1765373

Uniform Federal Policy
Quality Assurance Project Plan
For
Remedial Investigation at
Colorado Smelter

Pueblo, Pueblo County, Colorado

November 11, 2015

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ACRONYMS

As	Arsenic
AutoCAD	Automated Computer Aided Design/Drafting
bgs	below ground surface
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act
CF & I	Colorado Fuel and Iron
CLP	Contract Laboratory Program
COC	chain of custody (based on the context in which the acronym is used)
COPC	contaminant of potential concern
CPSA	Community Properties Study Area
CRQL	Contract Required Quantitation Limits
CSM	conceptual site model
CSU	Colorado State University
DMA	demonstration of methods applicability
DQI	data quality indicator
DQO	data quality objective
DU	decision unit
E2	E2 Consulting Engineers Inc.
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GIS	geographic information system
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHRA	human health risk assessment
HASP	Health and Safety Plan
ICP-MS	Inductively coupled plasma-mass spectrometry
ICS	incremental composite sampling
ID	identification number
IDW	Investigation-Derived Waste
IVBA	In-Vitro Bioavailability
LCS	laboratory control sample
MDL	method detection limit
mg/kg	milligrams per kilogram
MPC	measurement performance criteria
MS/MSD	matrix spike/matrix spike duplicate
NA	not applicable
ng/Kg	nanograms per kilogram
NPL	National Priorities List
NS	not specified
OSHA	Occupational Safety and Health Administration
OSRTI	Office of Superfund Remediation and Technology Innovation
Pb	Lead
ppm	parts per million
PQL	practical quantitation limit
PQO	project quality objectives
PWT	Pacific Western Technologies, Ltd.
QA	quality assurance
QAO	Quality Assurance Officer
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
RAC2	Remedial Action Contract 2
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act

RI	Remedial Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	regional screening levels
Scribe	USEPA’s software tool used to assist in the process of managing environmental data
SEDD	Staged Electronic Data Deliverable
SOP	standard operating procedure
SOW	statement of work
TAT	turnaround times (depending on context)
TAL	Target Analyte List
TBD	to-be-determined
TIIB	Technology Integration and Information Branch
TtEMI	TetraTech EM Inc.
UCL	upper confidence limit
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
VSP	Visual Sampling Plan USEPA-supported software that helps determine the number of samples or increments)
XRF	X-Ray Fluorescence Spectrophotometer

INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared by Pacific Western Technologies, Ltd. (PWT) under Remedial Action Contract (RAC2) Work Assignment No. 136-RICO-08UA, U.S. EPA Contract No. EP-W-06-006 to the United States Environmental Protection Agency (US EPA) Region 8 to support the Remedial Investigation (RI) for the assessment of soils and indoor dust at up to 1,200 residential properties. Properties are located in the vicinity of the Colorado Smelter Superfund site (Site) located in Pueblo, Colorado. Soils will be assessed for the potential presence of arsenic, lead, and other heavy metals related to the historical Colorado Smelter.

Data generated will support the RI and help the EPA to determine the nature and extent of smelter related contamination at the Site, and to support the EPA in conducting a human health risk assessment (HHRA). Data will also be generated from the focused sampling of the former smelter soils area to determine the relative bioavailability of arsenic and lead in smelter-related soils, further informing site risk assessment and risk management. Data generated will be used to periodically refine the contaminants of potential concern (COPCs) that will be characterized throughout the full RI.

Site Description, History & Background

The Colorado Smelter (also known as the Colorado Smelting Company and the Eiler's Smelter) was one of five smelters in Pueblo at the turn of the last century. This smelter processed silver-lead ore from the Monarch Pass area and operated from 1883 to 1908. There is a steel mill (Evraz/Rocky Mountain Steel/Colorado Fuel & Iron (CF&I)) located to the south of the Site that is still operating and that the Colorado Department of Public Health and the Environment (CDPHE) Resource Conservation and Recovery Act (RCRA) program is involved with.

In 2006, a Colorado State University-Pueblo (CSU-Pueblo) professor and co-authors published a paper that described heavy metals in Pueblo surface soils. The authors found that in some areas, the topsoil in Pueblo has more arsenic, cadmium, mercury and lead than national soil averages and these areas were in low income and minority neighborhoods. The authors recommended more soil sampling to identify hotspots within the city.

The CDPHE investigated the Blende Smelter, Fountain Foundry, and Colorado Smelter sites in Pueblo because they were in, or close to, residential neighborhoods, and previous soil sampling data indicated the need for more detailed sampling of these residential areas. The Blende Smelter was cleaned up using an EPA lead Removal Action. One of the three remaining smelters, Pueblo Smelter/Rockwool facility, is bordered by commercial/industrial properties and was addressed via a removal action in which source material was capped in place. The former New England/Massachusetts Smelter and the Philadelphia Smelters were located on the eastern edge of the steel mill facility. It is unknown if these smelters have impacted any nearby communities, but limited historic sampling suggests these sites appear to pose less of a public health concern (CDPHE 2011).

Historical data that were collected by the CDPHE in 1994 and EPA contractors in 1995 indicated the presence of elevated levels of lead and arsenic; however, the studies were not systematic and lacked sufficient data density to clearly determine if metals posed a significant threat to residents living near the former smelter. In 2010, CDPHE collected 434 surface soil samples from 47 yards in the Eilers and Bessemer residential neighborhoods surrounding the Colorado Smelter, including the old slag pile area and two background locations. The former smelter site consists of an approximate 700,000 square foot slag pile that is 30 feet high in places and lead and arsenic contaminated residential soils. The lead levels measured using X-Ray Fluorescence (XRF) on composite samples of residential soils collected from the area south and east of the former smelter ranged from 300 to 785 parts per million (ppm). The lead benchmark that EPA and CDPHE set to protect people is 400 ppm. Arsenic concentrations varied from 100 to 340 ppm range in an area immediately south of the former smelter site. Arsenic cleanup levels have ranged from 40 to 70 ppm at similar sites in Region 8. Lead levels in the slag pile ranged from 480 to 26,000 ppm; arsenic from 30 to 1,700 ppm. In addition, these concentrations are well above preliminary background levels designated for that field effort (47 ppm for lead and 16 ppm for arsenic).

The 2010 Analytical Results Report (CDPHE 2011) provides the most recent data for the Site and helped determine the initial scope of the RI. This report will also be used to identify possible prioritization criteria for sampling, as well as possible early actions.

For additional information, refer to UFP QAPP Worksheet #10 that addresses results of historical documentation and data review.

Project Approach Overview

The project approach framework was developed by EPA's Office of Superfund Remediation & Technology Innovation (OSRTI), was tested and refined in the field during the May 2015 DMA, and has been customized by PWT in coordination with Region 8 to address site-specific conditions and issues.

Figure 1 is a summary flowchart that outlines this process. Where applicable, the figure is supported by a series of attachments that provide additional detail on the project activities to be performed at key milestones of the project. Sequential application of these activities is described in Uniform Federal Policy (UFP) QAPP Worksheet # 16 – Project Schedule / Timeline.

The following brief descriptions describe the nature and purpose of each of the project milestones.

Review Historical Information and Data – Between August 2014 and March 2015, the technical project team reviewed relevant site historical information and data to develop a Preliminary Conceptual Site Model (CSM) for the properties that are to be assessed. The Preliminary CSM is a milestone deliverable developed as a fundamental element of preparation for systematic planning of the assessment effort. The Decision Logic Diagram for the Colorado Smelter RI Process is described in Figure 1; Attachment A. The Preliminary CSM and the summary results of the data quality assessment of the historical data are included as attachments to Worksheet #13.

Diligence in gathering and evaluating key data from previous investigations and other site-related information was required to prepare a thorough and effective Preliminary CSM.

Systematic Planning – Between February 2015 and August 2015, the project team engaged in four systematic planning meetings to comprehensively plan and design the implementation of all stages of the assessment project. It involved planning for known decisions and building in contingencies to accommodate changes in project conditions so that stakeholders are able to facilitate the project through all key decision-making stages. This RI UFP QAPP and associated site-specific standard operating procedures (SOPs) are the primary products of the systematic planning effort.

The systematic planning meetings are documented in Worksheet #9.

A key component of systematic planning was the performance of a data quality assessment as part of US EPA's DQO process to develop data acceptance and other project performance criteria for incorporation in this UFP QAPP (for documentation of the DQO process, see Worksheet #11 of the QAPP). In addition, a thorough analysis of historical data was performed to determine whether and how previous data could be used to guide assessment planning, or in some cases provide data of adequate quantity and acceptable quality to offset some of the assessment requirements. Specifically, data were reviewed to determine their usefulness in directly supporting the establishment of constituent background concentrations, substituting or augmenting data collection needs, performing HHRA and providing information for potential future remediation / mitigation planning and engineering.

Specific DQO guidance used to support this effort included:

- EPA Quality Manual for Environmental Programs. (EPA 2000, May).
- Guidance on Systematic Planning Using the Data Quality Objectives Process. (EPA 2006, February).
- Guidance for Developing Quality Assurance Project Plans. (EPA 2002a, December).
- Uniform Federal Policy for Quality Assurance Project Plans (Manual) (EPA 2005a, March).
- Workbook for Uniform Federal Policy for Quality Assurance Project Plans (Workbook). (EPA 2005b, March).

A strong emphasis was placed on developing the Preliminary CSM. The Preliminary CSM is the version that was agreed upon by the stakeholders during systematic planning and subsequently served as the basis for the detailed planning of all phases of this RI project. The Preliminary CSM was specifically used to identify data needs, develop the site-specific sampling plan design, and confirm the selection of appropriate data collection, analysis, and use methodologies. Inherent to the sampling design is an explicit recognition that spatial heterogeneity and analytical method variance are likely to be the primary sources of uncertainty affecting confident site decision-making. Data collected in the DMA was used to update the preliminary CSM and refine it before continuing the Site RI. The data collected during the RI will be used to refine the preliminary CSM to a baseline CSM.

In addition to addressing scientific issues, systematic planning also considered financial, contractual, stakeholder, legal, and regulatory issues; such as budgets, contracts, stakeholder concerns, site reuse, legal and regulatory issues, and relevant social and economic factors.

<u>Design and Conduct Background Study</u> – A background study will be designed and conducted under a separate QAPP to determine naturally occurring and urban

background appropriate for the study area. The background study will include sampling schemes similar to that employed in the RI to allow for data comparison.

Design and Conduct Sampling – As indicated above, the assessment design presented in this UFP QAPP is based on a project approach framework developed by OSRTI, and was customized by Region 8 for site-specific application based on the results of the DMA and the systematic planning efforts. This UFP QAPP provides comprehensive details of the assessment plan and strategy for the site.

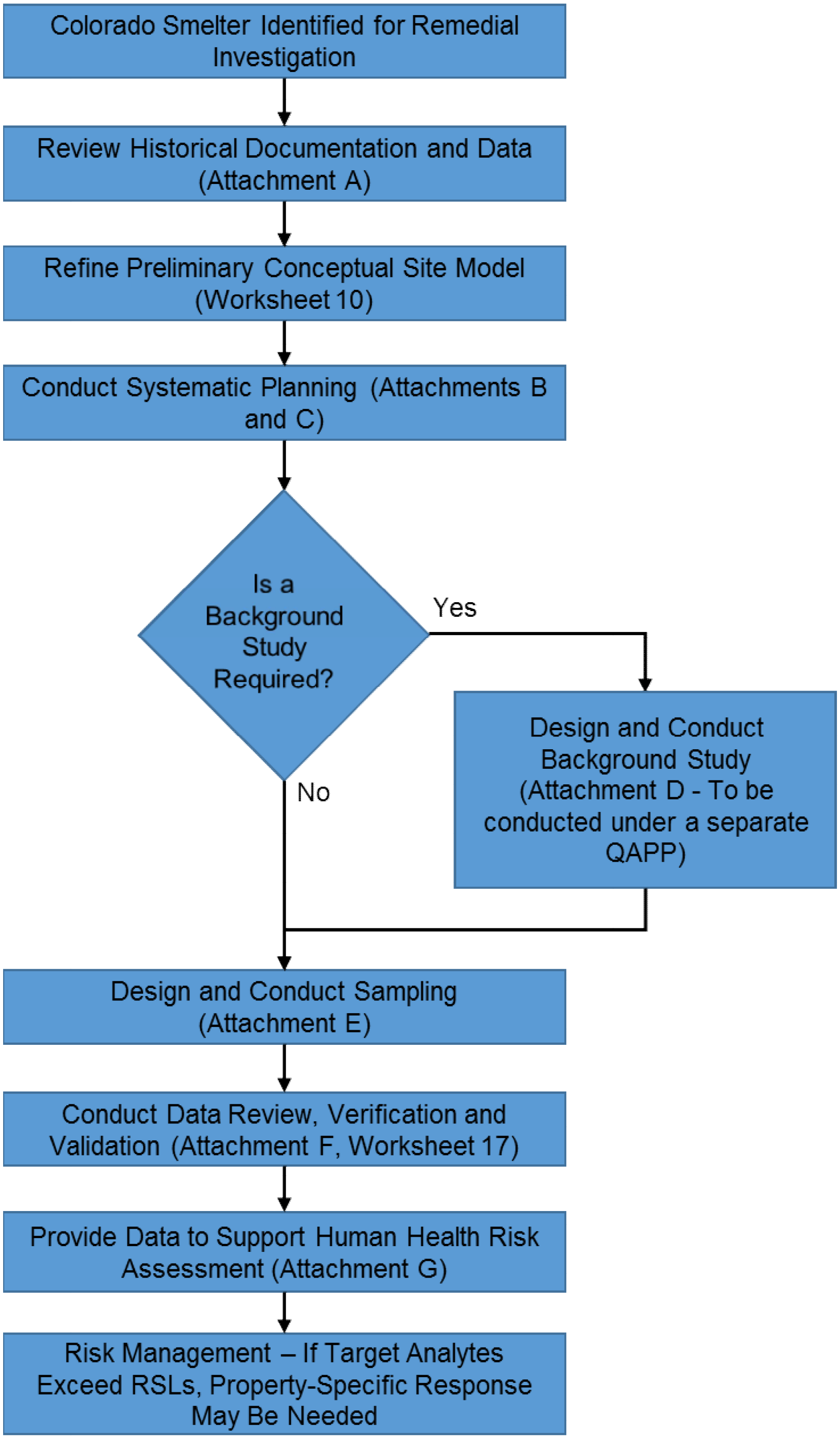


Figure 1: Decision Logic Diagram for the Colorado Smelter RI Process

Attachment A to Figure 1
Colorado Smelter RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Historical Documentation and Data Review

Historical Site documentation and data were compiled and reviewed to inform the systematic planning effort and serve as the basis for developing the Preliminary CSM. Systematic planning included the evaluation of available historical site data sets for applicability to data needs for the Colorado Smelter DMA (PWT 2015a). As it was compiled, the quality of historical data was assessed from sampling and analytical perspectives. Data quality assessment addressed the following items.

Results of the DMA verified several of the implicit assumptions of the CSM, demonstrating that windblown dust from the waste piles, or aerial deposition from stack emissions from the former smelter site is a potential source of the metals contamination found in Site soils. Also, in at least some locations, smelter slag appears to have been placed in residential areas of the Site. Upon completion of the RI, additional refinement of the CSM will be possible.

Evaluation of Historical Sampling Approach

- General sampling strategy
  - Statistical/probabilistic
  - X **Judgmental**

- Sample representativeness and comparability relative to new data needs
  - Soil media sampled (sites and sub-sites, soil/waste types, background vs. site)
  - Sampling density
  - Depth intervals
  - X **Grab or composite**
  - Sample processing (sizing, homogenization)

- Data end uses
  - X **Site screening**
  - Risk assessment
  - Remedial design/remedial action (engineering evaluations, characterization of treated or removed wastes, confirmation of soil/waste removal)

- Decision uncertainty management approach
  - X **Qualitative/professional judgment**
  - Analytical Quality Assurance (QA) program only
  - Classical statistics
  - Other (e.g., geostatistics, modeling)
  - Unknown

Data Quality Assessment via Evaluation of Analytical Methods and Quality Assurance Program

- Is the data of known and documented quality; i.e., were samples analyzed and data reported and validated under an EPA QA program or equivalent? Yes
- What was the level of review and the SOP for review at the time? Stage 4 for EPA Contract Laboratory Program (CLP) data; treatment of XRF data like CLP data, i.e., generation of full validation report and XRF data quality assessment report.
- Were data qualified and was the review narrative available? Yes
- Status of analytical data in terms of whether it was collected for all COCs for use in Colorado Smelter evaluations. Majority of XRF data focused on lead, but other analytes were measured. CLP analysis was for full Target Analyte List (TAL) metals.
- Were quantitation/detection limits sufficient for use in prior Colorado Smelter evaluations? Yes
- Did data quality indicators (DQIs) meet method performance requirements and did they indicate sufficient data quality for use in Colorado Smelter evaluations (e.g., precision, bias, completeness, comparability)? Yes
- Were there any applications of field-based or screening methods (e.g., CALUX or immunoassay methods)? No
- If non-traditional methods were used, was there a DMA or other type of pilot study, or subsequent data analysis to establish the comparability between conventional and alternativeN/A
- Is data from non-traditional methods sufficiently usable to estimate the variability in concentration over both short and long spatial scales? Also, can the data provide indications of hotspots or source areas? N/A
- Did any of the DMA analytical methods find matrix interferences that should be considered for future analyses? N/A
- Are there QC or validation records available for any applications of non-traditional methods? N/A

Documentation of Historical Documents and Data Review

Colorado Smelter and Santa Fe Bridge Culvert Site Inspection analytical results reports.

Findings from previous screening investigations indicate high levels of lead and arsenic in several residential soil samples and the remaining slag area. Due to the large area needing additional detailed characterization, the site will be addressed using the Superfund RI process. Worksheet 10 provides the Preliminary CSM.

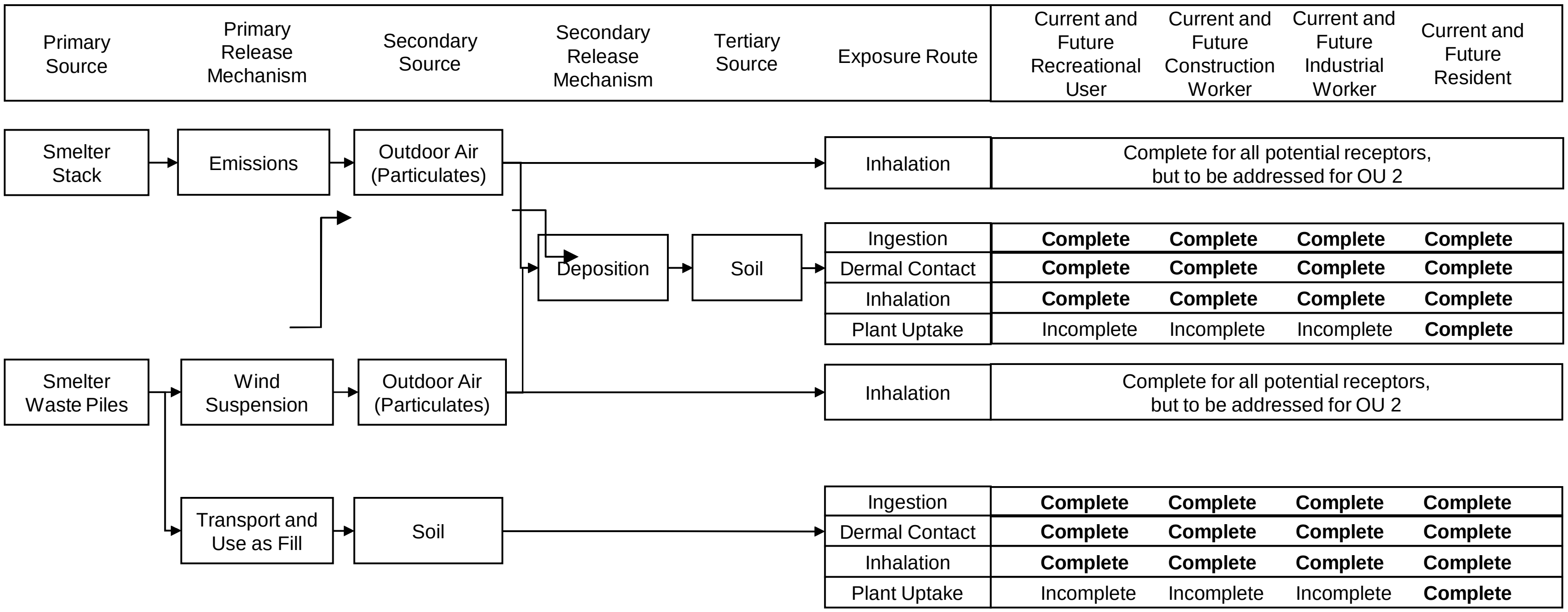
Colorado Smelter DMA Sampling Design and Strategy
Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Attachment B to Figure 1 - SYSTEMATIC PLANNING MEETING AGENDA

1. Systematic planning for the RI involved discussion of the DMA findings, and occurred in a series of meetings between July and August 2015. The DMA report summarizes the discussion that occurred, and included discussion of the following items:Did XRF technology demonstrate adequate data quality relative to ICP-MS methods to ensure adequate support for long-term decision-making at the site?
2. Is 30-point incremental sampling necessary, or does 5-point composite sampling adequately address matrix heterogeneity and provide decision0quality data for the site?
3. Are triplicate samples necessary for all DUs and depths, or can triplicate samples be collected at a lower frequency?
4. Is sampling at all four depth ranges investigated during the DMA necessary?

Attachment C to Figure 1 - CSM AND DATA GAP ASSESSMENTS DURING SYSTEMATIC PLANNING

Attachment C to Figure 1 – CSM AND DATA GAP ASSESSMENTS DURING SYSTEMATIC PLANNING



Exposure Route	Current and Future Recreational User	Current and Future Construction Worker	Current and Future Industrial Worker	Current and Future Resident
Inhalation	Complete for all potential receptors, but to be addressed for OU 2			
Ingestion	**Complete**	**Complete**	**Complete**	**Complete**
Dermal Contact	**Complete**	**Complete**	**Complete**	**Complete**
Inhalation	**Complete**	**Complete**	**Complete**	**Complete**
Plant Uptake	Incomplete	Incomplete	Incomplete	**Complete**
Inhalation	Complete for all potential receptors, but to be addressed for OU 2			
Ingestion	**Complete**	**Complete**	**Complete**	**Complete**
Dermal Contact	**Complete**	**Complete**	**Complete**	**Complete**
Inhalation	**Complete**	**Complete**	**Complete**	**Complete**
Plant Uptake	Incomplete	Incomplete	Incomplete	**Complete**

Attachment D to Figure 1 - BACKGROUND STUDY DESIGN AND PERFORMANCE

A BACKGROUND STUDY WILL BE DESIGNED AND CONDUCTED UNDER A SEPARATE QAPP.

Attachment E to Figure 1
Colorado Smelter RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

SUMMARY OF RI SAMPLING APPROACH, OBJECTIVES AND ASSUMPTIONS

The residential properties and sampling locations within the former smelter area/slag contaminated soils to be selected for inclusion in the RI will span the approximate range of conditions expected to be encountered within the Colorado Smelter Community Properties Study Area (CPSA). Spatial locations and historic wind directions will be factored into the property selection process. Sampling areas will include up to 1,200 residential properties ranging in size from approximately 0.05 to 0.5 acres, and parks, schools, commercial properties, and alleys. The 1,200 homes will be drawn from the preliminary study area, which is a ½-mile radius area containing approximately 1,900 properties.

Sampling Strategy Elements

1. Contaminant Types to be Assessed
    a. Target analytes are TAL metals in soil samples. Lead and arsenic will be analyzed by XRF. Additional analytes may be added to XRF analysis if ICP-MS data indicates that these analytes should be reported by XRF, and comparability of XRF and ICP-MS data is demonstrated.
    b. TAL metals in soil and indoor dust samples from residential properties via EPA CLP inductively coupled plasma-mass spectrometry (ICP-MS) analysis using EPA method 6020B, under CLP contract ISM 01.3,
    c. TAL metals in soil samples from residential properties via EPA CLP cold-vapor atomic absorption (CVAA) analysis using EPA method 7471B, under CLP contract ISM 01.3,
    d. Bioavailability analysis for lead in site-specific matrices using US EPA's "Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil" (EPA 9200.2-86, April 2012),
    e. Bioavailability analysis for arsenic in site-specific matrices using University of Colorado "Standard Operating Procedure In Vitro Bioaccessibility (IVBA) Procedure for Arsenic" (June 2011), and
    f. Geospeciation of select samples lead and arsenic via special analytical services at the University of Colorado

2. Exposure Scenario
    a. Residential, industrial, recreational, other specific scenarios (e.g., construction and utility worker exposure)

    b. Direct contact with surficial soil (within the 0–1.5 feet below ground surface (bgs) interval) and indoor dust (e.g., ingestion, inhalation, dermal contact)

3. Decision Units (DUs) should be delineated so as to be consistent with site type and exposure scenario. A residential property may have three or more DUs, and the typical residential property is expected to have approximately 5 DUs.

