassware for Trace Metals Analysis

4.0 Materials and Apparatus

4.1 Agilent 7500 series Inductively Coupled Plasma Mass Spectrometer with Autosampler, data station.

4.2 Reagents and Standards

Hydrochloric Acid, Concentrated (~35%), Ultra-High Purtiy Grade

Nitric Acid, Concentrated (~70%), Ultra-High Purity Grade

Commercially Available Single- or Multi-Element Standards, in both "high" and "low" concentrations, or Ultra-High Purity Compounds

Argon Gas, High Purity (99.9998%)

Reagent water 18Mohm free or analytes at levels of concern (0.001-50ug/L)

4.3. Equipment

Polyethylene or Teflon autosampler vials.

Class A - Volumetric Glassware

Adjustable Volumetric Pipettes

Autosampler Racks capable of holding vials

5.0 Methods/Procedures

5.1. Preparation of Reagents

5.1.1 All stock multi-element Standards, HNO3 / HCl solutions, and other procedural standards are numbered and recorded in a Metals Standard Log Book. Subsequently, each lot of prepared solution is assigned a reference number (e.g. M-XXX). Unless prepared for immediate use and consumption, containers of prepared solution must be identified with solution name and expiration date. Solutions are

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

stored at ambient temperature when not in use; solutions must be used in advance of their expiration dates.

5.1.2 Reagent Milli-Q® water is used in the preparation of all trace metals reagents and standards and also as rinse water, unless indicated below.

5.1.3 Trace Metals standards are prepared most frequently from commercially available standard solutions, in either single or multi-element concentrations. Standards are diluted using Milli-Q® water, 20% HCl/ 20% HNO_3 Solution and volumetric glassware, to achieve the desired concentrations. Standards are stored at ambient temperature away from sources of light, and prepared daily with instrument use.

5.1.4 1% HCl/ 1% HNO_3 Solution

A 1% HCl/ 1% HNO_3 Solution is used as the initial and continuing calibration blanks and is prepared daily.

The 1% HCl/ 1% HNO_3 Solution is prepared by adding 36mL of HNO3 and 71mL of HCl to 2L of Milli-Q then bringing to a final volume of 2.5 L.

5.1.5 20% HCl/ 20% HNO_3 Solution

A 20% HCl/ 20% HNO_3 Solution is used in the preparation of CCV, ICV, and CCB/ICB solutions.

The 20% HCl/ 20% HNO_3 Solution is prepared by mixing 333.33mL of HN03 with 666.66mL of HCl in a glass container.

5.2 ICP Instrumentation Preparation and Operating conditions:

The manufacturer's Operation Manual should be consulted for equipment specifics.

5.3. System Start Up

5.3.1 Ensure that the cooling fan is on. Check the outside of the fan's grate cover to ensure that the fan is running. Do not attempt to start the system up unless the cooling fan is running.

5.3.2 Turn on the water recirculator.

5.3.3 Start the plasma, using system software.

5.3.3.1 Monitor system meters that indicate problems with the pump, gas, etc.

5.3.4 Ensure that all tubing lines are properly connected. Check the tension on the peristaltic pump; sample should be flowing continuously into and out of the nebulizer.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

Observe tubes for flow.

5.3.5 Select target elements and set up instrument acquisition an Quantitation parameters in the system software according to manufacture's recommendations and based on the needs of the analytical session.

5.4 Instrument Calibration

Pre-calibration routine - The following pre-calibration routine must be completed prior to calibrating the instrument until such time it can be documented with periodic performance data that the instrument meets the criteria listed below without daily tuning.

5.4.1 Initiate proper operating configuration of instrument and data system. Allow a period of about 30 minutes for the instrument to warm up, or until the spray chamber cooler temperature reaches 2+/- 1C. During this process conduct mass calibration and resolution checks using the tuning solution. Resolution at low mass is indicated by magnesium isotopes 24, 25, and 26. Resolution at high mass is indicated by lead isotopes 206, 207, and 208. For high quality performance adjust spectrometer resolution to produce a peak width of approximately 0.75 amu at 5% peak height. Adjust mass calibration if it has shifted by more than 0.1 amu from unit mass for any of the tune elements.