4. Five-point composite sampling locations and sample distribution:
    a. The majority of DUs will be characterized using a single 5-point composite sample.
    b. Specific sample points within the DU will be loosely arranged in a 5 point star pattern, adjusted as necessary to take yard features into account.

5. Incremental composite sampling (ICS) locations and sample distribution:

    a. A subset of DUs including those units with the largest areas, will be sampled via ICS.
    b. Specific sample points within the DU will be determined via Random Start Systematic Grid method for each DU.

6. Replicate quantities

    a. Field replicate samples will be collected in triplicate (two replicate samples collected along with one associated investigative sample) from selected DUs at a frequency of 5% (one triplicate set per 20 investigative samples). Triplicate samples will be collected such that triplicates are collected from all four depths at specific locations. A strategy will be developed and adjusted as the effort progresses to ensure that triplicates are available for a range of distances and directions from the smelter, a wide range of concentrations, and a variety of DU types.
    b. A small number of replicate samples (approximately 5% of samples) will be collected for mercury analysis only. These samples will be discrete samples that are not processed for XRF analysis to prevent volatilization of mercury. The samples will be sent to a CLP laboratory for analysis by methods appropriate for mercury.

Attachment F to Figure 1
Colorado Smelter RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Historical data review allowed the site investigation and risk screening program to focus on selected constituents and supported streamlining of the sampling and analytical program, eliminating several categories of contaminants to focus on Site-specific smelter related metals. However, additional COPC screening still remains to be completed. COPC screening will take place during the TAL metals analysis of soil samples collected during theOU1 RI from select residential properties and former smelter area via EPA CLP inductively coupled plasma (ICP) analysis using EPA methods 6020B and 7471B, under CLP contract ISM 01.3.

In accordance with Figure 1, the analytical results from soil samples previously collected at the Colorado Smelter site may be used to assist the RI. The sampling design and rationale is presented in detail in Worksheet 17 of this UFP QAPP and the sampling methodology is described in the attached SOPs.

- Because of the possibility of reanalysis, holding times for archived samples will be tracked to ensure the proposed holding time of 6 months not exceeded.
- Measured concentrations (by XRF and/or ICP-MS) for all target analytes will be compared to the residential Regional Screening Levels (RSLs) or site-specific project remediation goals (PRG) once they are developed.

If the sensitivity analysis shows that sample reporting limits impede screening evaluations for one or more sample analyses, the affected samples may be reanalyzed to assess whether the elevated reporting limits are due to laboratory or matrix issues. If reanalysis confirms matrix interferences, the laboratory will be consulted to identify and undertake corrective actions. If matrix problems cannot be corrected, the original analytical results may be subjected to statistical evaluation to assess data usability and application.

Attachment G to Figure 1
Colorado Smelter RI Sampling Design and Strategy

Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP)

Human Health Risk Assessment

The project team is coordinating with EPA and CDPHE risk assessors to ensure that the RI data will meet the needs of the HHRA.

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QAPP WORKSHEET #1

Title and Approval Page

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
REMEDIAL INVESTIGATION

COLORADO SMELTER SUPERFUND SITE
PUEBLO, PUEBLO COUNTY, COLORADO

November 2015

Revision 0

Prepared for:

U.S. EPA Region 8
Denver, Colorado

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Sabrina Forrest 11/16/15

U.S. EPA
Sabrina Forrest, RPM, EPA

Date

QAPP WORKSHEET #2

QAPP Identifying Information

Site Number/Code:	CON000802700/08UA
Operable Unit:	OU1
Contractor Name:	Pacific Western Technologies, Ltd.
Contractor Number:	EP-W-06-006
Contract Title:	Remedial Action Contract
Work Assignment Number:	136-RICO-08UA

1. Identify guidance used to prepare QAPP:

UFP QAPP USER GUIDE, US EPA; Office of Superfund Remediation and Innovative Technology (OSRTI); Technology Innovation and Field Services Division (TIFSD), September 2011; The EPA's Guidance on Systematic Planning Using the Data Quality Objective Process (USEPA 2006a).

2. Identify regulatory program:

Comprehensive Environmental Restoration, Compensation and Liability Act (CERCLA)

3. Identify approval entity:

US EPA Region 8 Superfund Remedial Program

4. Indicate whether the QAPP is a generic or a project-specific QAPP.

This UFP QAPP is specific to the Colorado Smelter RI

5. List dates of systematic planning sessions that were held:

February 27, 2015; March 24, 2015

6. List dates and titles of QAPP documents from previous site work, if applicable:

Title	Received Date
Colorado Department of Public Health and Environment Generic Quality Assurance Project Plan for Site Assessment under Superfund. Revision 1.	March 17, 2000
Colorado Department of Public Health and Environment Preliminary Assessment Colorado Smelter	April 28, 2008
Colorado Department of Public Health and Environment Sample and Analysis Plan Colorado Smelter	May 2010

Pacific Western Technologies Uniform Federal Policy Quality Assurance Project Plan for Demonstration of Methods Applicability at Colorado Smelter		May 2015
Pacific Western Technologies Demonstration of Methods Applicability at Colorado Smelter Data Summary Report		September 2015

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

U.S. Environmental Protection Agency:

Ms. Sabrina Forrest, Remedial Project Manager (RPM)

Dr. Charles Partridge, EPA Region 8 Toxicologist

Ms. Deana Crumbling, EPA OSRTI TIIB

Mr. Stephen Dyment, EPA ORD Region 8 Superfund and Technology Liaison

Mr. Donald Goodrich, EPA Contract Laboratory Program/Sample Management Office Liaison

Colorado Department of Public Health and Environment:

Ms. Alissa Schultz, CDPHE Project Officer

Pacific Western Technologies, Ltd.:

Dr. Ram Ramaswami, RAC2 Program Manager

Mr. Steve Singer, PG, PMP, Project Manager

Mrs. Robin Witt, PE, Field Team Coordinator

Mr. Bruce Peterman, Quality Assurance Officer (QAO)

Mr. Craig Walker, PWT Team Project Chemist

Tetra Tech EM Inc. (TtEMI):

Dr. Rob Tisdale, Field Team Leader

8. List data users:

Ms. Sabrina Forrest, Remedial Project Manager (RPM)

Dr. Charles Partridge, EPA Region 8 Toxicologist

Ms. Deana Crumbling, EPA OSRTI TIIB

Mr. Stephen Dyment, EPA ORD Region 8 Superfund and Technology Liaison

Mr. Steve Singer, PG, PMP, Project Manager

Mrs. Robin Witt, PE, Field Team Coordinator

Mr. Craig Walker, PWT Team Project Chemist

Dr. Rob Tisdale, Field Team Leader

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below:

Note: This table does not apply to the RI QAPP, since a UFP format QAPP has been provided, rather than a traditional narrative QAPP following EPA QA R-5.

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
Project Management and Objectives			
2.1 Title and Approval Page		1	- Title and Approval Page
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information		2	- Table of Contents - QAPP Identifying Information
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet		3 4	- Distribution List - Project Personnel Sign-Off Sheet
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		5 6 7 8	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
2.5 Project Planning/Problem Definition 2.5.1 Systematic Planning Meeting 2.5.2 Problem Definition, Site History, and Background		9 10	- Project Planning Session Documentation (including Data Needs tables) - Systematic Planning Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)
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		11 12	- Site-Specific PQOs - Measurement Performance Criteria Table
2.7 Secondary Data Evaluation		13	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule		14 15A, 15B, and 15C 16	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table
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		17 18 19 20 21 22	- 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

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures			
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		23 24 25	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody		26 and 27	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples		28A, 28B, 28C, 28D, and 28E	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree
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		29 30	- Project Documents and Records Table - Data Management SOPs - Analytical Services Table
Assessment/Oversight			
4.1 Assessments and Response Actions 4.1.1 Planned Assessments		31	- Assessments and Response Actions - Planned Project

Required QAPP Element(s) and Corresponding QAPP Section(s)	Crosswalk to Related Documents	QAPP Worksheet # in QAPP Workbook	Required Information
4.1.2 Assessment Findings and Corrective Action Responses		32	Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table
4.2 QA Management Reports		33	- QA Management Reports Table
4.3 Final Project Report			
Data Review			
5.1 Overview			
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities		34 35 36 37	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining			

QAPP WORKSHEET #3
Distribution List

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Sabrina Forrest	Remedial Project Manager	EPA, Region 8	Office: 303-312-6484	forrest.sabrina@epa.gov
Charlie Partridge	Toxicologist	EPA, Region 8	Office: 303-312-6094	partridge.charles@epa.gov
Deana Crumbling	OSRTI TIIB	EPA	Office: 703-603-0643	crumbling.deana@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	Office: 303-312-7044	dyment.stephen@epa.gov
Don Goodrich	Environmental Scientist	EPA, Region 8	Office: 303-312-6687	goodrich.don@epa.gov
Alissa Schultz	Project Officer	CDPHE	Office: 303-692-3324	alissa.schultz@state.co.us
Steve Singer	Project Manager	PWT	Office: 303-274-5400 x53 Fax: 303-274-6160	ssinger@pwt.com
Rob Tisdale	Field Sample Lead (TtEMI Project Manager)	TtEMI	Office: 303-312-8843 Fax: 303-295-2818	rob.tisdale@tetratech.com
Robin Witt	Field Team Coordinator	PWT	Office: 303-274-5400 x35 Fax: 303-274-6160	rwitt@pwt.com
Bruce Peterman	Project QAO	PWT	Office: 303-274-5400 x45 Fax: 303-274-6160	bpeterman@pwt.com
Ram Ramaswami	RAC2 Program Manager	PWT	Office: 303-274-5400 x19 Fax: 303-274-6160	rramaswami@pwt.com

QAPP WORKSHEET #4
Project Personnel Sign-Off Sheet

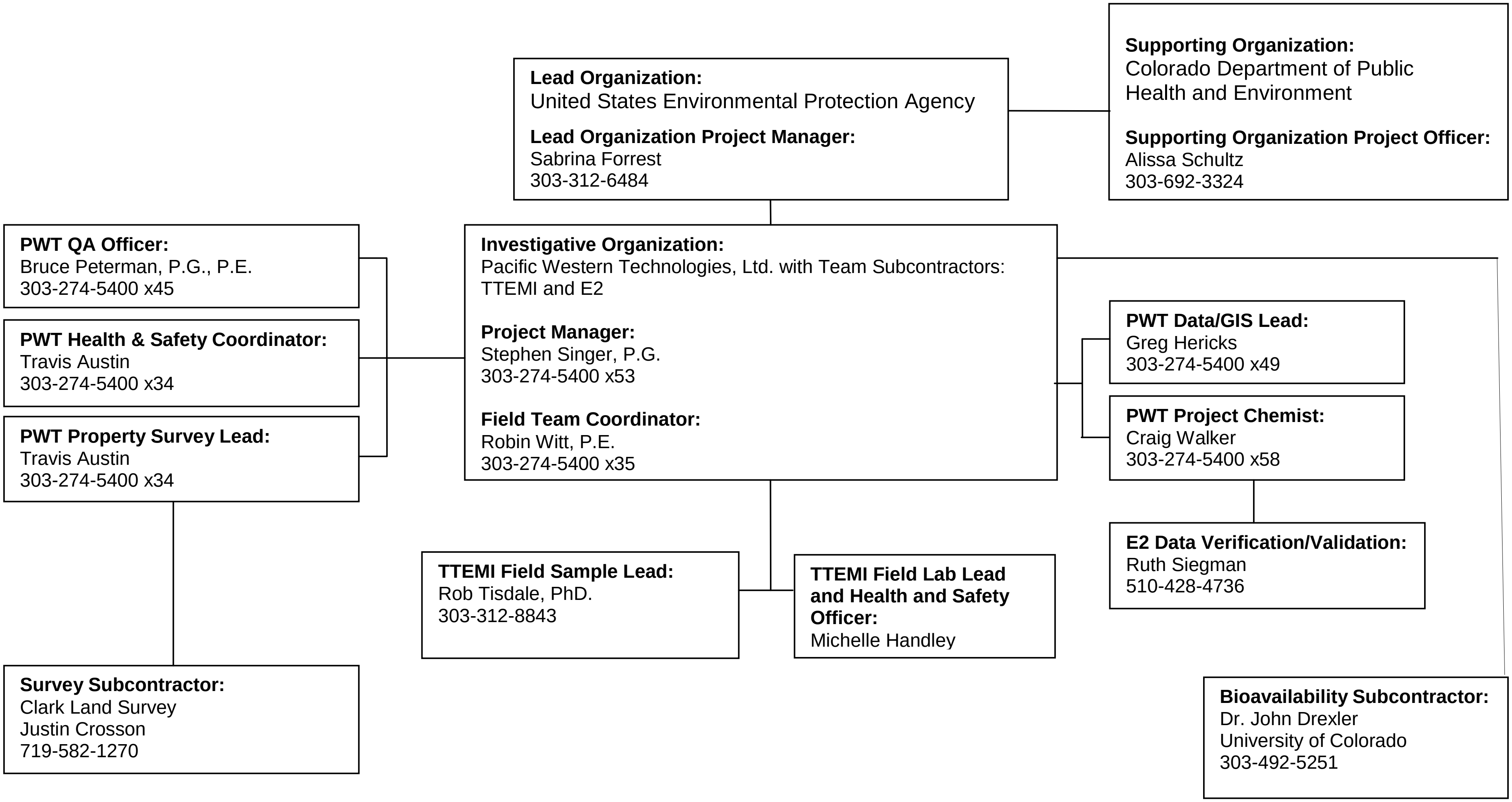
Organization: EPA and CDPHE

Project Personnel	**Title**	**Telephone Number**	**Signature**	**Date QAPP Read Email Receipt**
Sabrina Forrest	RPM	303-312-6484		
Charlie Partridge	EPA Toxicologist	303-312-6094		
Deana Crumbling	EPA OSRTI Technology Integration and Information Branch (TIIB)	703-603-0643		
Steve Dyment	EPA ORD Region 8 Superfund and Technology Liaison	303-312-7044		
Alissa Schultz	CDPHE	303-692-3324		

Organization: PWT, TtEMI, E2

Project Personnel	**Title**	**Telephone Number**	**Signature**	**Date QAPP Read Email Receipt**
Ram Ramaswami	RAC2 Program Manager	303-274-5400 x19		
Steve Singer	Project Manager	303-274-5400 x53		
Robin Witt	Field Team Coordinator	303-274-5400 x35		
Bruce Peterman	Project QAO	303-274-5400 x45		
Rob Tisdale	Field Sample Lead (TtEMI Project Manager)	303-312-8843		

QAPP WORKSHEET #5
Project Organizational Chart



Lead Organization:
United States Environmental Protection Agency
Lead Organization Project Manager:
Sabrina Forrest
303-312-6484

Supporting Organization:
Colorado Department of Public Health and Environment

Supporting Organization Project Officer:
Alissa Schultz
303-692-3324

PWT QA Officer:
Bruce Peterman, P.G., P.E.
303-274-5400 x45

PWT Health & Safety Coordinator:
Travis Austin
303-274-5400 x34

PWT Property Survey Lead:
Travis Austin
303-274-5400 x34

Investigative Organization:
Pacific Western Technologies, Ltd. with Team Subcontractors: TTEMI and E2

Project Manager:
Stephen Singer, P.G.
303-274-5400 x53

Field Team Coordinator:
Robin Witt, P.E.
303-274-5400 x35

PWT Data/GIS Lead:
Greg Hericks
303-274-5400 x49

PWT Project Chemist:
Craig Walker
303-274-5400 x58

E2 Data Verification/Validation:
Ruth Siegman
510-428-4736

TTEMI Field Sample Lead:
Rob Tisdale, PhD.
303-312-8843

TTEMI Field Lab Lead and Health and Safety Officer:
Michelle Handley

Survey Subcontractor:
Clark Land Survey
Justin Crosson
719-582-1270

Bioavailability Subcontractor:
Dr. John Drexler
University of Colorado
303-492-5251

QAPP WORKSHEET #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Telephone Number	Procedure
Project Management	PWT Project Manager	Stephen Singer	303-274-5400 x53	Project manager will manage field and project personnel, and serve as liaison to the EPA, team members, and all subcontractors.
Quality Management	PWT QA Officer	Bruce Peterman	303-274-5400 x45	QAO will remain independent of direct project involvement and day-to-day operations. The QAO will ensure implementation of the quality assurance elements outlined in this QAPP. The QAO will be the point of contact with the PWT Project Manager for quality matters. The QAO is responsible for maintaining the official, approved QAPP.
Coordination and communication of fieldwork activities	PWT Field Team Coordinator	Robin Witt	303-274-5400 x35	Field team coordinator will communicate relevant field information to the project manager, team members, and subcontractors.
Field data and quality control reports	TtEMI Field Sample Lead	Rob Tisdale	303-312-8843	Field team leader will generate and report data and documents as required by this UFP QAPP along with quality control reports to the Site project manager.
Coordination of sampling supplies for field activities				The Field Team Leader will acquire all sample containers and appropriate shipping materials (such as coolers and bubble wrap) before field sampling begins and throughout the project. Refer to SOPs for supplies and consumables lists: PWT-COS- 302, PWT-COS- 303, PWT-COS-0427, PWT-ENSE-406, PWT-ENSE-423, PWT-ENSE-424, and PWT-ENSE-430
Submittal of samples to the field laboratory				Sampling personnel will package and deliver samples in accordance with this QAPP.
Submittal of samples to CLP Laboratory	TtEMI Field Lab Lead	Michelle Handley	417-257-9977	Submit selected samples to analytical laboratories in accordance with this QAPP.
Submittal of samples for	TtEMI Field Lab Lead	Michelle	417-257-9977	Submit selected samples to analytical

geospeciation and bioavailability analysis		Handley		laboratories in accordance with this QAPP.
Internal chain-of-custody records and sampling documentation	TtEMI Field Team Lead	Rob Tisdale	303-312-8843	Internal chain-of-custody records and sampling documentation will be submitted to the field lab at the end of each day that samples are collected.
External chain-of-custody records and shipping documentation	TtEMI Field Lab Lead	Michelle Handley	417-257-9977	Copies of external chain-of-custody records and shipping documentation will be kept on file. Original copies shall accompany sample shipping containers for laboratory use.
Field and analytical corrective actions	TtEMI Field Lab Lead TtEMI Field Sample Lead	Michelle Handley Rob Tisdale	417-257-9977 303-312-8843	The TtEMI Field Lab Lead and/or TtEMI Field Sample Lead will immediately notify the QAO in writing of any field or analytical procedures that were not performed in accordance with this QAPP. The QAO or designee will complete documentation of the non-conformance and corrective actions to be taken. The TtEMI Field Lab Lead and/or TtEMI Field Sample Lead will verify that the corrective actions have been implemented.
Sample shipping/receipt issues	Laboratory Project Manager	TBD	TBD	The laboratory project managers will report all sample shipping and receipt issues associated with the investigation to the PWT Field Team Coordinator and/or TtEMI Field Lab Lead within 2 business days.
Reporting laboratory data and quality issues	Laboratory Project Manager	TBD	TBD	Report documents and data in an electronic format as required by this UFP QAPP and report QA and QC issues.
Minor deviations from QAPP procedures identified during field activities	TtEMI Field Lab Lead TtEMI Field Sample Lead	Michelle Handley Rob Tisdale	417-257-9977 303-312-8843	The PWT Field Team Coordinator and/or TtEMI Field Team Leader will prepare a field change request for any minor changes in sampling procedures that occur as a result of conditions in the field. This request will be submitted to the QAO for approval before the change is initiated.
QAPP amendments	PWT Project Manager EPA RPM	Stephen Singer Sabrina Forrest	303-274-5400 x53 303-312-6484	Any changes to the QAPP will require the QAO to prepare an addendum that will be approved by the PWT PM and EPA RPM

				before any changes are implemented. The PWT PM will deliver the most current copy of the approved QA Project Plan to those on the distribution list.
QAPP – routine communications regarding analyses during implementation	PWT Project Chemist	Craig Walker	303-274-5400 x58	Primary point of contact to ensure that analytical services comply with the QAPP so that resulting data will meet data quality objectives.

QAPP WORKSHEET #7

Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Steve Singer	PWT Project Manager	PWT	Responsible for providing management and technical oversight during RI activities. Review and sign-off on QAPPs and any future modifications to the plans; provides quality-related direction through the EPA RPM to the Site QAO; and has authority to suspend affected project or Site activities if approved quality requirements are not adequately met.
Bruce Peterman	PWT Program QA officer	PWT	Overall QA and QC of technical work at the Site; develops and maintains a comprehensive QA program and is responsible for audits, reviews of work performed, and recommendations to project personnel regarding quality. Verifies compliance with required QC procedures and reviews deliverables to verify conformance with QA and QC procedures. Provides oversight of the QA program and has authority to suspend affected project or Site activities if approved quality requirements are not adequately met.
Rob Tisdale	Health and Safety officer	PWT	Responsible for implementing the health and safety plan and accident prevention plan; authority to correct and change Site control measures and the required level of health and safety protection.
Robin Witt	Field Team Coordinator	PWT	Responsible for ensuring coordination between PWT staff and Team Subcontract resources and that they are available to conduct the RI as described in this QAPP. Also responsible for development of field related work plans, and adherence to field task schedules and deliverables. The Field Team coordinator will serve as the main point of contact for the Field Team Leader.
Craig Walker	Project Chemist	PWT	Reviewing analytical data to ensure conformance with QA testing and standards, reviewing data validation and verification reports provided by third party validation team member, E2, and approving analytical data. Interfacing with the EPA Analytical Program Manager on matters concerning chemical sampling and analysis, laboratory reports, verifications and validation of data, and the resolution of nonconforming activities or data.
Travis Austin	Property Survey Lead	PWT	Responsible for oversight of property survey activities; review of property survey deliverables; main point of contact for survey subcontractor.
Rob Tisdale	Field Team Lead	TTEMI	Implementation of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements. Coordination and management of field staff. Implementation of QC for technical data provided by the field staff, including field sample collection and measurement data. Adherence to field work schedules. Generation, review, and approval of text and graphics required for field team efforts. Coordination and oversight of technical efforts of subcontracted sampling staff. Identification of problems at the field-team level and discussion of resolutions between the field team and upper management.

QAPP WORKSHEET #8

Special Personnel Training Requirements Table

All staff associated with this project will have sufficient training to safely, effectively, and efficiently perform their assigned tasks. Training will be provided to project personnel to insure compliance with the project-specific PWT Health and Safety Plan (HASP) (PWT 2015b), or other applicable HASP(S) and technical competence in performing the work effort.

All field personnel will read this QAPP and the PWT HASP (PWT 2015b) (at a minimum) and will have sufficient training to assure compliance with health and safety protocols and to meet the technical requirements of this project. The Field Team Lead will ensure that a hard copy of this QAPP and the HASP are kept in each field vehicle for ready access during all field operations.

In accordance with the HASP, field personnel will have satisfactorily completed either the Occupational Safety and Health Administration (OSHA) 24-hour or the 40-hour Health and Safety Course for Hazardous Waste Operations and Emergency Response (HAZWOPER) Training in accordance with Sections e and p of the OSHA 29 Code of Federal Regulations (CFR) 1910.120. This certification will be maintained with annual HAZWOPER Refresher Training as required by Sections e and q of 29 CFR 1910.120. The determination of whether 24-hour or 40-hour training is appropriate for field personnel is described further in the project-specific HASP.

Field staff will have completed and maintain certification in First Aid and Adult Cardio-Pulmonary Resuscitation Training. All personnel will also have a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. The Field Team Lead and Field Team Coordinator will also have completed the OSHA eight-hour HAZWOPER Supervisor Training prior to field activities.

Personnel operating Portable XRF Analyzers will have completed the appropriate equipment maintenance and use safety trainings prior to the start of field work.

The Project Manager will ensure all on-site personnel have the appropriate training and maintain copies of the training certificates in the PWT Wheat Ridge, Colorado office and in the Pueblo field office. EPA staffs’ certificates are kept by individual staff and the EPA Region 8 Health and Safety Officer. State and local staff are responsible for ensuring they have the appropriate training and certification to be on site.

QAPP WORKSHEET #9AC

Systematic Planning Meeting Participants Sheet

Project Name: Colorado Smelter DMA **Project Manager:** Steve Singer	**Site Name:** Colorado Smelter **Site Location:** Pueblo, Colorado

Date of Session: July 29, 2015
Systematic Planning Meeting Purpose: Evaluate DMA data and refine site specific plan for OU1 RI sample collection, processing, and analysis.

Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**
Sabrina Forrest	EPA RPM	EPA	303-312-6484	forrest.sabrina@epa.gov
Charlie Partridge	Toxicologist	EPA	303-312-6094	partridge.charles@epa.gov
Deana Crumbling	OSRTI TIIB	EPA	703-603-0643	crumbling.deana@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	303-312-7044	dyment.stephen@epa.gov
Alissa Schultz	Project Officer	CDPHE	303-692-3324	alissa.schultz@state.co.us
Raj Goyal	Toxicologist	CDPHE	303-692-2634	raj.goyal@state.co.us
Steve Singer	Project Manager	PWT	303-274-5400 x53	ssinger@pwt.com
Robin Witt	Field Team Coordinator	PWT	303-274-5400 x35	rwitt@pwt.com
Rob Tisdale	Field Sample Lead	TtEMI	303-312-8843	rob.tisdale@tetratech.com

QAPP WORKSHEET #9B

Systematic Planning Meeting Participants Sheet

Project Name: Colorado Smelter DMA **Project Manager:** Steve Singer	**Site Name:** Colorado Smelter **Site Location:** Pueblo, Colorado

Date of Session: August 6, 2015
Systematic Planning Meeting Purpose: Evaluate DMA data and refine site specific plan for OU1 RI sample collection, processing, and analysis.

Name	Title	Affiliation	Phone #	E-mail Address
Sabrina Forrest	EPA RPM	EPA	303-312-6484	forrest.sabrina@epa.gov
Charlie Partridge	Toxicologist	EPA	303-312-6094	partridge.charles@epa.gov
Deana Crumbling	OSRTI TIIB	EPA	703-603-0643	crumbling.deana@epa.gov
Steve Dyment	ORD Region 8 Superfund and Technology Liaison	EPA	303-312-7044	dyment.stephen@epa.gov
Raj Goyal	Toxicologist	CDPHE	303-692-2634	raj.goyal@state.co.us
Alissa Schultz	Project Officer	CDPHE	303-692-3324	alissa.schultz@state.co.us
Steve Singer	Project Manager	PWT	303-274-5400 x53	ssinger@pwt.com
Robin Witt	Field Team Coordinator	PWT	303-274-5400 x35	rwitt@pwt.com
Rob Tisdale	Field Sample Lead	TtEMI	303-312-8843	rob.tisdale@tetratech.com

QAPP WORKSHEET #10

Colorado Smelter Preliminary Conceptual Site Model (CSM)

The conceptual site model (CSM), as shown in Attachment C to Figure 1, will be updated over time to incorporate new data about the Site. Primary sources of contamination which are considered for the Colorado Smelter Superfund Site include fugitive dust and particulate air emissions from the historic smelter stack, solid wastes such as slag and slag-impacted soils, and liquid wastes such as process solutions, acids, and rinsates from historic facility operations. Findings from previous screening investigations indicate high levels of lead and arsenic in several residential soil samples and the remaining slag area. Due to the large area needing additional detailed characterization, the site will be addressed using the Superfund RI process. This preliminary CSM will be used to refine and update the CSM and help the EPA identify data that are needed to perform a Risk Assessment. A detailed human health assessment will be performed at a later date and will include data collection and analysis, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. The risk assessment will also quantify the risks for each complete source-pathway-receptor as appropriate.

A background study will be conducted because multiple other natural and other historic sources of metals are present in Pueblo. The background study will be used to compare site concentrations to background as part of COPC and COC determination.

Release mechanisms considered for the RI:

Through the mechanisms of air dispersion and deposition, air emissions from the former smoke stack had the potential to impact surface soils and surface water, potentially contaminating these media. Historic air emissions are not a current source of contamination to the air to the CPSA; however, fugitive dust emissions caused by wind or human activity may still occur.

Solid wastes had (and still have) the potential to impact surface water of the Arkansas River through the mechanisms of surface runoff and erosion. Piles of tailings and slag have the potential to impact surface soils through direct contact, and the potential to impact subsurface soils and groundwater under the site by infiltration of rain or snowmelt that leaches metals contamination out of the tailings or slag, transporting this contamination down the soil column. Particulate solid waste can also become entrained in the air as a result of wind or human activities.

After site-related contamination migrated from its original sources to the outdoor exposure media being evaluated for this RI (surface soil and subsurface soil), interactions between these media provide ongoing pathways for contaminant transport.

The potential exposure routes by which potential human receptors may come in contact with the contaminants include inhalation of the air-entrained particles/dust; ingestion (eating or drinking); and dermal contact (or direct physical contact). Potential exposure routes and receptors will be described in more detail in the human health risk assessment. Ecological risk assessment will be performed within the RI for OU2. They will be performed as part of the overall RI.

The problem to be addressed by the project (note that this corresponds to traditional DQO process question 1, “State the problem”): The problem to be addressed by the project is to determine the nature and extent of metals contamination associated with the Colorado Smelter in the neighborhoods surrounding it. The study area consists of approximately 1,900 homes and other properties (parks, schools, alleys, and commercial properties) located within a 0.5-mile radius of the former smelter, primarily in the Eilers and Bessemer neighborhoods. The 0.5-mile radius is a preliminary study area based on the distance between the Colorado Smelter and the edges of the neighborhoods to the east, south, and southeast. The study area boundary and number of residences investigated may be increased or decreased as data provide more information about the area affected by the Colorado Smelter.

In addition to residential properties, parks, schools, commercial properties, and alleys will be sampled as part of the RI. Larger DUs such as parks, schools, and commercial properties will normally be sampled using the ICS approach. Alleys will be sampled using a linear 5-point composite approach., Alleys will be split into segments the length of a block, with the composite increments spread along the length of the block.

The environmental questions being asked:

What are the preliminary COPCs for the Site (COPC determination will be made as part of the risk assessment)?

Are the concentrations of preliminary COPCs at each DU above human health risk screening levels or background concentrations?

What are the concentrations of preliminary COPCs in indoor and attic dust within the Site?

Can concentrations of preliminary COPCs measured in indoor or attic dust be correlated with concentrations measured in outdoor soil such that indoor dust concentrations could be estimated for homes without dust data?

Are QC procedures continuing to ensure that XRF data collected and samples submitted for laboratory analysis are not only of known and documented analytical quality but also of known and documented sampling quality?

Observations from any site reconnaissance reports: See Attachment A - Historical Documentation and Data Review

A synopsis of secondary data or information from site reports: See Attachment A - Historical Documentation and Data Review

The classes of contaminants and the affected matrices: Pb, As, other possible heavy metals associated with the historic smelter. Matrices include surface and subsurface soil, and indoor dust. To maintain consistency with the August 2003 EPA *Superfund Lead-contaminated Residential Sites Handbook*, depths will consist of: Surface 0-1 inches bgs; Subsurface 1-6 inches bgs; 6-12 inches bgs; and 12-18 inches bgs.

The rationale for inclusion of chemical and nonchemical analyses:

Previous sampling (Analytical results report CDPHE 2011) has indicated the potential for elevated metals concentrations for the soil and surface water pathways from historical smelting operations associated with the Colorado Smelter. The site was listed to the NPL on December 11, 2014.

Information concerning various environmental indicators: Pb, As, other possible heavy metals associated with the historic smelter may be at levels in residential soils and indoor dust that pose a threat to human health.

Figure 1.

QAPP WORKSHEET #11

Project Quality Objectives/Systematic Planning Process Statements

Use this worksheet to develop project quality objectives (PQOs) in terms of type, quantity, and quality of data determined using a systematic planning process (note that PQOs correspond to DQOs in a traditional approach). Provide a detailed discussion of PQOs in the QAPP. List the PQOs in the form of qualitative and quantitative statements. These statements should answer questions such as those listed below. These questions are examples only, however; they are neither inclusive nor appropriate for all projects.

Who will use the data? EPA Region 8, EPA HQ, CDPHE and EPA's RAC (PWT, TtEMI, and E2)

What will the data be used for (note that this also corresponds to traditional DQO process question 2, "Identify the goal of the study")? Data generated from the RI will help the EPA to determine the nature and extent of smelter related contamination at the Site, and to support the EPA in conducting a human health risk assessment (HHRA). Data generated from the RI will be used to refine the COPCs that will be characterized throughout the full RI.

What type of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques; note that this corresponds to traditional DQO process step 3 and 5, "Identify the information inputs" and "Develop the analytical approach")? Data for metals in soil and indoor dust from residential properties are needed to assess risk potentially associated with the Colorado Smelter site.

Data will consist of XRF analytical results and ICP-MS results. XRF will be used to analyze for target analytes (Pb/As) and potentially for accessory analytes (Cu, Mn, and Zn) in surface and subsurface soil. Accessory analytes may be analyzed by XRF if results indicate that they routinely exceed screening levels and can reliably be analyzed by XRF. Data for all other metals will be obtained using a subset of samples analyzed by ICP-MS. ICP-MS analysis will be performed on 20% of all samples initially. If results indicate that a lower percentage of analysis by ICP-MS is acceptable, the percentage may be reduces to as low as 10%, provided that bioaccessibility, preliminary COPC determination, and XRF to ICP correlations have been satisfactorily documented.

Based on the DMA findings, which indicated that XRF results could be adjusted to be comparable to ICP-MS results, adjustments will continue to be made as was done during the DMA. This may be done on an instrument-specific basis if results indicate this is necessary (see worksheet #37 for additional discussion of adjustments to XRF data).

ICP-MS will be used to analyze for all TAL metals in surface, soil,subsurface soil, and indoor dust (via EPA Methods 3050B and 6020B as defined by CLP SOW ISM 01.3). Analyses will be conducted by laboratories certified in the methods of concern. Raw data information should be retained in the project file in case a need for its use arises. In particular, all analytical quality control checks should be retained.

Sampling will be performed using either a 5-point composite or a 30-increment approach at each DU. Most DUs will be sampled using the 5-point composite approach, but larger DUs (those 5,000 square feet or larger) will be sampled using the 30-increment approach. During the DMA, it was shown that both approaches provided acceptable decision error rates for making decisions for DUs.

Soil samples will be archived at the Pueblo field lab or appropriate secure storage location after XRF analysis and subsampling is complete.

In addition to soil data from residential properties, background data for soil will be collected during a background study, which will be used for COPCs and COC determination in the risk assessments.

What are the boundaries of the study (this corresponds to traditional DQO process step 4, "Define the boundaries of the study")? The study area consists of approximately 1,900 homes and other properties located within a 0.5-mile radius of the former smelter. The 0.5-mile radius is a preliminary study area based on the distance between the Colorado Smelter and the edges of the neighborhoods to the east, south, and southeast. The study area boundary may be increased or decreased as data is collected. Surface and subsurface soil, and indoor dust are the matrices of concern within this project boundary. Each of these matrices is detailed separately below for the remainder of the PQOs.

Matrix: Surface and subsurface soil.

How "good" do the data need to be in order to support the environmental decision (note that this corresponds to traditional DQO process question 6, "Specify the performance or acceptance criteria")? Data results will be calculated to be expressed as parts per million (ppm or milligrams per kilogram [mg/kg]) that can be confidently compared to a soil RSL (or site-specific PRG) in units of ppm or mg/kg (at HQ=0.1) in the risk assessment. Soil data need to have provided with it with measures of its sampling and analytical variability (i.e., definitive data). Overall statistical variability in the data needs to be small enough so that decision error rates are below 5% for false negatives and 20% for false positives. Detection limits need to be low enough to statistically compare on-site with background concentrations. See Worksheets # 12, 15 and 37.

How much data are needed (number of samples for each analytical group, matrix, and concentration; note that this question and the following four questions all correspond to traditional DQO process question 7, "Develop a plan for obtaining data)")?

Based on the expected number of DUs and depth intervals for the RI effort, approximately 25,000 residential soil samples are planned for collection. This estimate is based on 1,200 properties, 5 DUs at each property, 4 depths at each DU, and triplicate samples collected at all four depths for 1 of every 20 DUs. Each of these samples will be analyzed via XRF while a subset (initially approximately 20%) will also be analyzed by CLP using method 6020B. Any changes in the frequency of samples analyzed via Method 6020B will be discussed with project stakeholders prior to implementation and documented in the RI report.

Alleys will be separated into DUs of appropriate lengths for risk assessment, likely one 5-point composite per block of alleyway. It is anticipated that approximately 200 samples will be collected for alleys (based on 50 unpaved alley DUs and 4 depths for each DU).

Parks, schools and commercial properties will be divided into DUs and sampled using either 5-point or 30-point incremental approach depending on the size of the DUs selected. It is anticipated that approximately 200 samples will be collected for these properties based on 50 DUs and 4 depths for each DU.

Where, when, and how should the data be collected/generated? Samples will be collected and prepared on site. See Attachment E, Worksheets 17 and 18

Who will collect and generate the data? PWT and TtEMI, RAC

How will the data be reported? Both XRF and ICP data will be reported electronically. Results for individual properties will be reported to residents in letter format.

XRF sample results for each sample bag will include a mean concentration, a relative standard deviation, and an upper confidence limit on the mean (UCL). XRF raw data will be exported from the instrument as excel spreadsheets, processed in a spreadsheet program, and imported into Scribe (access database) in accordance with ERT SOPs. The ERT SOP is attached and also available at:
http://www.epaosc.org/sites/ScribeGIS/files/xrf%20edd%20for%20scribe.zip

The mean XRF concentration for each sample bag will be reported. When triplicates are collected, the mean for the three triplicates will be reported.

The CLP laboratory will provide EDDs for Method 6020B ICP-MS data and Method 7471B CVAA data in accordance with the CLP contract.

How will the data be archived? Data collected during the RI will be archived electronically using a Scribe database, and will be managed in the Regional data repository using Water Quality Exchange (WQX) in accordance with the Region 8 SF remedial data management plan (reference).

Matrix: Indoor dust.

How "good" do the data need to be in order to support the environmental decision? Data results will be calculated to be expressed as parts per million (ppm or milligrams per kilogram [mg/kg]) that can be confidently compared to a soil RSL ppm or mg/kg (at HQ=0.1) in the risk assessment. Indoor dust data need to have provided with it with measures of its sampling and analytical variability (i.e., definitive data). Overall statistical variability in the data needs to be small enough that the chance of decision error is acceptable to the risk manager. Acceptable decision error rates have been set at 5% for false negatives and 20% for false positives. Detection limits need to be low enough to statistically compare concentrations with risk-based screening levels. See Worksheets # 12, 15 and 37.

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

Based on the expected number of homes and rooms per home to be sampled for indoor dust during the RI effort, up to 7,200 indoor dust samples are planned for collection. This estimate is based on 1,200 homes, 5 rooms per home, and one replicate sample per home. No dust samples will be analyzed via XRF, all will be analyzed by CLP using method 6020B.

Where, when, and how should the data be collected/generated? Samples will be collected and prepared on site. See Attachment E, Worksheets 17 and 18

Who will collect and generate the data? PWT and TtEMI, RAC

How will the data be reported? ICP data from Method 6020B will be reported electronically in EDDs in accordance with the CLP contract.

How will the data be archived? Data collected during the RI will be archived electronically using a Scribe database.

QAPP WORKSHEET #12

Measurement Performance Criteria Table

Complete this worksheet for each matrix, analytical group, and concentration level. Identify the data quality indicators (DQIs), measurement performance criteria (MPC), and QC sample and/or activity used to assess the measurement performance for both the sampling and analytical measurement systems. Use additional worksheets if necessary. If MPC for a specific DQI vary within an analytical parameter, i.e., MPC are analyte-specific, then provide analyte-specific MPC on an additional worksheet.

Matrix	Soil
Analytical Group[1,6]	Pb, As, other TAL metals
Concentration Level	All Levels[7]

Sampling Procedure[2]	**Analytical Method/SOP**[3]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**[6]	**QC Sample and / or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Incremental-Composite Surface Sampling SOP (PWT-COS-427, see Worksheet 17)	XRF: PWT-COS-303	Analytical Precision Instrument Precision	Instrument duplicate results – used for instrument troubleshooting only.	Instrument duplicate, second result must lie within the 95% confidence interval of the first result, based on the instrument-reported counting standard deviation..	A (evaluates instrument stability and repeatability)
		Measurement (instrument and operator) Precision	LCS results within control chart limits (2 standard deviations)	LCS (Standard reference material - Pb and As)	A (Instrument and operator performance)
		Accuracy (bias)	LCS results within control chart limits (2 standard deviations) Blank results	LCS Silica or sand blank, no detections of target analytes	A
		Sensitivity	For NDs: Pb DL < background Pb concentration (XRF typically able to report DL at <10ppm Pb) As DL <background As	For NDs: Instrument reported DLs for the silica blank and SRMs and field samples	A

Incremental-Composite Surface Sampling SOP (PWT-COS-427, see Worksheet 17)	XRF: PWT-COS-303		concentration (XRF typically able to report DL at <10ppm As)		
		Completeness	95% (depends on number of DUs in sampling design)	Data review and validation	S&A
		Representativeness	Sample bag will represent the concentration of the <250 micrometer fraction of the DU – Triplicate incremental or composite samples - RSD<25% Particle size will represent the exposure pathway Reported result will be representative of the true bag concentration with 95% statistical confidence.	At a frequency of once per 20 investigative samples (5%), two replicate samples will be collected and associated with a single paired investigative sample. Sieve using 60 mesh. Analyze fraction < 250 microns. Repeated measurements to control subsampling error until 95% statistical confidence is achieved. An excel worksheet programmed for this real time evaluation is provided.	S&A S A
		Comparability (XRF to ICP, XRF to bioaccessibility analysis)	See discussion regarding assessment of XRF comparability to ICP in Worksheet 37	Linear regression of paired analyses of the same sample. Subsampling error affecting comparability analyses will be minimized by analyzing 1-2 g soil samples via XRF and submitting the entire sample for digestion and analysis via ICP method. Subsamples sent for analysis by ICP-MS may be analyzed by multiple XRFs to help establish comparability between XRF and ICP-MS data using consistent data sets..	S&A A
		Comparability (between multiple XRFs used during the project	Comparability between XRFs will not be addressed directly, but indirectly.	If comparability between XRF and ICP-MS is established for each individual XRF, the XRFs will have been established to be comparable to each other after adjustment to ICP-MS-like concentrations.	A

Matrix	Soil
Analytical Group^{1,6}	Pb, As, other TAL metals
Concentration Level	All Levels^7

Sampling Procedure^2	Analytical Method/SOP^3	Data Quality Indicators (DQIs)	Measurement Performance Criteria^6	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Incremental-Composite Surface Sampling SOP (PWT-COS-427, see Worksheet 17)	CLP SOW ISM 01.3	Analytical (Laboratory) Precision	RPD < 25%	Laboratory sub-sampling replicates and LCS/LCSD	A
		Sampling Precision	Does not apply- laboratory will not be sub-sampling.	Field replicates at the DU level; and field/laboratory sample preparation replicates.	
		Accuracy (bias)	%Recovery 70-130%	LCS	A
			Pb/As < PQL^4	Method blank	A
			Pb/As < PQL^4	Equipment blank	S&A
		Sensitivity	TAL metals SDL < PQL^5	CLP SOW ISM01.3	A
		Completeness	95%	Data review and validation	S&A
		Representativeness	Result will be representative of the true concentration of the sample because the entire mass submitted will be digested and analyzed.	Subsampling error eliminated	S
		Comparability	ICP comparability will be established by using a standard EPA analytical method and assessing whether the laboratory followed that method.	NA	NA

Matrix	Dust
Analytical Group[1,4]	Pb, As, other TAL metals
Concentration Level	All Levels[7]

Sampling Procedure[2]	**Analytical Method/SOP**[3]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**[6]	**QC Sample and / or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Indoor and Attic Dust Sampling SOP (see Worksheet 17)	CLP SOW ISM 01.3	Analytical (Laboratory) Precision	RPD < 25%	Laboratory LCS/LCSD	A
		Accuracy (bias)	%Recovery 70-130%	LCS	A
			Pb/As < PQL[4]	Method blank	A
			Pb/As < PQL[4]	Equipment blank	S&A
		Sensitivity	TAL metals SDL < PQL[5]	CLP SOW ISM01.3	A
		Completeness	95% of collected samples have valid analytical results	Data review and validation	S&A
		Representativeness	RPD < 35%	Field duplicates	S
		Comparability	ICP comparability is established by using standard CLP method.	NA	NA

[1] If information varies within an analytical group, separate by individual analyte.

[2] Reference number from QAPP Worksheet #21 (see Section 3.1.2).

[3] Reference number from QAPP Worksheet #23 (see Section 3.2).

[4] Detected blank contaminants must be less than the Project Quantitation Limit (PQL) Goal listed in Worksheet #15. For samples analyzed according to CLP SOW , blank concentrations up to 3 times the PQL are allowable for Pb, As, >>>.

[5] The sample detection limit (SDL) must be less than the PQL Goal (see Worksheet #15).

[6] These criteria apply to each individual target analyte reported by the analytical methods.

[7] A maximum RSD criteria of 25% is specified for all samples including low concentration samples. If this criterion cannot be met, the ability to assess uncertainty at low levels may be technology limited.

CLP	Contract Laboratory Program	RSD	Relative Standard Deviation
LCS	Laboratory control sample	SDL	Sample Detection Limit
LCSD	Laboratory control sample duplicate	SOP	Standard operating procedure
MS	Matrix spike	SOW	Statement of Work
MSD	Matrix spike duplicate		

QAPP WORKSHEET #13
Secondary Data Criteria and Limitations Table

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
XRF and CLP data from 2010 sampling conducted by CDPHE under Cooperative Agreement with EPA	CDPHE, Analytical Results Report, June 2011	CDPHE, XRF and CLP metals Sampling Event conducted Sampling activities included the collection of waste pile samples, residential yard soil samples, indoor and attic dust samples, public access road right-of-way and vacant lot samples, and background soil samples, all for metals analysis. Surface water and sediment samples were also collected and analyzed for metals. All samples were collected June 21 – 23, 2010.	These data will not be used for risk screening and risk assessment. Data will be used to establish expected contaminant concentration ranges.	Data will not be used for risk screening or risk assessment.
County property parcel information	Pueblo County	Unknown	Visual presentation of information	Parcel information does not include survey data, therefore may not provide accurate information.
XRF and CLP data from 2015 DMA conducted by PWT under contract to EPA(PWT 2015c)	PWT, Demonstration of Methods Applicability at Colorado Smelter, Data Summary Report, September 2015	PWT, XRF and CLP metals, May and June 2015	Data were used to plan the RI sampling approach, and will be used to guide RI work.	None

QAPP WORKSHEET #14
Summary of Project Tasks

Sampling Tasks: Sample collection per PWT-COS- 427 and PWT-ENSE-430

Sample Processing Tasks: Sample preparation per PWT-COS- 302

Analysis Tasks:

- Metals in soil via XRF analysis per SOP PWT-COS- 303
- Metals in soil and dust via CLP SOW method ISMO1.3, EPA SW846/ICP methods 6020B and 7471B
- Arsenic and lead bioavailability and geospeciation analysis of soil by EPA Method 9200.2-86 for IVBA Lead and IVBA Arsenic

Quality Control Tasks: Full EPA QA program including field and laboratory QC checks, auditing/oversight, and data review/validation. 100% of data will be verified, and 10% of data will be validated.

Secondary Data: Establish expected ranges of contaminant concentrations. Compile and review of historical site data for development of preliminary and baseline CSM. Obtain parcel layers from Pueblo County.

Other Data: No other data is expected to be used.

Data Management Tasks: Sample tracking and documentation, field data entry, data mapping, statistical analyses, data verification, data qualifier entry, and database upload.

Documentation and Records: Per EPA QA and CLP requirements (per CLP SOW and SEDD requirements).

Assessment / Audit Tasks: Field and laboratory audits as determined by project chemist and QA staff.

Data Review Tasks: Data verification and completeness checks for 100% of data, data validation in accordance with EPA National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014) for 10% of the CLP data. Validation of XRF data utilizes the checklist provided in Appendix B.

QAPP WORKSHEET #15A

Reference Limits and Evaluation Table – Metals by XRF

Matrix: Soil
Analytical Group: Metals by XRF
Concentration Level: All levels definitive analysis per PWT-COS-303

Analyte	CAS Number	Project Action Limit (i.e. Decision Criteria) * (mg/kg)	XRF Project Quantitation Limit	Achievable XRF Limits	
				Device Detection Limits (mg/kg)	QLs
Arsenic	7440-38-2	0.39 *	TBD	3	TBD
Lead	7439-92-1	400 *	TBD	5	TBD

TBD To be determined by the field XRF instrument; actual detection limits reported by the instrument for each sample are the quantitation limits.