5.4.2 Instrument stability must be demonstrated by running the tuning solution a minimum of five times with resulting relative standard deviations of absolute signals for all analytes of less than 5%.

5.4.3 Internal Standardization

Internal standardization must be used in all analyses to correct for instrument drift and physical interferences. A list of acceptable internal standards is provided in Table 3. For full mass range scans, a minimum of three internal standards must be used. Procedures described in this method for general application, detail the use of five internal standards; scandium, yttrium, indium, terbium and bismuth. These were used to generate the precision and recovery data attached to this method. Internal standards must be present in all samples, standards and blanks at identical levels. This may be achieved by directly adding an aliquot of the internal standards to the CAL standard, blank or sample solution (Method A, Section 5.4.3), or alternatively by mixing with the solution prior to nebulization using a second channel of the peristaltic pump and a mixing coil (Method B, Section 5.4.3). The concentration of the internal standard should be sufficiently high so that good precision is obtained in the measurement of the isotope used for data correction and in order to minimize the possibility of correction errors if the internal standard is naturally present in the sample. Depending on the sensitivity of the instrument, a concentration range of 20-200 ug/L of each internal standard is recommended. Internal standards should be added to blanks, samples and standards in a like manner so that dilution effects resulting from the addition may be disregarded.

5.4.1 Standards are prepared. The CCV, CCB, ICV and ICB standards are placed into the

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

appropriate plastic bottles and placed in the autosampler area.

5.4.2 Aspirate tuning solution. Verify that mass assignment and stability tuning criteria are met.

5.4.3 Aspirate a blank sample to set instrument intercept.

5.4.4 Aspirate a medium level standard to set instrument slope.

5.4.5 Aspirate the ICV check solution. Determine if the ICV meets criteria.

5.4.6 Aspirate the ICB check solution. Determine if the ICB meets criteria.

5.4.7 Analyze ten samples. If quality control criteria do not meet acceptance criteria re-analyze affected samples for affected analyte.

5.4.8 The ICV and ICB must be done at the start of each analytical session. A CCV and CCB must be run at the beginning and end of every 10 samples. If either the beginning or ending CCV/CCB pairs fails to meet pass/fail criteria, the sample data must be re-analyzed.

5.4.9 If the field program requires it analyze, a Reporting Limit solution (standard at one to four times the reporting limit). Verify that results are within the program acceptance criteria.

5.5 Sample Analysis

5.5.1 Samples for Trace Metals analysis are digested prior to their ICP analysis. See SOP QA-1323 "Sample Preparation: Trace Metals Digestion" for instruction.

5.5.2 Place samples in the autosampler and verify correct entry int the ICP-MS software system sequence table.

5.5.3 Initiate sample analysis.

5.6 Shut Down

5.6.1 The ICP may be shut down manually through the Instrument Operation panel or automated through system sequence table programming.

5.6.2 When the water circulator is cool it may be shut down.

5.6.3 Turn off the exhaust fan.

5.6.4 Unload tension from peristaltic pump tubing.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

6.0 Quality Control Requirements

6.1 Sample Acceptance

Samples received for trace metals analysis must be collected in plastic disposable 250 - 500mL bottles, preserved with HNO_3 to pH <2.0, stored at ambient temperature, and analyzed within 180 days of sampling.

6.2 QC Acceptance Criteria

6.2.2 Instrument Quality Control

6.2.2.1 Tune Check - Every day the instrument is used the tune check solution must be analyzed, peak assignment must be verified within 1.0 amu, and an RSD of five replicate measurements verified to be < 5%.

6.2.2.1 Linear Range Verification - Perform annually or with changes to the instrument. Standards over the desired ranger or to be analyzed and verified to a response 90 to110% that of calibration.

6.2.2.2 Initial Calibration Verification- An Initial Calibration Verification (ICV) sample is analyzed at each analytical session after updating the intercept and the slope, and before any samples have been analyzed. Verify that results are 90-110% of reference values.

The ICV is followed immediately by an Initial Calibration Blank, (ICB) consisting of 1% HCl/ 1% HNO_3 Solution. The value of the ICB should be no higher than the 2.2 times the IDL or less than one tenth of the reported values.