* The project action limit may be adjusted based on factors such as background study results, bioavailability results, or changes to EPA policy for screening levels. Instrument performance will be documented at a range of concentrations to permit these adjustment to be made.

QAPP WORKSHEET #15B

Reference Limits and Evaluation Table – Metals by ICP-MS

Matrix: Soil / Dust
Analytical Group: Target Analyte List (TAL) Metals by CLP Method 6020B
Concentration Level: Low-level definitive analysis by CLP-SOW ISMO1.3/1.2 Method 6020B

Analyte	CAS Number	Analytical Method		Achievable Laboratory Limits	
		MDLs	CRQLs	MDL[1]	MRL[1]
Antimony	7440-36-0	ND	1	0.02	0.05
Arsenic	7440-38-2	ND	0.5	0.2	0.5
Barium	7440-39-3	ND	5	0.02	0.05
Beryllium	7440-41-7	ND	0.5	0.005	0.02
Cadmium	7440-43-9	ND	0.5	0.009	0.02
Chromium	7440-47-3	ND	1	0.07	0.2
Cobalt	7440-48-4	ND	0.5	0.009	0.02
Copper	7440-50-8	ND	1	0.04	0.1
Lead	7439-92-1	ND	0.5	0.02	0.05
Manganese	7439-96-5	ND	0.5	0.02	0.05
Nickel	7440-02-0	ND	0.5	0.04	0.2
Selenium	7782-49-2	ND	2.5	0.2	1
Silver	7440-22-4	ND	0.5	0.005	0.02
Thallium	7440-28-0	ND	0.5	0.002	0.02
Vanadium	7440-62-2	ND	2.5	0.08	0.2
Zinc	7440-66-6	ND	1	0.2	0.5

1. Typical Achievable Laboratory Limits MDL and MRL; source ALS Laboratories.

MDL	Method Detection Limit
CRQL	Contract Required Quantitation Limit
MRL	Method Reporting Limit
NA	Not applicable
ND	Not developed (laboratory-dependent)

QAPP WORKSHEET #15C

Reference Limits and Evaluation Table – Metals by CVAA

Matrix: Soil
Analytical Group: Mercury by CLP Method 7471B
Concentration Level: Low-level definitive analysis by CLP-SOW ISMO1.3/1.2 Method 7471B

Analyte	CAS Number	Analytical Method		Achievable Laboratory Limits	
		MDLs	CRQLs	MDL[1]	MRL[1]
Mercury	7439-97-6	ND	0.1	0.02	0.05

1. Typical Achievable Laboratory Limits MDL and MRL; source ALS Laboratories.

MDL	Method Detection Limit
CRQL	Contract Required Quantitation Limit
MRL	Method Reporting Limit
NA	Not applicable
ND	Not developed (laboratory-dependent)

QAPP WORKSHEET #16

Project Schedule / Timeline Table

Activities	Organization	Anticipated Date(s) of Initiation	Anticipated Date of Completion	Deliverable	Deliverable Due Date
Review Historical Documentation and Data (see Figure 1, Attachment)	PWT, TtEMI	2014	March 2015	Preliminary CSM and Supporting Information	NA
Systematic Planning Meeting	PWT, TtEMI, EPA, CDPHE	January 2015	March 2015	DMA QAPP	May 2015
DMA Field Work	PWT, TtEMI, EPA	March, 2015	June, 2015	DMA Data Summary Report	September, 2015
Systematic Planning Meeting for RI	PWT, TtEMI, EPA, CDPHE	July 29, 2015	August 6, 2015	RI QAPP	November 2015
RI Property Selection	PWT, EPA	September 11, 2015	Will occur on an ongoing basis throughout the project	List of approved properties	TBD
RI Property Recon	PWT, EPA, CDPHE	September 21, 2015	September 30, 2015	NA	NA
RI QAPP completion – attach PWT and EPA HQ/ERT (as applicable) SOPs	PWT/TtEMI, EPA HQ staff (EPA R8 delegated approving official)	September 1, 2015	November 13, 2015	RI UFP QAPP	November 13, 2015
Lab Procurement - CLP	PWT	September 15, 2015	November 13, 2015	Approved LSRs	November 13, 2015
Lab Procurement – CU	PWT	September 15, 2015	November 30, 2015	CU acknowledgement of analytical work	November 30, 2015

Activities	Organization	Anticipated Date(s) of Initiation	Anticipated Date of Completion	Deliverable	Deliverable Due Date
RI Field Lab restocked and equipment calibration checks	PWT, TtEMI	November 2, 2015	November 13, 2015	XRF control charts, other equipment logs	NA
RI Sampling Effort(s)	PWT, TtEMI, EPA HQ staff Steve Dyment or Deana Crumbling	November 16, 2015	TBD	XRF data	Ongoing basis
Selection of samples for CLP analysis	PWT, TtEMI, EPA	November 23, 2015	TBD	Field log, SCRIBE documentation of which samples should be submitted to CLP	Ongoing basis
Selection of samples for Bioavailability/ Geospeciation	PWT, TtEMI, EPA	November 23, 2015	TBD	Field log, SCRIBE documentation of which samples should be submitted to CU for Bioavailability/ Geospeciation	Ongoing basis
XRF data validation	E2	November 23, 2015	TBD	XRF validation report	Ongoing basis
CLP data validation	E2	November 30, 2015	TBD	CLP validation report	Ongoing basis
Receipt and analysis of Bioavailability and Geospeciation data	CU – John Drexler to PWT; PWT/TtEMI, EPA (Charlie Partridge)	January 1, 2016	TBD	Bioavailability and Geospeciation Report	Ongoing basis
RI Completion	PWT, TtEMI	September, 2016	TBD	RI Report	December, 2016

QAPP WORKSHEET #17

Sampling Design and Rationale

Describe the project sampling approach. Provide the rationale for selecting sample locations and matrices for each analytical group and concentration level.

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

Based on results from the DMA, sampling teams will collect 5-point composite samples at most DUs (PWT 2015c). Triplicate 5-point composites will be collected at a frequency of one triplicate sample set per 20 investigative samples. For DUs with an area exceeding 5,000 square feet at the site, 30-point incremental approach will be used, with triplicate 30-point composites to be collected from approximately 5% of such DUs.

The number and size of DUs planned for a typical residential property at the Site were evaluated during systematic planning as part of the data quality objectives (DQO) process, and the sampling design (number and size of DUs to be sampled at each residential property) is site-specific based on the Site's conceptual site model (CSM) (See Worksheet #10) and sampling objectives (See Figure 1, Attachment A, Worksheets #9A, #9B, and #11).

A DU is defined as the smallest area about which a risk-based decision can be made. For residential use at the site, DUs are designated based on the attributes of the property and apparent use as it relates to risk. Most properties anticipated to be evaluated in the RI are <0.5 acres in size (the properties investigated during the DMA ranged from 0.07 to 0.47 acres). Properties are further segregated into DUs such as front yard, side yard, back yard, and street apron. Special DUs such as house drip line, garden, and play areas may also be designated at certain properties. Determining appropriately sized DUs is a critical function of systematic planning, and the approach to determining DU areas for the RI was developed in consultation with risk assessors and other key technical team members to ensure DUs match exposure units (EUs) and exposure assumptions.

A property database has been created to track property ownership and access permissions for properties within the site. This database includes: unique property ID, address, year built, area (sq. ft.), size in acres, sensitive population data, and structure building material. The Preliminary Study Area is shown in Figure 7 of this section.

RI soil sampling will consist of a blend of complementary approaches, with a majority of samples collected using a five-point composite procedure and a subset of samples collected using a 30-point ICS procedure. This blended sampling approach was selected because sampling designs using 30 or more increments have lower variability than discrete sample data and a higher level of reproducibility (Hawaii DOH 2009), and during the 2015 DMA, incremental samples were shown to outperform the 5-point composite technique in terms of estimating the mean concentration and using the UCL on the mean for statistical confidence in decision making within DUs (PWT 2015c). However, the DMA showed that the improvement was small, and that decision errors are expected to be within an acceptable range of 5% false negatives and 20% false positives using a 5-point approach, which will expedite sample collection and analysis effort at the Site.

Composite samples will consist of 5 increments combined into a single composite sample. All DUs within a property except special DUs (defined below) will have one 5-point composite sample collected at each of 4 depth intervals between ground surface and 18 inches. Special DUs include the following:

- DUs where subsurface utilities do not allow safe collection of samples to full depth. These DUs will be sampled using the 5-point composite approach, but may not be collected to full depth.
- DUs where a competent weed barrier is known to be present (this was common in garden DUs during the DMA, but sometimes occured for other DU types also). These DUs will be sampled using the 5-point composite approach, but may not be collected to full depth.
- DUs with areas greater than 5,000 square feet, which will be sampled using the 30-point incremental approach.

One investigative sample in 20 will have one 5-point composite sample and two replicate composite samples associated with it. Samples collected in triplicate will allow an estimation of the DU/depth mean concentration, calculation of a UCL on the mean and an estimate of variability.

Individual soil increments (that make up an incremental sample) are expected to typically weigh between 5 and 50 grams each. When choosing the mass per increment, the field composite sample should typically weigh between 300 and 2,500 g after sieving soil samples to the target particle size. The “300 to 2,500 g” suggestion is based on the mass sufficient to minimize Gy’s Fundamental Error for sample collection (USEPA 1999). However, for the RI it should be noted that sieving of “raw” incremental- and composite samples to a particle size less than 250 microns (the particle size of interest identified by project risk assessor and consistent with the August 2003 EPA *Superfund Lead-contaminated Residential Sites Handbook*), will be completed in the field laboratory, reducing the amount of soil mass available for analysis. Further, some of the dried and sieved samples will be subsampled for ICP analysis in small bags and weigh 1-2 grams. This mass is sufficient to analyze using XRF (which is nondestructive and can therefore be replicated). The entire mass in the small bag will be sent to a fixed lab as a single sample for digestion and analysis by ICP. This procedure will remove the need to manage sub-sampling error via Gy sampling techniques.

The entire sample preparation, subsampling and analysis process was taken into consideration during DQO development (see Worksheets #10 and #11) when the target increment mass and target soil particle size was determined. The mass of the composite sample is a function of the number of increments collected, the depth at which samples were collected, the size of the sample collection tool utilized, the total number and type of analyses planned, and the laboratory digestion/analysis mass required for each test. Consideration of these factors is recorded in Worksheet #17, section 17.2.2. As discussed below, the mass of the incremental and composite samples will be reduced by sieving to <250 microns in size prior to analysis via XRF or submittal to the laboratory. The < 250 micron sized soil particles are of most interest for contaminant analysis due to exposure considerations, while larger particles are unlikely to be mistakenly ingested.

Indoor dust will be sampled at select properties. Dust sampling will be performed in accordance with PWT-ENSE-430, the PWT Team indoor dust sampling SOP. A minimum of three and a maximum of five discrete dust samples may be collected in the living areas of each residence. One composite sample will be collected from the attic, if an attic exists, and if the resident can routinely access the attic (by stairway, ladder/trap door, etc), and if the resident uses the attic for storage. If collected, the attic sample will be collected by vacuuming the exposed horizontal surfaces in the attic, such as rafter tops or flooring. If possible, dust will be collected from portions of the attic which appear relatively undisturbed. If vermiculite or suspected/known asbestos is visually observed in the attic or noted by the homeowner, no sampling will occur.

Areas sampled inside the home will vary by residence, but generally, samples will be collected from the main entryway (front door or preferred entry), the floor area in the most frequently occupied room (usually the kitchen or living room), and the floor in a child's bedroom (or any bedroom if there are no children living in the home).

In order to correctly identify sampling areas, a pre-sampling questionnaire will be completed by the residents (or with the residents) before sampling begins. Copies of this questionnaire and the indoor dust sampling form are included with the SOP in Appendix A.

The total floor area vacuumed for each dust sample will depend on the volume of dust present in each sampling area. The target sample mass is a minimum of 20 grams of sample, but at a minimum, enough dust to completely cover the bottom of the sample container must be collected. The floor area from which dust is collected will be measured and recorded to calculate the dust and metals loading for different parts of the home. If there is not enough dust present in the living spaces of the home to send discrete samples for analysis, the discrete living space samples will be composited. Under no circumstances will attic samples be mixed with discrete or composite living area samples.

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

At most DUs, a single 5-point composite sample will be collected at four intervals between ground surface and 18" bgs, with depth horizons of 0-1 inch, 1-6 inches, 6-12 inches, and 12-18 inches. Once per twenty investigative samples, a sample and two replicate 5-point composite samples will be collected to generate a triplicate sample set. In selected DUs, a single ICS will be collected for the 0-1 inch soil horizon, and 5-point composites will be collected for all four depth horizons.

Samples will be dried, disaggregated, sieved to <250 microns, measured via XRF in a larger bag and 1-2 grams placed in a small sample bag. Each bag will be analyzed via XRF in the field laboratory, (including replicates/triplicates) for calculation of a sample mean and UCL and a percentage of the bag samples will be submitted for analysis via ICP methods where the entire 1-2 gram soil mass will be digested and analyzed. If samples are also needed for bioavailability or metals speciation the procedure is repeated starting with collection of the 1-2 gram sample (these methods also require and will digest the entire 1-2 gram mass).

Properties within the Preliminary Study Area will be chosen based on logistics, schedule, and access, and preliminary DUs will be assigned based on property layout and apparent use. Properties in the DMA ranged in size from 0.1 acres to 0.5 acres in size with most in 0.1 to 0.2 acre range; a similar range is expected in the RI (PWT 2015c). The number of DUs identified for the DMA properties ranged from 3 to 6 depending on the property layout, exposed soil (i.e., unpaved), and the presence of specialty DUs like drip lines, gardens, and play areas. A similar range of DUs per property is expected during the RI.

17.2.1 Sample Collection Procedure for a DU

To collect incremental samples from each DU, a systematic random transect walk or a systematic random grid with grid blocks, is the general approach to the increment collection scheme. The incremental layout scheme will be determined manually and will result in generally equal distribution of increment collection points across the DU. Field samplers may also walk the DU, collecting increments as they pace the area in a systematic way. For example, a square-shaped DU may be divided into five rows, with six increments collected from each row in a systematic random fashion, with an initial random starting point. For more rectangular-shaped DUs, fewer rows might be used, with more increments per row collected. Row lengths and increments per row may be modified as needed to accommodate a variety of DU shapes and orientations. Figure 1 and 2 provide examples of how incremental and incremental triplicate samples may be oriented, flagged, and sampled. Figures 3-6 show common point orientations used in 5-point composite schemes. In each case increment or points will be offset for the collection of triplicate samples.

Figure 1. Single DU with 30 Increments Going into a Single ICS Sample

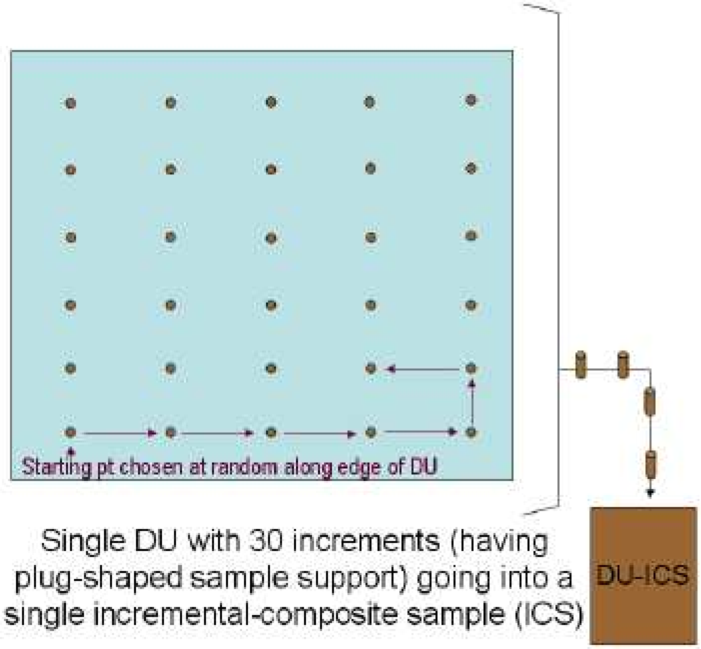


Figure 2. Three Replicate DU-ICS Samples of 30 Increments Each

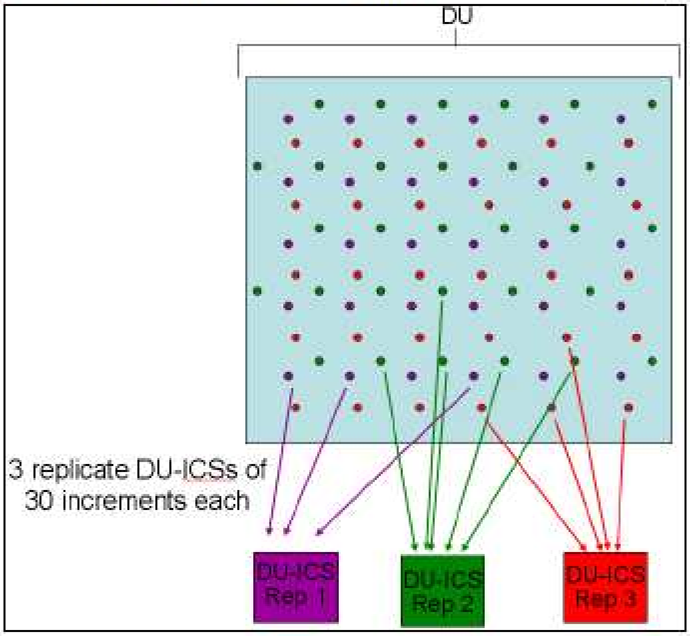


Figure 3 Examples of Commonly Used 5point composite aliquot orientation

From the EPA Superfund Lead-Contaminated Residential Sites Handbook
OSWER 9285.7-50

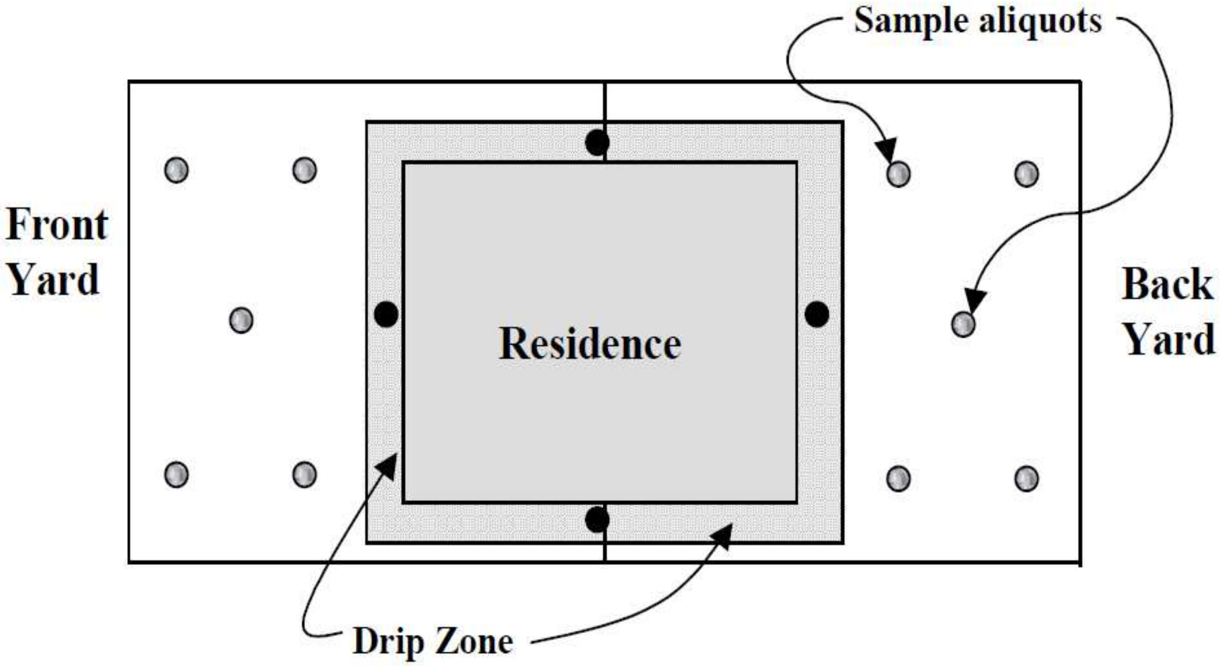


Figure 4

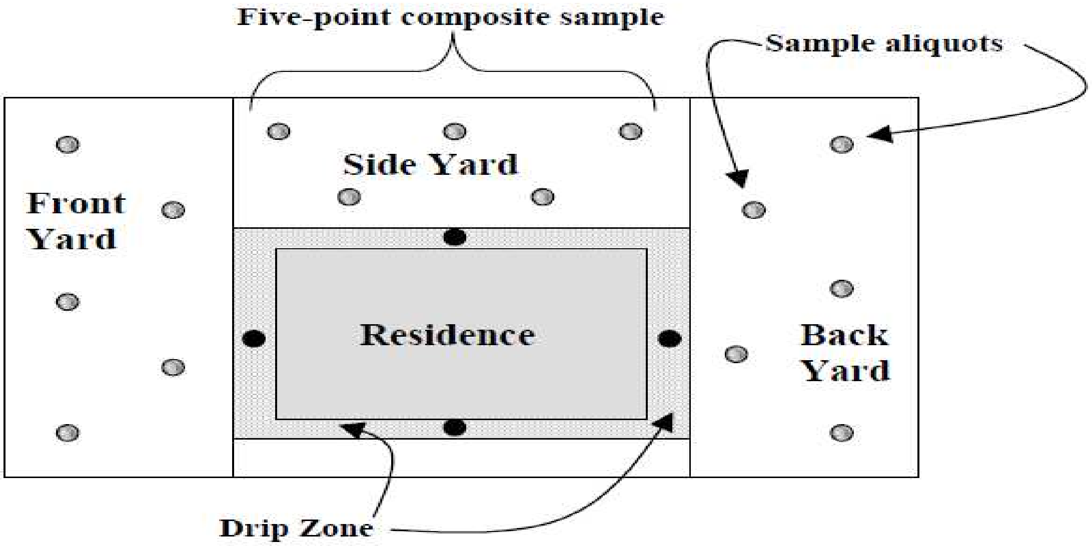
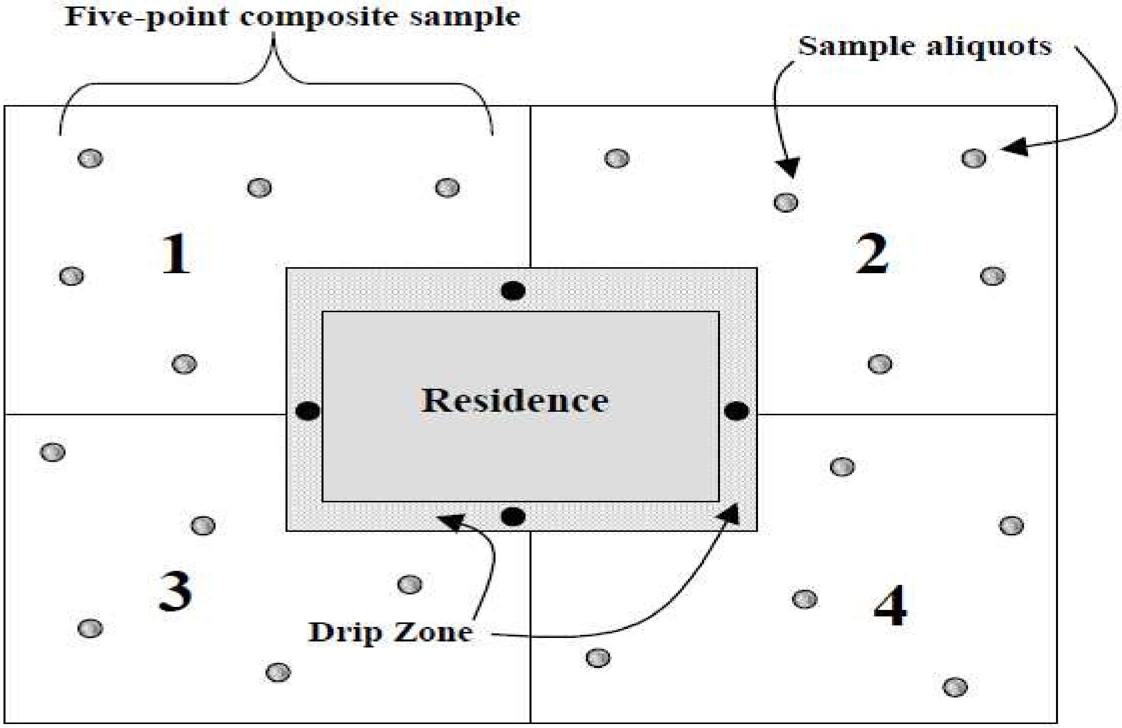


Figure 5



The ends of each row will be marked with flags to help establish approximate lines for the collection of increments. Flags will also be placed along the edges of the DU parallel to the rows to help ensure approximate spacing. Flags will be placed at every increment collection point. Global Positioning System (GPS) technology or surveys consistent with methodology approved in the DMA QAPP will be used to document the DU location and to create maps for the RI soil investigation. With the exception of cases where a modified mapping need is identified, only the four corners of the DU (or enough points to delineate a DU's irregular shape) will be located via GPS or a sufficient number of locations for survey. As GPS location information can be several feet off, depending on the specific GPS device used; this factor was considered in establishing DQOs for the investigation.

For a systematic random walk collection, 30 individual soil increments are determined by "pacing" a set distance along the rows of the DU, and not individually measured.

For a systematic random walk with grid blocks increment collection, 30 to 60 equal-sized blocks are first established (e.g., a grid established across the DU), then a random location would be selected in each grid block to collect a single increment.

Increments will be collected in a manner that produces a cylindrical or core-shaped sample to the extent possible.

One goal of the DMA was to determine the best approach for collecting increments including the requirement to obtain increments from 4 distinct soil horizons (0-1 inch, 1-6 inches, 6-12 inches, 12-18 inches). For incremental and composite samples collected from within the 0-18 inches interval bgs, the tools described in the DMA Sample Collection SOP were proved to be adequate for the RI (PWT 2015a). If problems with soil sample collection are unexpectedly encountered during implementation of the RI, this sample collection SOP will be revisited, and any necessary and appropriate revisions to the procedure will be considered at that time.

Care will be taken to collect samples that contain the same amount of soil particles from the top of the sampled depth interval as the bottom. Care will be taken to collect equal volumes of soil from each location for all composite samples. The soil for each increment and each depth horizon will be placed in a large bag along with all the other increments for that depth horizon. Soil will be processed in the field laboratory by drying, disaggregating, and sieving to <250 microns before analysis.

The sample preparation process of drying, disaggregation, and sieving will be used as the method for mass reduction. Subsampling to generate representative 1-2 gram samples of a uniform particle size for XRF and ICP analysis will be conducted in accordance with the SOPs for sample preparation (PWT-COS-302) and sample analysis (PWT-COS-303). All sample containers will be labeled and stored as described in Worksheet #27.

17.2.3 Field Replicates

When the number and spacing of field increments are adequately “representative,” repeat measurements within the same DU are expected to provide similar estimates of the average contaminant concentration. Field replicate results (planned as triplicates) will be used as a QC check to evaluate acceptable performance of the sampling and analysis chain, including having an appropriate number of increments and adequate homogenization in sample preparation (see Figure 6). This data will be used to assess decision error rates and confirm that they remain within the target goals of 5% false negatives and 20% false positives.

Determining whether the estimate of average contaminant concentration(s) will be adequately representative for the area under investigation (per the established DQO criteria for the statistical evaluation of the ICS analytical data) was a primary goal of the DMA (PWT 2015c). For this project, field replicates (triplicates) will be collected for approximately 5% of non-specialty DU samples. There are a number of options available for determining what measure of data variation from the mean will be used when evaluating the field replicate measurements and comparing the data to applicable criteria. If the increment density, or some other aspect of the sampling and analytical design is not sufficient to support DU decision-making, this will show up mathematically when evaluating the decision error rates.

The usual link between variability and decision-making is the UCL. The greater the variability between the replicates, the higher the UCL on the mean will be. The greater the numerical gap between the mean of the replicates and the UCL from the replicates, the greater the amount of uncertainty in the data. The SD for the replicates will be calculated using preprogrammed spreadsheets provided by EPA OSRTI/TIFSD/TIIB. The SD will be used in the equation to calculate the UCL and to calculate the relative standard deviation (RSD). The equation for the RSD is the SD of the replicates divided by the average of the replicates times 100%. The UCL may be used qualitatively. During the DMA, it was demonstrated that the variability associated with both the 5-point composite approach and the 30-point composite approach were low enough that decision error rates were acceptable rates. These decision error rates will continue to be monitored during the RI.

Side by side replicate samples will be used to assess variability in indoor dust and to assess sampling and analytical precision. A replicate sample pair will consist of samples collected from immediately adjacent floor surfaces in the same room. For each replicate sample pair, one of the samples is labeled with the investigative sample identification and the other is labeled with the replicate sample identification in accordance with the naming convention described in Section 7.3.1. This sample pair is then submitted to the same laboratory and analyzed as two separate samples.

Precision will be evaluated by calculating the RPD between the field replicate samples. For field replicate pairs whose measured values are both greater than the MRL. The RPD is expected to be less than 35 percent for replicate dust sample pairs, with RPD higher than 35 percent indicating a high level of heterogeneity in the solid matrix. If highly variable dust is encountered, as evidenced by RPDs consistently above 35 percent, then the duplicate frequency in the subsequent sampling event may be increased to ensure that representative data are collected. The frequency for replicate dust samples will be one per 20 indoor/attic dust samples.

At this time, no different statistical data assessment procedures are planned; however, if they are determined to be needed, a QAPP Addendum will be attached that will explain why different statistical data assessment procedures were needed.

17.2.3.1 Relative Standard Deviation (RSD)

The RSD is a measure of the variation among a group of sample results. It will be used to assess the degree of variability between a set of DU replicates. The degree of variability is also related to the shape of the data distribution. A skewed shape (where one side is pulled out, for example, a lognormal distribution) has a higher RSD than a normal distribution. Therefore the RSD can be used as an indicator of the parent distribution from which the replicates came. RSD is the only statistical test that can be applied to determine distribution shape, since all standard statistical techniques require more than 3 data results. Computer simulations have led statisticians to make the following recommendations, which can be used to aid data assessment:

- If the RSD is low (i.e., less than 1.5), the Student's t-distribution will be used to calculate the 95% UCL for the concentration.
- If the RSD is between 1.5 and 3, the non-parametric Chebyshev 95% UCL will be used.
- If the RSD is high (greater than 3), the non-parametric Chebyshev 99% UCL will be used. Although this is a 99% UCL by calculation, it is treated as a 95% UCL for the purposes of decision-making when the RSD is high.

17.2.3.2 Calculating the 95 Percent Upper Confidence Limit for a DU

$$UCL_{95\%,Students-t} = \bar{C} + \frac{t_{0.95} \times s}{\sqrt{n}}$$

Where:

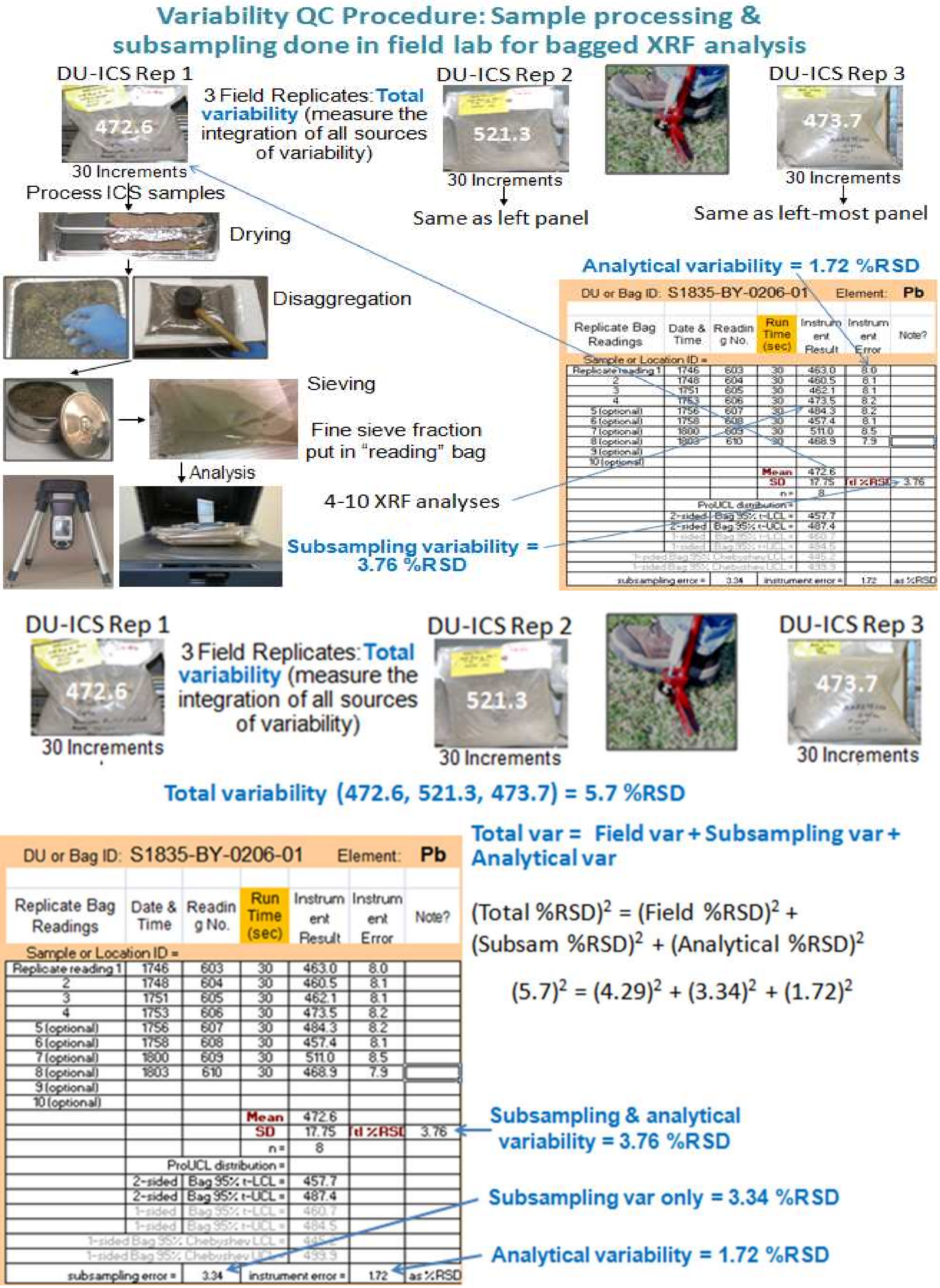
$UCL_{95\%,\text{Students-t}}$ = 95% UCL based on Student's t distribution
C = mean concentration for the samples in the DU
$t_{0.95}$ = one-sided Student's t factor, based on 95% confidence and the number of samples
s = standard deviation for the samples in the DU
n = number of samples collected in the DU

$$UCL_{95\%,Chebyshev} = \bar{C} + \frac{4.359 \times s}{\sqrt{n}}$$

$$UCL_{99\%,Chebyshev} = \bar{C} + \frac{9.950 \times s}{\sqrt{n}}$$

Unacceptably high data variability (i.e., high RSDs for triplicates and associated high decision error rates) may suggest that the DU's matrix heterogeneity requires denser incremental sampling coverage to ensure an accurate representation of the DU's average, or it may indicate that sample preparation and homogenization procedures were not rigorous enough for this matrix. If necessary, the source of high variability can be evaluated with a series of field and laboratory replicates as shown in Figure 6 below.

Figure 6 Variability Source QC Procedure: Measures Sources of Data Variability



Variability QC Procedure: Sample processing & subsampling done in field lab for bagged XRF analysis

3 Field Replicates: **Total variability** (measure the integration of all sources of variability)

Process ICS samples → Drying → Disaggregation → Sieving → Fine sieve fraction put in "reading" bag → Analysis → 4-10 XRF analyses

Rep 2: Same as left panel

Rep 3: Same as left-most panel

Analytical variability = 1.72 %RSD

Subsampling variability = 3.76 %RSD

DU or Bag ID: S1835-BY-0206-01 Element: Pb

Replicate Bag Readings	Date & Time	Reading No.	Run Time (sec)	Instrument Result	Instrument Error	Note?
Sample or Location ID =						
Replicate reading 1	1746	603	30	463.0	8.0	
2	1748	604	30	460.5	8.1	
3	1751	605	30	462.1	8.1	
4	1753	606	30	473.5	8.2	
5 (optional)	1756	607	30	484.3	8.2	
6 (optional)	1758	608	30	457.4	8.1	
7 (optional)	1800	609	30	511.0	8.5	
8 (optional)	1803	610	30	468.9	7.9	
9 (optional)						
10 (optional)						
			Mean	472.6		
			SD	17.75	Std %RSD	3.76
			n =	8		
		ProUCL distribution =				
	2-sided	Bag 95% t-LCL =		457.7		
	2-sided	Bag 95% t-UCL =		487.4		
	1-sided	Bag 95% t-LCL =		460.7		
	1-sided	Bag 95% t-UCL =		484.5		
1-sided Bag 95% Chebyshev LCL =				445.2		
1-sided Bag 95% Chebyshev UCL =				499.9		
subsampling error =		3.34	instrument error =		1.72	as %RSD

DU-ICS Rep 1
472.6
30 Increments
3 Field Replicates: Total variability (measure the integration of all sources of variability)
DU-ICS Rep 2
521.3
30 Increments
DU-ICS Rep 3
473.7
30 Increments

Total variability (472.6, 521.3, 473.7) = 5.7 %RSD

Total var = Field var + Subsampling var + Analytical var

$$(\text{Total \%RSD})^2 = (\text{Field \%RSD})^2 + (\text{Subsam \%RSD})^2 + (\text{Analytical \%RSD})^2$$

$$(5.7)^2 = (4.29)^2 + (3.34)^2 + (1.72)^2$$

DU or Bag ID: S1835-BY-0206-01 Element: Pb

Replicate Bag Readings	Date & Time	Reading No.	Run Time (sec)	Instrument Result	Instrument Error	Note?
Sample or Location ID =						
Replicate reading 1	1746	603	30	463.0	8.0	
2	1748	604	30	460.5	8.1	
3	1751	605	30	462.1	8.1	
4	1753	606	30	473.5	8.2	
5 (optional)	1756	607	30	484.3	8.2	
6 (optional)	1758	608	30	457.4	8.1	
7 (optional)	1800	609	30	511.0	8.5	
8 (optional)	1803	610	30	468.9	7.9	
9 (optional)						
10 (optional)						
			Mean	472.6		
			SD	17.75	Std %RSD	3.76
			n =	8		
		ProUCL distribution =				
	2-sided	Bag 95% t-LCL =		457.7		
	2-sided	Bag 95% t-UCL =		487.4		
	1-sided	Bag 95% t-LCL =		460.7		
	1-sided	Bag 95% t-UCL =		484.5		
1-sided Bag 95% Chebyshev LCL =				445.2		
1-sided Bag 95% Chebyshev UCL =				499.9		
subsampling error =		3.34	instrument error =		1.72	as %RSD

Subsampling & analytical variability = 3.76 %RSD

Subsampling var only = 3.34 %RSD

Analytical variability = 1.72 %RSD

This procedure evaluates which steps in the sampling and analytical procedures are contributing most to overall variability. If the source of variability is in sample preparation (which will be revealed through the analysis of the sample preparation replicates), increasing the number of increments will not address the problem.

For this project, the mean of measurements for a particular DU/depth interval will be compared directly with the applicable threshold value. Triplicate results will be used to assess whether decision error rate targets are being met. ; If the triplicate data indicate that decision error rates are not being met, then additional evaluation of the field data and the “variability source” QC data may be performed, and action may be taken to reduce data variability and decision uncertainty, possible including collecting more increments, modifying sample prep procedures, resampling using an SU strategy to isolate hotspots and reduce DU replicate variability, etc.

17.2.3.3 Sample Collection Procedure for Collecting DU Replicates

DU replicates (triplicates) will be collected at the same time that original DU samples are collected at a frequency of one triplicate set per twenty investigative samples. An identical number of increments as used in the investigative sample will be collected for each of two field replicates.

17.2.4 Sample Collection for Anomalous Locations

During the field sampling efforts, if areas are noticeably different than surrounding areas, or have been previously identified by the CSM as a potential anomalous area, a separate DU will be formed specifically for this area (specialty DUs such as drip lines, play areas, gardens). These areas may be sampled by collecting either typical composite samples or ICS depending on the size of the area and ability to collect aliquots or increments to form an independent DU sample. All sample bags will be labeled and stored as described in Worksheet #27.

Colorado Smelter Preliminary Study Area

FIGURE 7

▭	CO_Smelter_Site_Limit (OU2)
	Preliminary Study Area Boundary (OU1
▭	ColoParcels_Master

PACIFIC WESTERN TECHNOLOGIES, LTD.

0 445 890 1,780 2,670 3,560 Feet

QAPP WORKSHEET #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location / ID Number	Matrix	Depth (" = inches bgs)	Analytical Group	Concentration Level	Number of Samples	Sampling SOP Reference	Rationale for Sampling Location
1,200 properties within Eilers/Bessemer (estimated number, subject to ability to obtain access). See Figure 7 for study area.	Soil	Surface and subsurface soil sample depths: 0”-1”, 1”-6”, 6”-12”, 12”-18”	Inorganic (Metals)	Low to Moderate	24,000	PWT-COS-427	See Worksheet 17
Up to 1,200 properties within Eilers/Bessemer opting for indoor dust sampling (estimated number, subject to ability to obtain access)	Dust	Surface	Inorganic (Metals)	Low to Moderate	7,200	PWT-ENSE-430	See Worksheet 17
Up to 100 non-residential properties within Eilers/Bessemer such as parks, schools, churches, commercial properties, and alleys (estimated number, subject to ability to obtain access)	Soil	Surface and subsurface soil sample depths: 0”-1”, 1”-6”, 6”-12”, 12”-18”	Inorganic (Metals)	Low to Moderate	400	PWT-COS-427	See Worksheet 17

QAPP WORKSHEET #19
Analytical SOP Requirements Table

Matrix	**Analytical Group**	**Concentration Level**	**Analytical and Preparation Method / SOP Reference**	**Sample Size**	**Containers** (number, size, and type)	**Preservation Requirement**[1] (chemical, temperature, light protected)	**Maximum Holding Time** (preparation / analysis)
Soil	Metals	All	XRF Analysis SOP PWT-COS-303	Varies (see PWT-COS-427)	Approved Plastic bags	None	Up to 6 months
Soil	Metals	All	CLP	Analytical aliquot volume 1-2 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months
Dust	Metals	All	CLP	Analytical aliquot volume 20 grams	Polyethylene or fluorinated ethylene propylene sample bottles, 250-mL	Cool, 4+/- 2˚ C, dark	Up to 6 months
Soil	Lead and Arsenic bioavailability	All	CLP	Analytical aliquot volume 1.5 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months
Soil	Lead and Arsenic geospeciation	All	Metal Speciation SOP	Analytical aliquot volume 1.5 grams	Approved Plastic bags	Cool, 4+/- 2˚ C, dark	Up to 6 months

1- Temperature Preservation will not be employed during sample preparation. See SOP PWT-COS-302

QAPP WORKSHEET #20

Field Quality Control Sample Summary Table

Matrix	**Analytical Group**	**Conc. Level**	**Analytical and Preparation SOP Reference**	**No. of Samples**	**No. of Field Replicate Sets**	**No. of MS/MSD**	**No. of Source Blanks**	**No. of Equip. Blanks**	**Total No. of Samples to Lab**
Soil	XRF Metals	Low Level	PWT-COS-302 and PWT-COS-303	~24,400	One sample per 20 investigative samples	Not applicable	Not applicable	Not applicable	~25,300
Soil	CLP Metals	Low Level	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	~2,440	Not applicable	Minimum 5% of sampling areas	1 per change in decontamination water supply	1 per sampling week	~3,000
Soil	Mercury	Low Level	CLP SOW method ISM O1.3, EPA SW846/CVAA method 7471B	~1,220	One per 20 investigative samples	Minimum 5% of sampling areas	1 per change in decontamination water supply	1 per sampling week	~1,300
Dust	CLP Metals	Low Level	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	~7,200	1 per 20 homes sampled	Minimum 5% of samples	Not applicable	1 per 20 homes sampled	~7,680

Note: For ICP data

- ICP data will be validated in the usual way, except that laboratory duplicates will not be performed.
    - There is no need for lab duplicate QC because the ICP lab will not be performing any subsampling.
    - The function of matrix spikes for XRF data (checking for aberrant matrix behavior) will be accomplished during XRF-ICP comparability analysis. Any XRF-ICP pair that significantly deviates from the general relationship observed between XRF and ICP pairs will be flagged as a potential instance of matrix interference. If evaluation for matrix interference does not find evidence of it, evidence of a blunder affected the aberrant pair will be sought. If a blunder was found to occur, the data pair will be removed from comparability analysis. Potential matrix interference will be evaluated by
        - Looking in the field notebook to determine the type of matrix, and compare the suspicious pair to other paired sample analyses from matrices that might be similar;
        - Comparing the XRF spectrum for that sample to spectra from samples from a similar matrix; and
        - Obtaining and investigating the ICP spectrum for unusual behavior.

QAPP WORKSHEET #21
Project Sampling SOP References Table

Reference Number	**Title, Revision Date and / or Number**	**Originating Organization**	**Equipment Type**	**Modified for Project Work?** (Y/N)	**Comments**
PWT-COS-302	XRF Sample Preparation	EPA/PWT	NA	Y	SOPs are included as Attachment
PWT-COS-303	XRF Sample Analysis	EPA/PWT	Niton XL3t 955 GOLDD Ultra	Y	
PWT-ENSE-402	Spatial Data Submittals	PWT	NA	N	
PWT-ENSE-406	Sample Handling	PWT	NA	N	
PWT-ENSE-413	Utility Clearance	PWT	NA	N	
PWT-ENSE-423	Investigation Derived Waste Management	PWT	NA	N	
PWT-ENSE-430	Indoor and Attic Dust Sampling	PWT	HVS3 and Magnehelic gage	N	
PWT-ENSE-424	Personnel and Equipment Decontamination	PWT	NA	N	
PWT-COS-427	Surface and Shallow Sub-Surface Soil Sampling for Inorganics (Project Specific Procedure)	PWT	Varies, see SOP	Y	

QAPP WORKSHEET #22

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maint. Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference
Digital balance	Per manual	Per manual	Per manual	Per manual	Daily	Per manual	Per manual	Field Sample Lead / Field Lab Lead	User Manual
Sieve Shaker	NA	Per Manual	NA	Per manual	Per manual	NA	Per manual	Field Lab Lead	User Manual
Magnehelic gage	Per manual	Not applicable	Calibration	Not applicable	Daily	Per manual	Per manual	HVS3 Operator	PWT-ENSE-430

QAPP WORKSHEET #23

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)
EPA 9200.2-86	April 2012	Definitive	IVBA Lead	ICP-MS or ICP-AES	Drexler/CU Boulder	No
NA	June 2011	Definitive	IVBA Arsenic	ICP-MS or ICP-AES	Drexler/CU Boulder	No
NA	Rev 2 October 2007	Definitive	Metal Speciation SOP	Electron Microprobe	Drexler/CU Boulder	No

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
PWT-COS-303	Rev 1 April 2015	Definitive	Metals (Arsenic and Lead)	Niton XL3t 955 GOLDD Ultra	PWT / TtEMI Field Lab	Yes
PWT-COS-303	Rev 1 April 2015	TBD	Metals (other than Arsenic and Lead)	Niton XL3t 955 GOLDD Ultra	PWT / TtEMI Field Lab	Yes

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
6020	Rev 1 February 2007	Definitive	Metals	ICP-MS	Assigned CLP Lab	NO
7471B	Rev 2 February 2007	Definitive	Mercury	CVAA	Assigned CLP Lab	NO

SOP	Standard operating procedure

QAPP WORKSHEET #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Niton XL3t 955 GOLDD Ultra Portable XRF Analyzer	Internal calibration	Prior to start of work	Not applicable	Not applicable	Manufacturer	PWT-COS-303
	Control charting	Prior to start of work	Not applicable	Not applicable	XRF Analyst	
	Instrument Blank	Start of each sample batch (<10 samples)	No detectable amount of target analytes	Repeat blank analysis. If still out of compliance, troubleshoot instrument, and repeat blank analysis until corrected	XRF Analyst	
	Laboratory Control Samples	Start and end of each sample batch (< 20 samples)	Measured concentrations of each target analyte within ±2 standard deviations of the mean from control chart data	Repeat LCS analysis. If still out of compliance, troubleshoot instrument, repeat LCS analysis until corrected	XRF Analyst	
	Instrument Duplicates	Start of each day	None	None – used only as diagnostic information for troubleshooting	XRF Analyst	
Magnehelic gage	Flow check	Start of each day	Within 3% of primary calibration standard (inclined manometer)	Service instrument to correct problem, per manual	HVS Operator	PWT-ENSE-430

QAPP WORKSHEET #25

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
XRF-Niton XL3t 955 GOLDD Ultra		System Performance Check	Per manual	Per manual	Per manual	Per manual	XRF Analyst	PWT-COS-303
HVS3	Routine Startup Maintenance	Leak test	Per manual	Per property	Per manual	Per manual	HVS3 Operator	PWT-ENSE-430
Inclined manometer	Fluid replacement	Not applicable	Per manual	Annually or as needed	Not applicable	Per manual	HVS3 Operator	PWT-ENSE-430
Analytical balances	Routine Startup Maintenance	Not applicable	Per manual	Daily	Per manual	Per manual	XRF Prep Staff or XRF Analyst	PWT-COS-303
	Not applicable	Calibration mass checks	Per manual	Prior to and following each prep batch	Mass within 1% of known mass	Troubleshoot instrument	XRF Prep Staff or XRF Analyst	

Note: Spare parts will be obtained and kept in stock as recommended in the applicable instrument/equipment manuals.