6.2.2.3 Continuing Calibration Verification - Continuing Calibration Verification (CCV) samples are analyzed after every ten samples. Verify that results are 90-110% of reference values. The CCV is followed immediately by an Continuing Calibration Blank, (CCB) consisting of 1%+1% HNO_3/HCl Solution. The value of the ICB should be no higher than the 2.2 times the IDL or less than one tenth of the reported values.

The system calibration may be updated with the CCV and CCB, provided that they are followed by a CCV and a CCB re-analysis. CCV results must fall within 90-110% of reference values and that the CCB should be no higher than the 2.2 times the IDL or less than one tenth of the reported values.

6.2.2.4 Reporting Limit (RL) Standard - A standard corresponding to the reporting limit is analyzed with each analytical batch. Results should meet the established acceptance criteria.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

6.2.2.4 Internal Standard Response - Internal standard response is evaluated for each sample. Acceptance criteria are 60-125% of the response for the preceding CCB.

6.2.3 Laboratory Quality Control

6.2.3.1 Laboratory Blanks - Laboratory Prep blanks prepared from Milli-Q® water are digested and analyzed with every twenty samples. If an analyte is detected in a prep blank, the data associated with the affected blank maybe used only with qualification unless the analyte result is not detected or it is ten or more times greater than the blank value detected.

6.2.2.3 Laboratory Control Samples - LCS or LCS/LCSD pairs are prepared from a commercial multi-element standard and diluted with Milli-Q®. 100 µL of "low concentration" standard is diluted with Milli-Q® water, and digested prior to analysis. LCS or LCS/LCSD pairs are analyzed with every twenty samples.

Acceptance criteria for the LCS or LCSD are 70-130% of the blank adjusted target value and less than or equal to 30% RelativePercent Difference (RPD).

6.2.3.2 Sample Duplicates and Spikes - Sample duplicates are analyzed with every twenty samples. A representative sample is selected for duplicate analysis. The RPD between the sample and its duplicate must not exceed 30%. The RPD need not be evaluated when one or both results are less than five times greater than the IDL.

A sample is spiked and analyzed with every twenty samples. Spikes are prepared by adding a volume of "low concentration" multi-element standard to a representative sample; the sample is digested prior to analysis. Recovery of the spiking compound must be within 70-130% of the sample corrected target value. Recovery need not be evaluated when the sample concentration exceeds spike value by a factor of $\geq$5.

6.3 Method Detection Limits

6.3.1 Method detection limit studies are conducted annually and are also conducted upon changes in method, equipment, or analyst.

6.4 Interferences

6.4.1 Samples submitted for boron or silica analysis should be prepared, stored and analyzed in plastic, PTFE or quartz vessels, from sample collection to the completion of sample analysis.

6.4.2 Background Intensities may be minimized by sample dilution.

6.4.3 Interelement Corrections are set in the system software in compliance with EPA 200.8

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

7.0 Calculations/Reporting

7.1 Data Review

Once the analytical session is complete, the data is reviewed by the analyst to ensure that the data is accurate, and that all quality control elements have been evaluated.

Evaluate tune for the day.

Evaluate ICV, ICB for the analytical session.

Evaluate CCV, CCB, and IS response for each instrument sample.

Evaluate PB, LCS, duplicate and spike for each laboratory sample.

7.2 Data Export

Once the data have been reviewed, the analytical session is exported to the LIMS system. The quality control data are entered into the Quality Control database . The sample data are entered into sample results database.

7.3 Example Reports

RESERVED

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

TITLE: Determination of Trace Metals by ICP-MS Analysis

Tune Report
Tune File : nogas.u
Comment :

m/z	Range	Count	Mean	RSD%	Background
7	100,000	51233.0	51132.7	2.01	1.10
89	100,000	65884.0	68790.7	2.02	0.30
205	100,000	63290.0	62895.8	1.52	1.40

Integration Time: 0.1000 sec
Sampling Period: 0.3100 sec
n: 50
Oxide: 156/140 8.112%
Doubly Charged: 70/140 4.882%

Resolution/Axis

m/z:	7	89	205
Height:	51,256	69,898	62,932
Axis:	7.00	89.00	204.95
W-50%:	0.70	0.65	0.55
W-10%:	0.7500	0.700	0.700