XRF	X-ray Fluorescence Spectrophotometer
SOP	Standard operating procedure

QAPP WORKSHEET #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Sample Team, PWT and TtEMI
Sample Documentation (Personnel/Organization): Field Sample Lead, TtEMI
Sample Packaging (Personnel/Organization): Field Lab Lead, TtEMI
Type of Shipment (Personnel/Organization): Overnight carrier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory sample custodian
Sample Custody and Storage (Personnel/Organization): Laboratory sample custodian
Sample Preparation (Personnel/Organization): Laboratory Analyst
Sample Determinative Analysis (Personnel/Organization): Laboratory Analyst
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 365 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Per CLP contract requirements
SAMPLE DISPOSAL
Personnel/Organization: Field Lab Lead, TtEMI
Number of Days from Analysis: 180 days
Personnel/Organization: Laboratory sample custodian, CLP Laboratory
Number of Days from Analysis: 365 days
Personnel/Organization: John Drexler/ CU Boulder
Number of Days from Analysis: 365 days

QAPP WORKSHEET #27

Sample Custody Requirements

27.1 Sample Documentation

To minimize common problems such as labeling errors, chain-of-custody errors, transcription errors, or preservation failures, detailed procedures for properly recording sample information and analytical requests on chain-of-custody records, for preserving samples as appropriate, and for sample packaging and shipment are described below.

27.2 Sample Naming Convention

The sample naming convention has been designed to maximize the useful information recorded while minimizing opportunity for clerical errors in the field or at the lab. Each sample name will consist of up to four parts separated by hyphens.

The first part of the sample name is the letter "S" designating the matrix sampled as soil or the letter "D" for dust, followed by a unique four digit parcel code assigned by the PWT Team. Property codes will be used instead of addresses for privacy. The Property code is not the same as the county parcel ID number. The second part of the sample name identifies the feature sampled at the property. The third part of the soil sample name refers to the depth interval sampled, and the final part of the soil or dust sample name is a letter to designate other sample information, including the sampling methodology (incremental or 5-point composite) and whether the sample is the primary, replicate, or triplicate from the DU. Five-point composite samples will be assigned the trailing numbers 01, 02, and 03, to indicate primary, replicate, and triplicate samples, while incremental samples will be assigned the trailing numbers 04, 05, and 06.

For example, the sample name S1402-FY-0612-04 refers to a soil sample collected from the front yard at property 1402. The sample was collected from the 6 to 12 inch interval, and it is a primary incremental sample, as indicated by the trailing number "04". The DUs which might be sampled and the associated feature codes assigned are as follows:

For Soil:
  FY = front yard
  BY = back yard
  SY = side yard (if more than one side yard is present, a cardinal direction should be used to identify location, e.g. SYN, SYE, SYS, or SYW)
  AP = apron (area between sidewalk and roadway)
  DZ = drip zone
  PA = play area
  GA = garden
  ED = earthen drive
  WP1= waste pile 1, waste pile 2, etc.
For Dust:
  E = main entryway
  K = kitchen
  L = living room
  B = bedroom (if more than one bedroom is present, numerals and cardinal directions should be used to identify location, e.g. B1NE, B2S, etc.
  A = attic

A unique CLP number will be assigned to each sample in addition to its sample identification as described above. Both identifications will be recorded on the sample label and the chain-of-custody in accordance with CLP requirements as identified in the *Contract Laboratory Program Guidance for Field Samplers* (USEPA 2014).

27.3 Sample Labeling

Sample labeling will be completed in accordance with PWT's Sample Handling SOP (PWT-ENSE-406) provided in Appendix A. Sample labels will be generated from Scribe in advance of sampling, and completed in the field using water-proof ink. Labels will be attached to the sample bags/containers at the time each sample is collected. The following information will be included on the sample label:

- Project name
- Sample identification and unique CLP number
- Date and time of sample collection
- Preservation
- Analyses to be performed
- Sample matrix
- Sampler's initials.

27.4 Sample Field Forms

Sample field forms will be completed for soil samples at each sampled property and for dust samples when applicable. All sample field forms are to be completed at the time of sampling and will accompany samples from the field to the to the field soils laboratory. Signature lines on the sample list included on the soil sampling form shall document the transfer of custody from the field sampler to the field soils laboratory. Field forms for environmental sampling are attached to their respective sampling SOPs and are included in Appendix A for reference.

27.5 **Chain-of-Custody Records and Procedures**

To ensure that samples are identified correctly and remain representative of the environment, careful sample documentation and custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis.

27.6 Field Chain-of-Custody Procedures

Field sampling personnel will be responsible for ensuring that proper documentation and custody procedures are initiated at the time of sample collection and followed until custody of the samples is transferred to the field soils laboratory. Field Soils Laboratory personnel will be responsible for ensuring that proper documentation and custody procedures are maintained until samples are transferred to an analytical laboratory, a commercial freight carrier, or disposed of in accordance with applicable regulations. Field sampling personnel and field soils laboratory personnel will be required to become familiar with this QAPP and PWT's Sample Handling SOP (PWT-ENSE-406) (provided in Appendix A) prior to initiating field work. The analytical laboratories will be responsible for maintaining sample custody and documentation, in accordance with their CLP contract. The procedures outlined below generally describe this process from the time the analytical laboratory receives the samples until final sample disposition.

Chain-of-custody procedures provide an accurate written record of the possession of each sample from the time it is collected in the field through laboratory analysis. Secure sample storage will be maintained at the PWT Team Pueblo Field Office. A sample is considered in custody if one of the following applies:

- It is in an authorized person's immediate possession
- It is in view of an authorized person after being in that person's physical possession

- It is in a secure area after having been in an authorized person's physical possession
- It is in a designated secure area, restricted to authorized personnel only.

All samples to be analyzed through the EPA Analytical Program will have a chain-of-custody/trip report record generated in the EPA SCRIBE database program, and will be signed by the field laboratory personnel prior to shipment. Signed shipping company waybills will serve as evidence of custody transfer between field laboratory personnel and the courier, and between the courier and the analytical laboratory. Copies of the chain-of-custody record and the waybill will be retained and filed by field personnel prior to shipment. Multiple coolers may be sent to a laboratory in one shipment, with one chain-of-custody record, provided the chain-of-custody record clearly indicates which samples are included in which cooler. This way, if there is a quality problem with the holding time with a single cooler in the shipment, the data quality of unaffected samples are not implicated. The outside of the coolers will be marked to show the number of coolers in the shipment. At a minimum, each chain-of-custody form will contain the following information:

- Sample identification and unique CLP sample number for each sample
- Analytical laboratory information
- Date and time of sample collection
- Sample matrix (i.e., soil, dust, water)
- Number and type of containers per sample
- Preservative (if applicable)
- Analyses to be performed
- Sampler's name and initials
- Release and acceptance information including date, location, and sampler's signature.

The carrier will relinquish samples to the laboratory upon arrival, and the laboratory personnel will then complete the chain-of-custody.

27.7 Laboratory Chain-of-Custody Procedures

A signed chain-of-custody form will be completed by the laboratory custodian after the samples have been received and their condition checked. For samples shipped by commercial carrier, the waybill will serve as an extension of the chain-of-custody. File copies of the chains-of-custody and waybills will be retained. An example chain-of custody is provided in Appendix A.

Upon receipt in the laboratory, samples will be carefully checked to ensure that there are not any broken or leaking sample containers, proper preservation methods have been followed (including receipt at 4°C ± 2°C when applicable), and labels and custody seals are intact. Each chain-of-custody will be verified for accuracy and completeness, and any discrepancies will be brought to the attention of the EPA Analytical Program Manager. If there are no deficiencies or discrepancies identified, the sample chain-of-custody will be signed, and a copy will be returned to the PWT Team along with the analytical case narrative. From the time of receipt, the laboratory will use its standard internal chain-of-custody procedures to ensure that the samples are appropriately tracked through completion of the analytical process.

If the samples and documentation are acceptable, each sample container will be assigned a unique laboratory identification number and entered into the laboratory's sample tracking system. Sample tracking will be documented in the laboratory information management system. Other information that will be recorded includes date and time of sampling, sample description, and required analytical tests.

When sample log-in has been completed, the samples will be transferred to limited-access temperature controlled storage areas. The sample storage areas (coolers, refrigerators) will be kept at 4°C ± 2°C and their temperatures will be recorded daily with thermometers calibrated against National Institute of Standards and Technology thermometers. Storage blanks will be used to assess the cleanliness of sample storage areas.

Sample custody will be maintained within the laboratory’s secure facility until the samples are disposed. Laboratories will be instructed to hold or return to the PWT Team the remaining sample quantities for the duration of the holding time or 6 months, whichever is shorter. The laboratory will be responsible for sample disposal, which will be conducted in accordance with all applicable local, state, and federal regulations. Disposal of all samples will be documented. The laboratory will maintain records in the project file.

QAPP WORKSHEET #28A

Field Fixed Lab QC Samples Table – XRF metals

Matrix	Soil
Analytical Group	Metals via XRF
Concentration Level	Low Level
Analytical Method / SOP Reference	PWT-COS-303

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Blank analysis	Start of each Batch (20 samples)	SOP-COS-303	SOP-COS-303	XRF Analyst	Accuracy/Bias	See SOP-COS-303
LCS	Before and after batch (minimum 1 in 10 samples)	SOP-COS-303	SOP-COS-303	XRF Analyst	Accuracy/Bias	See SOP-COS-303
Instrument Duplicate analysis	Once per day	SOP-COS-303	SOP-COS-303	XRF Analyst	Precision	See SOP-COS-303
Interference checks	Once per lot of plastic bags	SOP-COS-303	SOP-COS-303	XRF Analyst	Precision	See SOP-COS-303

LCS	Laboratory control sample/laboratory control sample duplicate
SOP	Standard operating procedure
XRF	X-ray fluorescence spectrophotometer
SRM	Standard Reference Material

QAPP WORKSHEET #28B

QC Samples Table – CLP Metals

Matrix: Soil / Dust	**Concentration Level:** Low to High
Analytical Group: Metals	**Analytical Method/ SOP Reference:** Per CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B

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/Extraction Batch (20 samples)	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias-Contamination	No Target Compounds>PQL Goal
LCS/LCSD	1/Extraction Batch (20 samples)	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias	%RSD ≤ 25%, percent recoveries of target analytes 70-130%, See CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B
Internal Standards/ labeled compounds	Spiked into every sample and QC sample	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Accuracy/Bias	25-150% Recovery, or See CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B
MS/MSD	1/20 samples or per request of project team	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Laboratory Analyst	Interferences - Accuracy/Bias - Precision	%RSD ≤ 35%, percent recoveries of target analytes 70-130%, See CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B

CLP	Contract Laboratory Program
%RSD	Percent relative standard deviation
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
MS/MSD	matrix spike/matrix spike duplicate
SOP	Standard operating procedure

QAPP WORKSHEET #28C

QC Samples Table – Mercury

Matrix: Soil	**Concentration Level:** Low to High
Analytical Group: Mercury	**Analytical Method/ SOP Reference:** Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B

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/Extraction Batch (20 samples)	CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias-Contamination	No Target Compounds>PQL Goal
LCS/LCSD	1/Extraction Batch (20 samples)	CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias	%RSD ≤ 25%, percent recoveries of target analytes 70-130%, See CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B
Internal Standards/ labeled compounds	Spiked into every sample and QC sample	CLP SOW method ISMO1.3, EPA SW846/ICP method 6020B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Accuracy/Bias	25-150% Recovery, or See CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B
MS/MSD	1/20 samples or per request of project team	CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Per CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B	Laboratory Analyst	Interferences – Accuracy/Bias – Precision	%RSD ≤ 35%, percent recoveries of target analytes 70-130%, See CLP SOW method ISMO1.3, EPA SW846/ICP method 7471B

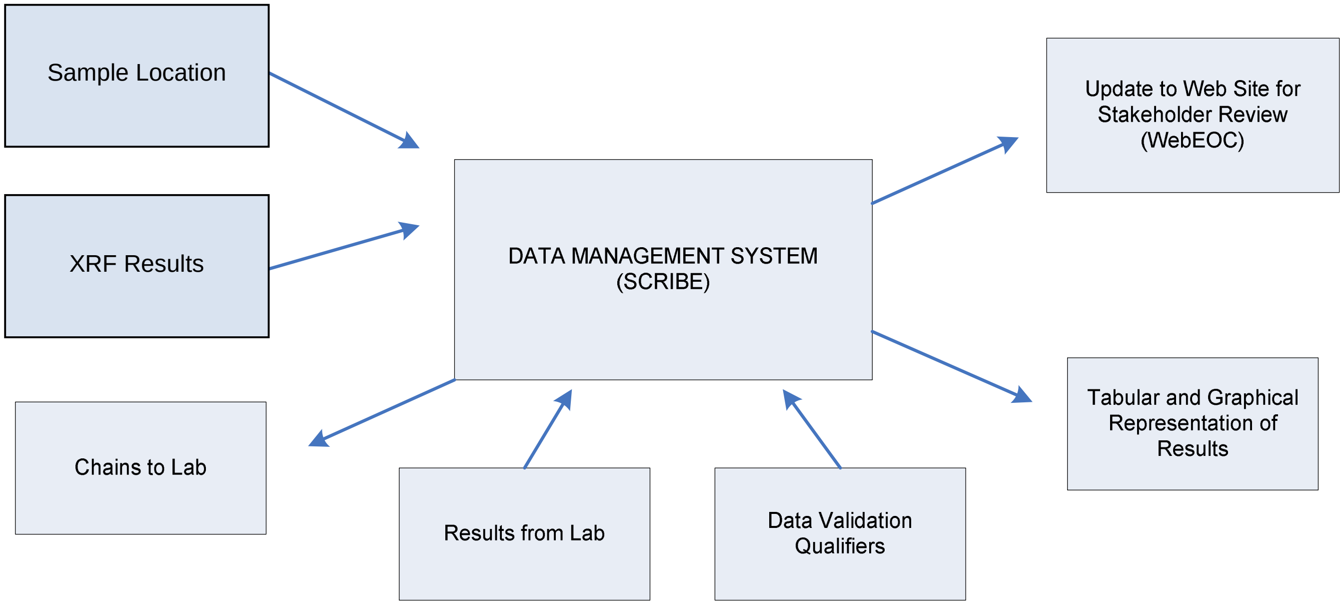
CLP	Contract Laboratory Program
%RSD	Percent relative standard deviation
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
MS/MSD	matrix spike/matrix spike duplicate
SOP	Standard operating procedure

QAPP Worksheet #29
Project Documents and Records Table and Data Management Information

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records[1]	Other
• Field notes • Property inventory maps • Daily quality control reports • Chain of custody • Photo documentation • GIS files • Airbills	• XRF sample analysis forms • Instrument data files • Daily quality control reports • Logbooks • Field notes • Sample storage	• Sample login and tracking information • Sample prep and instrument logs • Calibration and maintenance data • QA program data (checks, audits, reviews) • Analytical raw data and instrument output • Sample storage and disposal • Electronic data deliverable (SEDD) • Laboratory QA Plan, SOPs, and certification documentation • Chain of custody forms • Corrective action forms	• Sampling and analytical data in required format (SEDD/Scribe-compatible) • Laboratory full data and documentation packages (including raw data as provided by CLP Sample Management Office) • Data entry and upload into project database (Scribe) • Data download from Scribe; data reduction and visualization work-products (e.g., FIELDS, SADA, ProUCL, ArcView, EVS/MVS, statistical analysis) • External audit records (laboratory, file) • Data validation reports • Project reports • Meeting notes and collaborative work products/tools (e.g., project web portals and file sharing sites) • Site Administrative Record • XRF data files • Corrective action forms	• RI final report

DATA MANAGEMENT CONSIDERATIONS

The following diagram illustrates the basic concepts of data flow for the site assessment process based on using Scribe as the project database management system.



The following describes the flow of data to and from Scribe the central Data Management System:

Scribe is a data management decision support tool (DST) developed by EPA's Environmental Response Team (ERT) that allows a greater number of project teams working at sites to realize the benefits of maintaining data in a relational database. Scribe can import electronic data, including analytical laboratory results in electronic data deliverable (EDD) format and sampling location data such as global positioning system (GPS) coordinates. Scribe can print sample labels and chain-of-custody documents. Scribe can be integrated with software packages to capture and import sampling and monitoring data collected using handheld devices during field work.

Use of a front-end (pre-Scribe) data management, evaluation and communication system needs to be determined on a Regional basis and/or site-specific basis according to the project needs, available resources and technical capabilities of stakeholders to operate, maintain and utilize the system. The ERT EDD Generator for Scribe SOP may be found at http://www.epaosc.org/sites/ScribeGIS/files/xrf%20edd%20for%20scribe.zip

The following describes key elements of a field-based data collection and entry system.

Sample Location – GPS location coordinates are recorded at the approximate geographic center of each yard component sampled. This data is uploaded to scribe.

Sample Chain of Custody – COCs are generated in Scribe. The following is an example of the steps to be taken to generate a COC:

- Click on **Chain of Custody** under the Sample Management section of the navigation pane.
- Click the **Add a Chain of Custody** button
- Scribe automatically assigns the next sequential COC #.
- Enter the current date as the **date shipped**
- Click the **Assign Samples to COC** button to select which samples are in the bin.
- Select the **Simple Chain** Layout
- **Highlight the samples to be assigned** to the chain and **click the Assign to button** at the bottom of the screen.
- Click **Yes** to assign the samples to the chain
- Click the **Print Chain of Custody** button and select **Preview**
- Click the printer icon to send the COC to the printer
- Place the COC in the paperwork box for the crew.

XRF Results – Sample information to be recorded with XRF results includes:

- Project name, number and location
- Sample ID number
- Sample Location Coordinates
- Date and time of sample collection
- Sample collector’s initials/Name
- Number and type of containers filled
- Analysis requested
- Sample type (incremental or five-point composite sample)

Analytical Laboratory Results – Analytical results from the laboratory are loaded into the Scribe database by E2 and undergo a QC review before they are made available to end users. Scribe provides a quick turnaround of preliminary sample results.

Data Validation Results – Data qualifiers from the data validation shall be input into the database by E2 to document data usability for data end users and final work products.

Tabular and Graphical Representation of Results – Scribe’s data querying capabilities allow for flexible data analysis and integration into visual software packages like AutoCAD or geographic information system (GIS).

QAPP WORKSHEET #30

Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Number	Analytical SOP	Data Package TAT	Laboratory Options
Soil	Metals via XRF	All	All	PWT-COS-303	24-48 hours	PWT/TtEMI field lab
Soil / Dust	Metals via CLP	All	All	CLP SOW ISMO1.3 EPA Method 6020B	7-day	To be assigned by EPA, Don Goodrich
Soil	Mercury via CLP	All	5%	CLP SOW ISMO1.3 EPA Method 7471B	7-day	To be assigned by EPA, Don Goodrich
Soil	Arsenic & Lead bioavailability and geospeciation	All	All	EPA 8290A/1613B and 1668A	TBD	CU – John Drexler

QAPP WORKSHEET #31

Planned Project Assessments Table

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Field Readiness Review	Before mobilization for the RI	Internal	Project Team	Bruce Peterman, PWT	Steve Singer, PWT	Steve Singer, PWT	Steve Singer, PWT Bruce Peterman, PWT
Field Sampling Surveillance*	Once during the first 45 days of RI field sampling activities	Internal	Project Team	Robin Witt, PWT	Steve Singer, PWT Rob Tisdale, TtEMI	Steve Singer, PWT	Steve Singer, PWT Bruce Peterman, PWT
Field Laboratory Surveillance*	Once during the first 45 days of RI field laboratory activities	Internal	Project Team	Craig Walker, PWT	Michelle Handley, TtEMI	Michelle Handley, TtEMI	Steve Singer, PWT Craig Walker, PWT

Note: follow-up surveillances will be scheduled if necessary/appropriate.

QAPP WORKSHEET #32

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, organization)	Timeframe of Notification	Person Responsible for Corrective Action Response	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, organization)	Timeframe for Response
Field Readiness Review	Email documentation	Steve Singer, PWT Robin Witt, PWT Rob Tisdale, TtEMI	2 days	Rob Tisdale, TtEMI	Email documentation	Steve Singer, PWT Robin Witt, PWT	2 days
Field Sampling Surveillance	Email documentation	Steve Singer, PWT Robin Witt, PWT Rob Tisdale, TtEMI	2 days	Rob Tisdale, TtEMI	Email documentation	Steve Singer, PWT Robin Witt, PWT Michelle Handley, TtEMI	2 days
Laboratory Surveillance	Email documentation, checklist	Steve Singer, PWT Craig Walker, PWT Michelle Handley, TtEMI	5 days	Rob Tisdale, TtEMI	Email documentation, corrective action memorandum	Steve Singer, PWT Craig Walker, PWT Michelle Handley, TtEMI	5 days
Any observed deficiency or issue that will impact data quality	Anyone may stop work until corrected, email documentation	Steve Singer, PWT Robin Witt, PWT Rob Tisdale, TtEMI	Immediate	Rob Tisdale, TtEMI	Email documentation	Steve Singer, PWT Robin Witt, PWT Michelle Handley, TtEMI	2 day

QAPP WORKSHEET #33

QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Audit Report of Field inspections and sampling procedures[1]	One time for each field QA inspection	30 days after inspection	Bruce Peterman, PWT	Steve Singer, PWT Ram Ramaswami, PWT Sabrina Forrest, EPA Region 8
Data Validation Report[1]	For 10% of data	Ongoing	Ruth Siegman, E2	Steve Singer, PWT Craig Walker, PWT
Analytical Data Review [1]	Weekly	Ongoing	Craig Walker, PWT	Steve Singer, PWT
Weekly Progress Report	Weekly	5:00pm on Tuesday for the previous week	Rob Tisdale, TtEMI	Robin Witt, PWT or Steve Singer, PWT
Monthly Status Report	Monthly	At the end of each month	Steve Singer, PWT	Sabrina Forrest, EPA Region 8

[1] Reports and documentation for audits/assessments and data review/validation activities are further documented in Worksheets #32, #34, and #35.

QAPP WORKSHEET #34

Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Audit/assessment reports	When the report is complete, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the project manager will be notified to ensure action is taken.	I	Bruce Peterman, PWT
Field notes, logbook, sampling records	Field notes will be reviewed internally and placed in the project file. A copy of the field notes will be attached to the final report.	I	Rob Tisdale, TtEMI
Sample receipt	For samples shipped via commercial carrier, the chemist will verify receipt of samples by the laboratory the day following shipment.	I	Craig Walker, PWT Michelle Handley, TtEMI
Sample logins	Sample login information will be reviewed and verified for completeness in accordance with the chain-of-custody forms.	I, E	Craig Walker, PWT Michelle Handley, TtEMI CLP Lab Manager, TBD
Chain of custody records	Chain-of-custody forms will be reviewed internally when they are completed and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody form should be initialed by the reviewer, a copy of the chain-of-custody form will be retained in the project file, and the original and remaining copies will be taped inside the cooler for shipment.	I, E	Craig Walker, PWT Michelle Handley, TtEMI CLP Lab Manager, TBD
Laboratory data prior to release	Laboratory data will be reviewed and verified for completeness against analyses requested on the chain-of-custody forms.	E	CLP Lab Manager, TBD
Laboratory data due at turnaround time listed on chain of custody	Laboratory data will be verified that the analyses reported are consistent with the analytical suite requested on the chain-of-custody forms.	I, E	Craig Walker, PWT CLP Lab Manager, TBD

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Laboratory data completeness and accuracy	All laboratory data packages will be verified for completeness and technical accuracy by the laboratory performing the work. Data packages will then be reviewed by the E2 and PWT for completeness.	I, E	Craig Walker, PWT CLP Lab Manager, TBD Ruth Siegman, E2
Laboratory data consistency verification	Select analyses that will undergo a data consistency review and verification. Perform consistency review of data transfer from the original laboratory bench sheets and instrument data to the result reports.	I, E	Craig Walker, PWT Ruth Siegman, E2]
Field and electronic data verification and upload	One hundred percent of manual data entries (in the field or from field forms) will be reviewed against the hardcopy information, and 10 percent of electronic uploads will be checked against the hardcopy.	I, E	Craig Walker, PWT Ruth Siegman, E2
Data upload verification	Verify the correct transfer of results from the laboratory deliverables into the Database.	E	Ruth Siegman, E2

QAPP WORKSHEET #35

Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Field documentation	Field logbooks and forms will be reviewed weekly for accuracy associated with each sampling event. The inspection will be documented in weekly QC reports.	Robin Witt, PWT Rob Tisdale, TtEMI
IIa	Chain of custody forms	Chain-of-custody forms will be reviewed daily to ensure that project information, sample analyses requested, number of field QC samples collected, and percent level III or IV validation chosen is accurate and in accordance with the requirements in this UFP-QAPP	Michelle Handley, TtEMI CLP Lab Manager, TBD John Drexler
IIa	Sample receipt	The sample cooler will be checked for compliance with temperature and packaging requirements.	Michelle Handley, TtEMI CLP Lab Manager, TBD John Drexler
IIa	Sample logins	Sample login will be reviewed for accuracy against the chain-of-custody form.	Michelle Handley, TtEMI CLP Lab Manager, TBD John Drexler
IIa	Laboratory data prior to release	Laboratory data will be reviewed to ensure that the data are accurate and meets the requirements in this QAPP. Before they are released, data will be validated as follows:	CLP Lab Manager, TBD
		100 percent of the data comply with the method- and project-specific requirements; any deviations or failure to meet criteria are documented for the project file.	CLP Lab Manager, TBD
		100 percent of manual entries are free of transcription errors and manual calculations are accurate; computer calculations are spot-checked to verify program validity; data reported are compliant with method- and project-specific QC requirements; raw data and supporting materials are complete; spectral assignments are confirmed; descriptions of deviations from method or project requirements are documented; significant figures and rounding have been appropriately used; reported values include dilution factors; and results are reasonable.	CLP Lab Manager, TBD
		Data reported comply with method- and project-specific QC requirements; the reported information is complete; the information in the report narrative is complete and accurate; and results are reasonable.	CLP Lab Manager, TBD
		Data reported comply with method- and project-specific QC; analytical methods are performed in compliance with approved SOPs. (This review may be conducted after release of data since they involve only on 10	CLP Lab Manager, TBD

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
		percent of the data.)	
IIa	Laboratory data due at turnaround time listed on chain of custody	Laboratory data will be reviewed to ensure that the data reported met the analyte list and limits listed in Worksheet #15.	Craig Walker, PWT Ruth Siegman, E2
	Laboratory data packages	All laboratory data packages will be validated by the laboratory performing the work for technical accuracy before they are submitted.	CLP Lab Manager, TBD
		Data packages will then be reviewed for accuracy against the laboratory data that were faxed or e-mailed at the turnaround time listed on the chain of custody.	Craig Walker, PWT
		Data packages will be evaluated externally by undergoing data validation.	Ruth Siegman, E2
IIb	Data validation reports	Data validation reports will be reviewed in conjunction with the project DQOs and DQIs. Validation checklists provided in Appendix B.	Craig Walker, PWT

QAPP WORKSHEET #36

Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb[1]	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa	Soil	Metals, Mercury	All levels	In accordance with this QAPP, and PWT-COS-303	Ruth Siegman, E2
IIb	Soil	Metals, Mercury	All levels	In accordance with this QAPP, CLP SOW ISMO1.3 , 6020B, 7471B	Ruth Siegman, E2
IIa	Soil	Arsenic and Lead bioavailability and geospeciation	Low level	In accordance with this QAPP, CU-John Drexler requirements …	John Drexler, CU Ruth Siegman, E2

Notes:

1 IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.].
IIb=comparison with measurement performance criteria in the QAPP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005].

QAPP WORKSHEET #37

Usability Assessment

Describe the procedures / methods / activities that will be used to determine whether data are of the right type, quality, and quantity to support environmental decision-making for the project. Describe how data quality issues will be addressed and how limitations on the use of the data will be handled.

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

XRF Data

- The XRF data generated during field mobilization will be validated as usable via real-time QC activities that monitor instrument and operator performance. This will be accomplished by real-time charting of LCS QC and real-time verification that instrument duplicate QC results are acceptable (See the relevant SOPs for more information). If QC results are not acceptable, real-time trouble-shooting and correction of any problems will be performed before data are reported. Samples analyzed during out-of-control periods for the XRF will be reanalyzed prior to reporting.
    - All reported XRF data are required to be bounded by in-control QC results. Thus, no reported XRF data should be rejected at a later time due to QC non-conformance.
- During field work, the Field Team supervisor will perform spot-checks to ensure field staff are following XRF operation and XRF data entry procedures. Any observed deviations from procedures will be addressed by the field supervisor or designee, and if needed, staff will be retrained.
    - LCS control charts (these are paper) will be inspected by the supervisor to ensure real-time charting is being performed and control chart documentation is adequate. Completed paper control charts and their accompanying "Notes/Troubleshooting" sheets will be stored in a safe location and scanned into electronic files as soon as possible.
    - Past and current Instrument Duplicate QC Calculator files will be checked for complete entry information. Completed files (these are electronic Excel files) should be properly stored and backed up. This may involve password protection to avoid accidental changes to a completed file.
    - Previous and current DU-Bag Concentration Calculators (electronic Excel spreadsheets) will be inspected to ensure that all required spreadsheet inputs are filled out, and that statistical significance was attained for each final bag sample concentration result. Completed files should be properly stored and backed up. This may involve password protection to avoid accidental changes.
    - Written entries in field notebooks covering the relevant time periods will be scanned into electronic files that are stored with the relevant, completed spreadsheet files so that meta information is readily accessible.
    - On a daily basis, operators will create data packages documenting all data collected on that their instrument on that day. The data packages will be submitted for verification. After verification, the data will be uploaded into Scribe.

ICP data

- ICP data will be validated following QAPP Worksheets #35 and #36 and the National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014) The validation will follow normal validation procedures, except that Llaboratory duplicates will not be performed.
    - There is no need for laboratory duplicate QC because the ICP lab will not be performing any subsampling.

  - The function of matrix spikes (checking for aberrant matrix behavior) will be accomplished during XRF-ICP comparability analysis. Any XRF-ICP pair that significantly deviates from the general relationship observed between XRF and ICP pairs will be flagged as a potential instance of matrix interference. If evaluation for matrix interference does not find evidence of it, evidence of a blunder affected the aberrant pair will be sought. If a blunder was found to occur, the data pair will be removed from comparability analysis. Potential matrix interference will be evaluated by:
    - Looking in the field notebook to determine the type of matrix, and compare the suspicious pair to other paired sample analyses from matrices that might be similar;
    - Comparing the XRF spectrum for that sample to spectra from samples from a similar matrix; and
    - Obtaining and investigating the ICP spectrum for unusual behavior.

Scribe database

- Spots checks will confirm accurate electronic transfer of XRF data into the Scribe database.
- Some information that is vital to interpreting the DU results will need to be preserved in Scribe. This may have to be manually entered, such as the DU area and its depth interval (perhaps Scribe can auto calculate the DU volume?), the number of increments comprising the DU sample, whether the sample is part of a QC replication data set, and the particle size fraction analyzed.
- In addition, the final bag sample result (which is an average calculated by the Bag Concentration spreadsheet) and the 95% UCL and LCL on the bag mean should be entered into Scribe.
  - It should be possible to use the Student’s t UCL and LCL for repeated XRF readings on a sieved sample bag that has been mixed to ensure the particles are not segregated by size.
  - However, if high within-bag heterogeneity persists after corrective action efforts, it may be necessary to use the Chebyshev UCL and LCL.

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

A data validation report will be created for the project, including a summary of all QA/QC results from the project to provide documentation that the analytical methods were in control throughout sample analysis.

Comparability between XRF and ICP methods will be performed to allow all XRF data to supply information relevant to risk assessment. Since subsampling error is minimized, comparability analysis will reflect the difference between total metal content (read by the XRF) and metal content able to be solubilized by the nitric acid/peroxide/hydrochloric acid/heat digestion procedure used for ICP analysis.

- Normal Q-Q statistical plot(s) will be used to evaluate the data distribution for each data set.
  - If there are indications that different data populations might be present in the ICP data set (perhaps reflecting the different solubilities of different matrices), this will be noted.
  - If linear regression of the entire data sets is unsatisfactory, separate statistical analysis of each subpopulation may be attempted if the statistical subpopulations can be correlated with different matrix types (as recorded in the field notebook).

- Non-parametric (Wilcoxon Signed-Rank Test) or parametric (2-sample t-test) hypothesis tests of population means will be done to determine whether the XRF data set and ICP data set represent different populations.
- Regression analysis will be performed using the regression technique best suited to the data sets to quantitatively compare the XRF and ICP methods. This is expected to be linear regression, but the appropriateness of linear regression must be confirmed.
  - If the regressions appear to show outlier data pairs, the possible reason will be explored, including:
    - Concentration extremes outside the instrument’s linear range (an effort will be made to ensure this will not happen);
    - Spectral interference from the matrix (see discussion above under “ICP data”);,
    - Differences in digestion/solubilization that can be correlated with matrix type,
    - Clerical error with sample ID or recording of results.
  - If a justifiable reason for exclusion of outliers from the main data set can be identified, the outlier pair will be removed.
- After removal of valid outliers, the upper and lower prediction limits for the best fit regression line will be determined. These will be used to calculate the range of ICP results predicted by a certain XRF result, and the XRF concentration that could be used as a decision threshold when making risk decisions with specified statistical confidence while using XRF to analyze property samples.
- If any outliers had been removed, it will be necessary to repeat the hypothesis test mentioned above. If the hypothesis test finds that the XRF and ICP data sets are not different at the 95% confidence level, an equation to adjust XRF results for the solubilization bias will NOT be performed.
- If the hypothesis test finds that the XRF and ICP data sets are different at the 95% confidence level, an equation to adjust XRF for the solubilization bias will be developed. Since the goal is to transform an XRF result to be more “ICP-like,” the XRF results will be the independent variable (the x-axis) and the paired ICP results will be the dependent variable (the y-axis).
- The effectiveness of the adjustment equation will be evaluated by repeating the hypothesis test with the ICP and adjusted XRF data. If adjustment was successful, those two data sets should not show a statistical difference at the 95% confidence level. If the ICP and adjusted-XRF data sets show a statistical difference, assistance from a professional statistician will be sought to determine the reason for this unexpected behavior.

The same approach will be used to evaluate the relationship between XRF and the bioavailability testing results, and between ICP and the bioavailability testing results.

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

Overall measurement error will be assessed by measuring the amount of sampling error attributable to soil heterogeneity by periodically (1 per 20 DUs) taking three independent replicate (triplicate) samples at certain DUs.

- It is critical that these field replicates be independent, which means that they are collected as 3 separate, but identical increment collections. The only difference is the increment layout, which must cover the same area, but be offset so that two increments do not fall on the exact same spot.
- Ideally, the increments from all 3 field replicates will evenly cover the DU.
- Each sample must have the same number of increments, and to the extent possible, the same increment mass.
- Overall measurement error is calculated as the %RSD for the 3 replicate field samples.

Identify the personnel responsible for performing the usability assessment:

Craig Walker (PWT) with assistance from Dr. Rob Tisdale, (TtEMI), Deana Crumbling (EPA OSRTI TIIB), and Steve Dyment (EPA ORD Region 8), and CDPHE personnel.

Appendix A

Standard Operating Procedures

Standard Operating Procedure Number	Standard Operating Procedure Title	Revision Number	Revision Date	Annual Review Date
PWT-COS- 302	XRF Sample Preparation	0	Sept-15	NA
PWT-COS- 303	XRF Sample Analysis	0	Sept-15	NA
PWT-COS-0427	Surface and Shallow Sub-Surface Soil Sampling for Inorganics (Project Specific Procedure)	0	Sept-15	NA
PWT-ENSE-402	Spatial Data Submittals	3	Apr-14	NA
PWT-ENSE-406	Sample Handling	2	Mar-12	Nov-14
PWT-ENSE-413	Utility Clearance	1	Mar-12	Nov-14
PWT-ENSE-423	Investigation Derived Waste Management	1	Mar-12	Nov-14
PWT-ENSE-424	Personnel and Equipment Decontamination	2	Mar-12	Nov-14
PWT-ENSE-430	Indoor and Attic Dust Sampling	0	Sept-15	NA

XRF Sample Preparation		Procedure No. PWT-COS-302 Revision 1 Date effective: 11/10/2015
APPROVED: /s PWT Project Manager,	Date	Page i of ii

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Section Page No.

List of Attachments

Attachment A	Example Sample Preparation Log
Attachment B	Balance Calibration Log

REVISION LOG		
Revision Number	**Description**	**Date**
0	Original SOP	September 2015
1	Editorial Changes	November 2015

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to prepare soil samples for chemical analysis during environmental investigations performed during the Remedial Investigation (RI) in the Community Properties Study Area (CPSA) of the Colorado Smelter Site. This SOP serves as a supplement to site-specific Health and Safety plans and the site-specific CPSA RI Quality Assurance Project Plan (QAPP). This SOP may be used in conjunction with other SOPs.

This SOP is intended to be used to prepare all RI soil samples for analysis by x-ray fluorescence (XRF). Subsamples of selected prepared samples will also be taken for analysis by fixed-laboratory methods for metals and bioavailability of metals. This SOP follows the standard template for SOPs produced by Pacific Western Technologies, Ltd. (PWT) for environmental support operations.

2.0 REQUIREMENTS

2.1 Key Words

X-ray fluorescence (XRF), sample preparation.

2.2 Quality Assurance / Quality Control (QA/QC)

Follow all QA/QC requirements as identified in the approved Quality Assurance Project Plan (QAPP), and associated SOPs.

2.3 Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable task health and safety plans prepared by PWT subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.3 Personnel Qualifications

Personnel preparing samples for the RI will have knowledge and experience in the subject matter and the goals of the RI. Personnel performing sample preparation activities are required to have completed the initial 24-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and work under the supervision of a 40-hour OSHA trained person. Supervisors of sample preparation activities are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read and signed the appropriate HASP(s). Prior to engaging in sample preparation activities, personnel must have a complete understanding of the procedures described within this SOP and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this SOP.

2.4 Definitions

1. “Disaggregation” is the process of breaking clumps of soil into free-flowing individual soil particles. It does not include the fracturing, crushing, pulverization, or comminution of individual soil particles. Clay particles are microscopic. Breaking up clay clumps or clods into the actual dust-sized clay particles usually requires some mechanization. This is discussed in detail in the section on disaggregation. Particles such as very small bits of solid stone or minerals, such as sand, are not crushed by the disaggregation techniques listed in this SOP.

3.0 MATERIALS AND EQUIPMENT

In order to prepare soil samples for XRF analysis and shipment for additional analysis by other methods the following equipment may be needed:

- Plastic storage bags (thick-walled, not to be used for analysis)
- Polypropylene bags of 1.2 mil thickness, (various sizes as necessary)
- Clear adhesive tape
- Sample labels
- Powder-free gloves
- Rolling pins
- Rubber mallets
- 10-mesh sieves
- 60-mesh sieves
- Sieve catch pans and lids
- Sieve shaker
- Drying ovens
- Drying trays sized for the drying ovens
- Aluminum foil
- Timers
- Analytical balances
- Calibration check weights
- Decontamination supplies and equipment (e.g., wash/rinse tubs, brushes, Alconox (or equivalent), plastic sheeting, paper towels, sponges, baby wipes, garden-type water sprayers, potable water, and deionized or distilled water, clean silica sand.

4.0 PROCEDURES

All samples will be initially weighed, then inspected. The samples will be oven-dried, and weighed again. Samples will be disaggregated before, during, and after drying. The dried samples will then be sieved and bagged for XRF analysis. The sections below describe these procedures in detail.

4.1 Initial Sample Weight

Tare the balance with an empty bag of the same type used to collect the sample. Measure and record the initial weight of the sample (which is expected to be between approximately 100 grams and 3 pounds depending on the type of sample collected). Balance calibration checks should be performed weekly following the procedures described in Section 4.7, “Balance Calibration Checks.”

4.2 Sample Inspection

Each sample should be inspected for the presence of large rocks or other debris such as plastics, plant matter, or wood that should not be part of the soil sample. These materials should be removed from the sample prior to beginning sample processing, and retained in a separate bag for storage with the sample.

4.3 Drying

Each sample should be inspected for soil moisture prior to further processing. If any of the conditions noted below are observed, air drying or drying in an oven should be performed:

- Soil particles do not move relatively freely;
- The soil is visibly moist, as determined through observation of a slight color variation between the exposed surface of the sample and the rest of the sample.

If drying is necessary, perform the following steps to dry each sample:

1. Prior to drying, disaggregate the soil by hand (wear powder-free gloves) as much as possible. Disaggregation of clayey soils is easier when the soil is slightly damp, and may become difficult after the soil has dried, especially with oven drying.

2. Set the drying oven to a temperature of 100°C or lower.
3. Line a drying pan with aluminum foil, and spread the soils evenly over the foil. If the soil layer is too thick for air to reach the center of the sample, split the soil into two or more pans as needed.
4. Place the drying pan(s) in the oven for 5-20 minutes.
5. Remove the pan to inspect the soil, and disaggregate clumps by hand (gloved) when necessary and possible.
6. Repeat in 5- to 20- minute cycles as necessary.
7. After satisfactory dryness is achieved, as indicated by no color variation between the exposed surface of the sample and the rest of the sample weigh the dried soil on the aluminum foil and record the weight of the dried sample and aluminum foil in the appropriate column of the sample preparation form. Drying the samples is critical because even slightly damp soil will clog the screen openings rather than flowing through them.
8. Transfer the dried sample into the 10-mesh sieve of a sieve stack, then weigh the aluminum foil by itself and record the weight of the aluminum foil in the appropriate column of the sample preparation form.
9. Calculate the total weight of the dried sample by subtracting the recorded weight of the aluminum foil from the recorded weight of the dried sample and aluminum foil together, and then record the total weight of the dried sample in the appropriate column of the sample preparation form.

4.4 Disaggregation

Disaggregation will be conducted before, during, and after drying, if drying was necessary. During disaggregation, continue to remove any obvious stones larger than 2 mm, and retain these stones in a separate bag for storage with the sample (the same bag mentioned in Section 4.2 should be used). Disaggregation may be accomplished by several methods, and some methods may work better for certain soil types for others:

- Hand-disaggregation: This can be the fastest and easiest way to disaggregate small amounts of soft, semi-cohesive materials such as sandy and loamy soils. Repetitive motion injury and unseen sharp objects may be concerns during hand disaggregation, so care should be used.
    1. Hands must be gloved (powder-free) whenever handling soil directly.
    2. Hand disaggregation can also be accomplished by massaging through the plastic bag containing the soil.
    3. If there is a large amount of soil being processed in the bag, empty the bag contents into a pan for inspection to make sure no agglomerates were missed.
- Rolling pin: This option works well for soft soils able to be disaggregated by hand, but can be less tiring. Some soils may be rolled while still in the original plastic bag, but samples may still need to be emptied into a pan for inspection to make sure disaggregation was complete. If rolled in a pan, place a clean piece of thin plastic or butcher paper between the rolling pin and the sample to prevent contamination. The butcher paper may not be reused. Make sure the pan is either very shallow so that the handles are unobstructed, or is wide enough to easily accommodate the entire length of the rolling pin in motion (including handles and hands). Additional considerations:
    1. If larger stones, sticks, or anything sharp is present, remove them from the bag so they cannot interfere with the rolling pin or punch a hole in the bag (anything larger than 2 mm will eventually be removed during sieving).

   2. This technique might not be effective for hard clay agglomerates which could be ejected from the work area from the pressure from the rolling pin.
   3. If a rolling pin is used on soil that is outside of an enclosed bag, care must be used to avoid "popping" particles out of the sample. Lay sheets of butcher's paper or similar above and below the soil layer to be rolled. Fold, tuck or tape the edges so the material is completely enclosed and contained.
- <u>Rubber mallet</u>: Used to smash hard clods while soil is in the original heavy plastic bag or another enclosure, such as the butchers' paper described above.

Note that all techniques that disaggregate soil while it is in a plastic bag will create crinkles or dimples in the plastic. XRF readings through such a bag will present interference for the X-rays and result in poor data precision. Sample processing should be done in a heavy plastic bag to avoid tearing of the bag. However, even undamaged, thick-walled plastic bags should not be used for XRF analysis. Soil to be read by XRF must be in an undamaged thin-walled plastic bag that has been confirmed as free of interference (as described in the XRF Analysis SOP).

4.5 Sieving

Sieving will be conducted on all samples following disaggregation. Two sieve sizes will be used. The first is a coarse 10-mesh sieve which excludes material larger than 2 millimeters (mm) in diameter. This fraction will not be analyzed by XRF. The second is a 60-mesh sieve which excludes material larger than approximately 250 micrometers (µm) in diameter, which also will not be analyzed by XRF. The remaining material (smaller than 250-µm in diameter) is the fraction targeted for chemical analysis and project decision making. However, all three fractions will be weighed and stored.

1. Weigh the sample on the aluminum foil and record the weight on the sample preparation log.
2. Stack the sieves by placing the pan on the bottom, a 60-mesh sieve above the pan, and a 10-mesh sieve above the 60-mesh sieve.
3. Transfer the dried sample to the 10-mesh sieve, and fit a lid on the top of the 10-mesh sieve.
4. Weigh the aluminum foil (now without the soil) and record the foil weight. Calculate the total weight of soil and record on the sample preparation log.
5. Place one sieve stack on the sieve shaker, and set the sieve shaker to a 5-minute cycle. If the shaker is large enough, two set of sieves may be stacked together for simultaneous sieving.
6. Remove the sieves from the shaker.
7. Remove the bottom pan and pour the contents into the plastic bag to be used for XRF analysis (an appropriately sized polypropylene bag of 1.2 mil thickness, labeled with the sample ID and "fraction < 60-mesh"). Take care to ensure that the sample is transferred completely from the sieve to the storage bag.
8. Transfer the material retained by the 10-mesh sieve into the plastic bag containing material picked out of the sample by hand in previous steps (labeled with the sample ID and "fraction > 10-mesh"). Weigh and record the mass of this bag (using an empty bag of the same type for a tare weight).
9. Transfer the material retained by the 60-mesh sieve into a plastic bag (labeled with the sample ID and "10-mesh > fraction > 60-mesh". Weigh and record the mass of this bag (using an empty bag of the same type for a tare weight).
10. Weigh and record the mass of material passed through the 60-mesh sieve and into the bottom pan (using an empty bag of the same type for a tare weight).
11. Place the first two bags into a sample bag labeled with the sample ID and "overbag" for storage. The overbag storage bag will now contain any oversized material picked out of the

sample, as well as the two fractions of sample that did not pass through the 10-mesh and 60-mesh sieves.

12. Decontaminate the sieves before reusing them, following Section 4.7.

4.6 Final Sample Preparation

The soil fraction that passed through the 60-mesh sieve should now be in a polypropylene bag of 1.2 mil thickness of appropriate size for the amount of sample. The bag should be large enough for the soil inside to lay flat in a layer from 1 to 3 inches thick. The bag has a flap with a resealable sticky strip; however, the sticky strip will not prevent leakage from the bag. Clear adhesive tape (or equivalent) should be used to seal both sides of the flap. The tape should not be so wide that it interferes with the XRF readings. Tape may be necessary on the corners of bags to prevent pinhole leaks for certain bags. The bag should be placed in the corresponding overbag for storage before and after analysis.

The sample should now be transferred to the XRF analysis area.

4.7 Balance Calibration

On a weekly basis (or more frequently), the balances used for the project should be calibrated using 1-kilogram, 50-gram, or 1-gram calibration weights, as appropriate for the sample masses being measured. The following should be recorded:

1. Date.
2. Time.
3. Mass of the calibration weight.
4. Measured mass.

If the measured mass deviates from the measured mass by more than 1 percent, procedures described in the user manual for the balance should be followed to correct the deviation. If necessary, the balance manufacturer should be consulted. Any samples weighed since the last passing calibration should be re-weighed following successful corrective action.