Integration Time: 0.1000 sec
Acquisition Time: 22.7600 sec

===Plasma Condition===		===Ion Lenses===		===Q-Pole Parameters===	
RF Power :	1480 W	Extract 1 :	5.4 V	AMU Gain :	130
RF Matching :	1.74 V	Extract 2 :	-102.5 V	AMU Offset :	124
Smpl Depth :	7.2 mm	Omega Bias-ce :	-26 V	Axis Gain :	0.9997
Torch-H :	-0.6 mm	Omega Lens-ce :	-1.2 V	Axis Offset :	-0.01
Torch-V :	-0.3 mm	Cell Entrance :	-44 V	QP Bias :	-3 V
Carrier Gas :	1 L/min	QP Focus :	3 V		
Makeup Gas :	0.15 L/min	Cell Exit :	-70 V	===Detector Parameters===	
Optional Gas :	--- %			Discriminator :	8 mV
Nebulizer Pump :	0.1 rps	===Octopole Parameters===		Analog HV :	1650 V
Sample Pump :	--- rps	OctP RF :	150 V	Pulse HV :	1050 V
S/C Temp :	2 degC	OctP Bias :	-6 V		

===Reaction Cell===
Reaction Mode : ON
H2 Gas : 0 mL/min He Gas : 0 mL/min Optional Gas : --- %
Generated : Dec 03, 2007 09:09:54
Printed : Dec 03, 2007 09:09:57

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

8.0 Corrective Actions

8.1 Data Qualification

In the event that a QC element is outside acceptance limits, it may be necessary to qualify data using the appropriate qualification code and explanation. Qualification of sample data is dependent upon the needs of each particular client, and may not always be appropriate.

IS outside limits - qualify associated sample result as estimated(J).

ICV/CCV outside limits - qualify associated sample result as estimated(J).

ICB/CCB outside limits - qualify associated sample results less than five times the as affected (B).

LCS/LCSD outside limits - qualify associated samples result as estimated (J).

MS/MSD outside limits - qualify spiked sample result as estimated (J).

Sample Duplicate outside limits - qualify sample result as estimated (J).

8.2 Troubleshooting

8.2.1 Detailed instrument troubleshooting procedures may be found in the manufacturer's maunuals. In the event that calibrations or QC sample results are outside acceptance criteria, the following contingency is followed, in the order listed:

(a) Prepare new QC samples.

(b) Check to ensure the instrument is peaked properly.

(c) Update the CCB (intercept) and CCV (slope).

(d) Check to tubing to ensure that all connections are correct and that sample is flowing throughout the system.

(e) Check the tension on the pump: flow should be 0.1-0.4 mL/minute.

(f) Check the Autosampler probe and tubing.

9.0 Health and Safety

Only analysts and technicians who are qualified and experienced with this method may perform this procedure. Gloves and goggles should be worn during the handling of any samples or chemicals. Analysts are advised to wear goggles and a lab coat during sample preparation and analysis. Each analyst should familiarize themselves with the reagents and standards used in this analysis. MSDS sheets are available for all reagents used in analysis.

Acids are corrosive and should be used with due caution, under a fume hood.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.

10.0 Waste Management

Samples and reagents are disposed of in the dilute metals and acids wastes containers. These containers must be properly labeled. It is the responsibility of the analyst to ensure that all waste is disposed of according to ESI protocol, as well as state and federal law.

11.0 Responsibilities

11.1 It is the Analytical Technical Director's responsibility to ensure analysts performing this procedure are properly trained and the training is documented in their training file. The analyst is responsible for following the procedures outlined in this SOP.

11.2 Prior to any staff member working unsupervised on a testing procedure, they must be certified by the Laboratory Manager. Certification will include reading this and associated SOPs, review of the primary literature, and participation in similar procedures under the direct supervision of a trained staff member. Certification will be based upon a review of the analyst's demonstrated abilities.

12.0 Pollution Prevention

Minimize reagent use. Prepare reagents in amounts that will be used before expiration. Dispose of samples, reagents, and wastes in accordance with ESI policy and state and federal regulation.

This document is the property of EnviroSystems, Incorporated. All information contained herein is confidential. No parts may be used or distributed without Permission of EnviroSystems, Incorporated.