4.7 Sieve Decontamination

The sieves should be decontaminated between each sample by brushing with appropriate gauge brushes as recommended by the manufacturer. After brushing, each sieve component should be wiped with a damp paper towel to remove any remaining dust. Each sieve should be examined following decontamination for damage; damaged sieves should be taken out of service and replaced.

5.0 DOCUMENTATION

Sample preparation procedures for each sample will be documented on the Sample Preparation Log. A Sample Preparation Log will be generated in Scribe with the sample IDs pre-populated. An example of how this documentation will look is included in Attachment A. Balance calibration checks will be documented on the Balance Calibration Log (Attachment B). Similar forms that capture the same information are acceptable.

ATTACHMENT A
Sample Preparation Log

EXAMPLE SAMPLE PREPARATION LOG

Property ID: ______________ Sample Preparation Log Staff Initials: ___________

Sample #	Pre Drying Mass (g)	Post drying mass (g)			Mass of Fraction > 10 mesh	Mass of Fraction between 10 and 60 mesh	Mass of fraction < 60 mesh
		Sample and Foil	Foil Only	Sample Only (calc)			
S0269-AP-0001-01							
S0269-AP-0106-01							
S0269-AP-0612-01							
S0269-AP-1218-01							
S0269-BY-0001-01							
S0269-BY-0106-01							
S0269-BY-0106-02							
S0269-BY-0106-03							
S0269-BY-0612-01							
S0269-BY-1218-01							
S0269-DZ-0001-01							
S0269-SY-0002-01							
S0269-SY-0206-01							
S0269-SY-0612-01							
S0269-SY-1218-01							

ATTACHMENT B

Balance Calibration Log

BALANCE CALIBRATION LOG

Balance Serial Number:

Date	Time	Calibration Weight Used	Measured Mass	Accuracy	Corrective action necessary (yes/no)?	Initials	Comments

XRF Sample Analysis Procedure No. PWT-COS-303
Revision 0
Date effective: 9/10/2015
APPROVED: ______________/s______________ ______________ Page i of ii
PWT Project Manager, Date

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List of Attachments

Attachment A	Sample AnalysisLog
Attachment B	Subsample Preparation Log
Attachment C	Nonconformance Log

REVISION LOG		
Revision Number	**Description**	**Date**
0	Original SOP	September 2015

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for X-ray fluorescence (XRF) sample analysis during environmental investigations performed during the Remedial Investigation (RI) in the Community Properties Study Area (CPSA) of the Colorado Smelter Site. This SOP serves as a supplement to site-specific Health and Safety plans and the site-specific CPSA RI Quality Assurance Project Plan (QAPP). This SOP may be used in conjunction with other SOPs.

This SOP is intended to be used to analyze all soil samples collected during the Colorado Smelter RI by XRF. This SOP follows the standard template for SOPs produced by Pacific Western Technologies, Ltd. (PWT) for environmental support operations.

2.0 REQUIREMENTS

2.1 Key Words

X-ray fluorescence (XRF), sample analysis.

2.2 Quality Assurance / Quality Control (QA/QC)

Follow all QA/QC requirements as identified in the approved QAPP, and associated SOPs.

2.3 Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable task health and safety plans prepared by PWT subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.3 Personnel Qualifications

Personnel analyzing samples for the RI will have knowledge and experience in the subject matter and the goals of the RI. Personnel performing soil sample analysis activities are required to have completed the initial 24-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and work under the supervision of a 40-hour OSHA trained person. Supervisors of soil sample analysis activities are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read and signed the appropriate HASP(s). Prior to engaging in soil sample analysis activities, personnel must have a complete understanding of the procedures described within this SOP and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this SOP.

Training regarding x-ray safety is required in accordance with the HASP. Informal training on the procedures to be used will be performed during the RI by qualified project team staff.

2.4 Definitions

1. “Quality Control” (QC) refers to specific technical checks that allow a determination of whether the associated batch of products or services meets the specifications defined for that product or service. Analyzing samples of known composition (e.g., blanks and LCSs) is an important QC check on instrument performance. If an XRF performs well (i.e., gives results close to expected) on QC samples, then the assumption of equally good performance on unknown samples of a similar matrix may be justified.
2. “QC control chart” refers to a graphical representation of the acceptable limits for concentration results from an SRM of known concentration. The purpose of a control chart is monitoring the performance of an XRF before and after batches of samples are analyzed. Markings on a number

line (the y-axis) display the range of acceptable results. When an LCS is read, the result is plotted to show where it falls in relation to the acceptable limits which are derived from the mean and standard deviation of evaluation data. Results that fall outside of the limits indicate there is an analytical problem that needs to be resolved before sample results can be finalized and reported.

3. "XRF sample batch" refers to a group of samples bounded by LCS results. A sample batch must be bounded by in-control LCS results before the sample results for that batch can be reported. An LCS that is out-of-control at the start of a batch means that the batch cannot be analyzed until the performance problem has been resolved. An LCS that that is out-of-control at the end of a batch means that the batch cannot be reported until the problem is resolved, and the samples rerun.
4. "Standard Reference Material" (SRM) refers to a commercially prepared soil certified to have known (a mean plus/minus variability) concentrations for various elements or compounds.
5. "Lower confidence limit" (LCL) refers to a statistically calculated value that provides a specific level of confidence that the true mean for a sample with multiple measurements is above this value. If a 95% lower confidence limit is calculated, there is a 5% chance that the true mean actually lies below the LCL.
6. "Upper confidence limit" (UCL) refers to a statistically calculated value that provides a specific level of confidence that the true mean for a sample with multiple measurements is below this value. If a 95% upper confidence limit is calculated, there is a 5% chance that the true mean actually lies above the LCL.

3.0 MATERIALS AND EQUIPMENT

In order to analyze soil samples for XRF analysis and shipment for analysis by other methods the following equipment may be needed:

- Portable XRF analyzer
- Polypropylene bags of 1.2 mil thickness, (various sizes as necessary)
- Polypropylene bags of 1.2 mil thickness (for subsamples), approximately 2 inches by 2 inches
- Clear adhesive tape
- Sample labels
- Powder-free gloves
- Scoop or spatula
- SRMs for LCS checks.

4.0 PROCEDURES

Samples will be analyzed in a multi-step process. All samples will be initially inspected, then analyzed. Routine quality control procedures are to be conducted at the start of the day and periodically throughout the day. Corrective action may be required based on quality control results.

4.1 Sample Inspection

Each sample should be inspected to confirm the following:

1. The sample is in the correct type of plastic bag (polypropylene of 1.2 mil thickness). If the sample is double-bagged, remove the outer bag for analysis.
2. There are no crinkles or dimples in the bag walls that could interfere with the measurement.
3. The appearance of the soil particles should be identical on both sides of the bag. If one side appears different in color in or particle size, the following steps should be done to homogenize the soil in the bag:
    a. First, check that the bag is sealed properly. If it appears the bag may leak, use scotch tape to close the bag completely at the seam and in the corners as necessary.

   b. Suspend the bag by 2 corners and rotate the bag in the air through 360 degrees of rotation 5 times.

4. Repeat step 3 until the soil appears homogenous on both sides of the bag.

4.2 XRF Measurement for Full Samples

The following steps are used to analyze samples:

1. Start up the instrument using routine operating and QC procedures (see Section 4.4).
2. Lay the bag flat on the sample stand to take XRF readings. Make sure any taped areas of the sample bag are not in the area to be scanned by the XRF. Use the camera to check that no gaps are present in the portion of the sample to be scanned.
3. Take two readings on the first side of the bag (moving the sample between the two readings), and record each target element result and its instrument error in a spreadsheet. A minimum 30 second count time shall be used to perform each reading.
4. Flip the bag over.
5. Take two additional readings on the second side of the bag (moving the sample between the two readings). Again, record each target element result and its instrument error into the spreadsheet.
6. Repeat steps 3 through 5 until bias is not observed.
7. Check that the statistical confidence goals for the sample have been met:
   a. If the mean is lower than the decision limit for the metal being examined, compare the 95% upper confidence limit (95% UCL) of the mean to the decision limit. If the UCL is also below the decision limit, then no further analysis of the bag is necessary.
   b. If the mean is greater than the decision limit, compare the 95% lower confidence limit (95% LCL) of the mean to the decision limit. If the LCL is also above the decision limit, then no further analysis of the bag is necessary.
8. If further analysis is necessary as noted in steps 7a or 7b above, continue making additional measurements in pairs (one on each side of the bag) until one of the following occurs:
   a. The mean and UCL are both below the decision limit, or the mean and LCL are both above the decision limit.
   b. 10 measurements have been made, and the mean and UCL (or LCL) are still on opposite sides of the decision limit, but the RSD for the 10 measurements is below 25%. If this occurs, the data may be used without further reanalysis.
   c. 10 measurements have been made, and the mean and UCL (or LCL) are still on opposite sides of the decision limit, and the RSD for the 10 measurements is above 25%. If this occurs, remix the bag following Section 4.1.3, and reanalyze the sample following Section 4.2. See step 10 below for how to handle the results from the initial analysis.
9. If a second 10 measurements still does not provide a clear decision, the following steps may be taken to try to resolve the problem:
   a. Check whether the readings from the two sides of the bag demonstrate a consistent bias relative to each other. If a consistent bias is demonstrated and it appears that this bias may be introducing artificial variability, remix the bag by rotating it as described in Section 4.1.3. See step 10 below for how to handle the results from the initial analysis.
   b. If another sample from the same DU but a different depth interval for the same analyte provides a clear decision that that analyte is above the decision limit, then additional analysis is not required.

   c. If another sample from the same DU and the same depth interval (or a deeper interval) for a different target analyte provides a clear decision that that analyte is above the decision limit, then additional analysis is not required.

10. NOTE: If remixing of the bag is required to obtain data that meet the decision requirements as noted above, do not use the previous data.

4.3 Subsampling and XRF Analysis for Subsamples

Certain samples will be selected for comparability analysis by inductively-coupled plasma (ICP), geospeciation, and bioaccessiblity. These decisions will be made by the project team. In some cases, the project team may determine that a sample is a critical one, and a backup bag may be prepared for each specified comparability analysis. Each subsample should be prepared following the XRF sample preparation SOP, and analyzed following the procedures below:

1. Homogenize the soil in the bag, mixing thoroughly by hand. With the sample still in the storage bags (likely an analysis bag inside a thicker-walled plastic bag).
2. Reopen the outer sample bag, and open the inner sample bag by slitting the scotch tape along both sides. Open the flap.
3. Reach into the bag with a scoopula or similar implement.
4. Scoop out approximately half the mass of soil needed from a random location in the sample bag. For ICP/bioassay samples, this will be half of the target weight of 1 to 1.5 grams.
5. Place the soil into a small (2-inch by 2-inch) 1.2 mil thick polypropylene bag.
6. Carefully turn the large bag over, and scoop out the other half of the mass required into the subsample bag.
7. Check that sufficient soil is in the subsample bag to allow the XRF to shoot through a layer of soil at least 3 mm thick).
8. Weigh the bag, using an empty bag of the same type for a tare weight.
9. Analyze the small bag 4 times (twice on each side).
10. Check that the average of the readings on the subsample bag lies within the 2-sided 95% confidence interval for the large bag, or that the difference between the average of the subsample bag readings and average of the large bag readings is less than 10% of the large bag readings.
    a. If these conditions are not met, empty the small bag back into the large bag, and repeat steps 2 through 9. If the target cannot be met after 4 consecutive attempts, contact the project chemist for instructions on how to proceed.
    b. If these conditions are met, seal the flap of the small bag and tape to avoid leakage. Label the bag to allow association of the subsample bag and the measured concentration with the parent sample bag.

4.4 Routine Quality Control Procedures

The following quality control procedures will be performed during all sample analysis by XRF:

1. Initial control charting. Control charting will be conducted for each instrument, analyte, SRM, and scan time prior to the start of sample analysis. Follow the steps below to generate the initial control charts for the target analytes:
    a. Over a period of about 7 working days, generate at least 25 readings, and up to 50 readings, on each LCS, making 4 readings over the course of an 8-9 hour day, with an instrument restart between the third and fourth readings. If possible, use several different operators to collect data during this period.

   b. Prepare a control chart for each instrument, analyte, SRM, and scan time that will be used during the project. The chart should show a line for the mean value for the analyte, and lines at values for the mean plus and minus 2 standard deviations, and the mean plus and minus three standard deviations.

   c. Use the control chart to plot visually each LCS analyzed during the project. Assess the results following Section 4.4.4, below, and take corrective actions as necessary.

   d. Once an additional 25 to 50 LCS readings have been made, the new data may be incorporated into the control chart, or a new control chart generated. To assess ongoing instrument performance, statistical tests such as t-tests and F-tests may be conducted prior to incorporating the new data or substituting new data on the control chart; otherwise instrument drift may occur over the course of the project.

   e. It is important to note that the mean concentration measured by the XRF may vary from the concentration reported by the supplier of the SRM, even when uncertainty from precision is taken into account. This may occur because of bias in the XRF instrument relative to the techniques used by the manufacturer to establish the concentration of the SRM. This does not constitute a failure of the method; comparisons of XRF data with ICP data will be used to assess possible instrument bias, and if necessary, the XRF data may be adjusted for bias if this is supported by the data. Such adjustment is beyond the scope of this SOP, but any such processes will be documented in the remedial investigation report.

2. <u>Interference checks.</u> Each lot number of plastic bags should be checked for interference. Run LCS samples at both high and low concentrations with 7 to 10 readings. Conduct a t-test and an F-test to confirm that the bags do not interfere significantly with the results. Once a particular lot number has been cleared as free from interference, no other bags need to be checked from that lot.

3. <u>Blank analysis.</u> An instrument blank consists of silicon dioxide or sand in the same type of analysis bag as the samples. An instrument blank should be run at the start of every batch:
   a. Analyze the blank in the same manner as the samples (follow steps 4.2.2 through 4.2.10).
   b. If arsenic or lead is detected in the blank, the instrument should be considered to be out of control, and corrective actions identified in Section 4.5 should be taken.

4. <u>LCS analysis.</u> Before and after each batch of samples, LCS samples should be run to confirm that the instrument remains in control. The size of a batch is at the discretion of the analyst, but an LCS set should be run at least every 10 sample bags; if more replicate analysis is being performed for many samples, it may be better to run LCS sets more frequently. Early in the project it may be advisable to run the LCS sets at a higher frequency until it is established that the process is running smoothly.

   At least two and preferably three LCS samples should be run, with low, medium, and high concentrations of the target analytes. If the results for a specific instrument, target analyte, SRM, and scan time are outside of 2 standard deviations, the instrument may be out of control and corrective action is required - follow the actions identified in Section 4.5.2 or Section 4.5.3.

5. <u>Instrument duplicate analysis.</u> An instrument duplicate should be run once every day at startup samples to build an instrument history. To run an instrument duplicate, run the LCS sample twice consecutively to assess the instrument drift. Do not record the result for the instrument duplicate on the control chart. Instrument duplicates will be used for troubleshooting to assess whether electronic problems are occurring in the instrument. No specific corrective actions are required on the basis of the instrument duplicate; when electronic problems are suspected, another instrument duplicate may be analyzed and compared to previous instrument duplicate results as a diagnostic tool.

4.5 Troubleshooting and Corrective Actions

There are several possible causes of difficulties with XRF instruments:

1. Battery charge. Data may be affected before the instrument provides an indication that the batteries need to be recharged. This problem may be identified by downward trends on the control chart, and should be corrected by putting fresh batteries in the instrument. If possible, this should be done before an out-of-control situation occurs. The instrument should normally be operated on A/C power to prevent issues with battery charge, but if the instrument is used on battery power, the battery charge should be monitored.
2. Extreme ambient conditions. Extreme heat, cold, or humidity may all cause instrument problems. If these are the suspected cause, correct the conditions in the laboratory, and restart analysis.
3. Improper operator technique. The XRF should be mounted in a stand if possible for analysis, but vibration of the XRF during analysis may affect the instrument. If vibration is suspected, remove the source of vibration and repeat the analysis.
4. Torn XRF window membrane. A torn membrane may cause difficulties with internal temperature regulation. If the membrane is torn, replace it following the manufacturer's documentation. The instrument will need to be restarted after this service is conducted.
5. Jarring of the instrument strong enough to alter the alignment of the detector and/or internal optics, or electronic wear within the instrument. If either of these cases occurs, the XRF must be returned to the manufacturer for repair prior to further use.

Follow the instructions below for corrective actions based on specific causes:

1. <u>Detected target analyte in the blank.</u>
    a. Inspect the blank for possible problems such as wrinkles in the membrane, and correct if necessary.
    b. Repeat the blank analysis.
        i. If the repeat blank analysis shows no detections of target analytes, the instrument is in control, and sample analysis may begin.
        ii. If the repeat blank detects target analytes again, the instrument is out of control, and the cause must be investigated and corrected before sample analysis can begin.
2. <u>LCS reading outside 2 standard deviations but inside 3 standard deviations on the control chart for the specific instrument, SRM, analyte, and scan time.</u> The instrument should be considered to be in an uncertain state, and the following actions taken to either identify the instrument as in control or out of control.
    a. Do not analyze additional samples on the instrument until it is returned to in-control status.
    b. Immediately repeat the LCS analysis.
        i. If the repeat LCS reading falls within 2 standard deviations of the mean on the control chart, and there are no issues with the LCS results for any of the other analytes:
            1. The instrument is in control, and sample analysis may resume.
            2. All samples analyzed between the last passing LCS and the false alarm LCS may be reported without reanalysis.
            3. Record both the original and repeat LCS readings on the control chart.

            ii. If the repeat LCS also falls outside 2 standard deviations of the mean on the control chart for one or more analytes, examine the LCS cup for damage to the membrane.
                1. If damage is noted, repair or replace the damaged LCS cup. Use another LCS cup, and repeat the LCS analysis. If it passes, the instrument remains in control, and sample analysis may resume. All samples analyzed between the last passing LCS and the false alarm LCS may be reported without reanalysis. Record both the original and repeat LCS readings on the control chart.
                2. If damage is not noted, troubleshoot the instrument (check batteries, window membrane, vibration or jolting of the instrument during the reading, ambient temperature/humidity conditions, and operator error).
                    a. If any obvious problems are found, correct them and rerun the LCS set.
                        i. If the problem is corrected, the instrument is in control, and sample analysis may continue. All samples analyzed between the last passing LCS and the false alarm LCS may be reported without reanalysis. Record both the original and repeat LCS readings on the control chart.
                    b. If no obvious problems are found, shut down the instrument and restart it with all usual startup procedures and QC.
                        i. If the problem is corrected, return to an in-control state. The instrument is considered to have been out of control between the last passing LCS and the shutdown of the instrument. Reanalyze all samples run after the previous in-control LCS check.
                        ii. If the problem is not corrected, the instrument remains out of control, and additional troubleshooting may be necessary. Steps may include shutting the instrument down and letting it equilibrate for 3-4 hours or overnight, consulting the instrument manufacturer or other XRF expert, and returning the instrument to the manufacturer for repairs and/or recalibration.

3. <u>LCS reading outside 3 standard deviations on a control chart for the specific instrument, SRM, analyte, and scan time.</u> The instrument should be considered to be in an uncertain state, and the following actions taken to either identify the instrument as in control or out of control.
    a. Do not analyze additional samples on the instrument until it is returned to in-control status.
    b. Inspect the LCS cup for damage as noted in Section 4.5.2.a.ii, and whether damage is noted or not, proceed as described in that section.
4. <u>Seven consecutive readings on the same side as the mean of the control chart.</u> The instrument is considered to be out of control, and the following actions should be taken to correct the situation:
    a. Remove the batteries for charging, and replace them with new or recharged batteries.
    b. Re-analyze all samples analyzed by the XRF since it went into out of control status, which means those samples between the sixth and seventh LCS that were on the same side of the mean (earlier samples do not need to be reanalyzed).

Log all nonconformances and corrective actions using the Nonconformance Log (Attachment B).

5.0 DOCUMENTATION

XRF readings for each sample will be documented on a Sample Analysis Log (Attachment A). XRF readings and sample masses for subsamples will be documented on a Subsample Preparation Log. Record all nonconformances and corrective actions using the Nonconformance Log (Attachment C). Similar electronic or paper forms that record the same information may be substituted.

ATTACHMENT A

Sample Analysis Log

SAMPLE ANALYSIS LOG

Instrument ID:

ATTACHMENT B

Subsample Preparation Log

SUBSAMPLE PREPARATION LOG

Property ID:

Initials/Date of Preparer:

Sample ID	Subsample ID	Original mass of fraction < 60-mesh (g)	Subsample Mass (g)	Arsenic Reading of Original Sample (mg/kg)	Arsenic Reading of Subsample (mg/kg)	Lead Reading of Original Sample (mg/kg)	Lead Reading of Subsample (mg/kg)	Pass/Fail

ATTACHMENT C

Nonconformance Log

NONCONFORMANCE LOG

Instrument ID:

Date/Time	Maintenance Task or Problem Description	Corrective Actions Taken	Initials

PWT STANDARD OPERATING PROCEDURE

SURFACE and SHALLOW SUB-SURFACE SOIL SAMPLING for INORGANICS

Procedure No. PWT-COS-427
Revision 1
Date effective: 11/10/15

APPROVED: /s/ ____________
PWT Project Manager, Date

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List of Attachments

Attachment A Surface Soil Sample Field Data Sheet

REVISION LOG		
Revision Number	**Description**	**Date**
0	Original SOP	September 2015
1	Add sample collection for Mercury analysis; editorial changes	November 2015

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to collect surface and shallow subsurface soil samples for chemical analysis during environmental investigations performed during the Remedial Investigation (RI) in the Community Properties Study Area (CPSA) of the Colorado Smelter Site. This SOP serves as a supplement to site-specific Health and Safety plans and the site-specific CPSA RI Quality Assurance Project Plan (QAPP). This SOP may be used in conjunction with other SOPs. This SOP is not appropriate for sampling to determine concentrations of organic compounds.

The SOP describes procedures for collection of five-point composite samples (i.e., composed of five equal sized aliquots collected in a star pattern or otherwise distributed approximately evenly within the area to be characterized), and incremental samples (i.e., composite samples composed of 30 equal sized aliquots collected on a grid; typically performed on decision units (DUs) over 5000 square feet or vacant properties, and in park areas to be characterized).

Typically, five-point composite samples will be collected from the surface interval (0-1") from each DU on the property. Five-point composite samples will be collected at multiple depths (0-1", 1-6", 6-12", and 12-18") from each DU on the property, exceptions to five-point composite sampling are discussed in Section 4.3. Unless otherwise specified by the QAPP, the term "surface soil" refers to the top inch of soil following removal of surface vegetation and other debris from the sampling area. Samplers shall note the presence or absence of vegetative cover on the sampling sheets, and when vegetative cover is present, and the start of the depth interval will begin below the root structure of the plant material.

Shallow subsurface soil refers to the interval from 1" to 18" below the surface. Sample collection depths other than the ranges given above may be specified by the QAPP.

2.0 REQUIREMENTS

The following sections identify the requirements for Quality Assurance / Quality Control (QA/QC), health and safety, and personnel qualifications for surface soil sampling.

2.1. Quality Assurance / Quality Control

Follow all QA/QC requirements identified for the project as specified in the approved project planning documents.

2.2. Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable Task-Specific HASPs prepared by the PWT Team, or Subcontractors, and the associated Activity Hazard Analyses (AHAs).

A walkthrough shall be performed to identify any site specific hazards. Site specific hazards may include but are not limited to unidentified utilities such as underground propane lines, septic system drainfields, sprinkler systems, and owner placed electrical lines. Utility clearance will have been accomplished according to the PWT Utility Clearance SOP (PWT-ENSE-413). Other site specific hazards may include low tree limbs, uneven ground, unleashed animals, ponds, and miscellaneous equipment.

2.3. Personnel Qualifications

Personnel performing surface and shallow subsurface soil sampling activities are required to have completed the initial 24-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and work under the supervision of a 40-hour OSHA trained person. Supervisors of surface and shallow subsurface soil sampling activities are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements 29 CFR 1910.120(e), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read and signed the appropriate HASP(s). Prior to engaging in surface and shallow subsurface soil sampling activities, personnel must have a complete understanding of the procedures described within this SOP and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this SOP.

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. If work is being performed by a subcontractor, the subcontractor's project manager will document personnel qualifications related to this procedure in the subcontractor's project QA files.

3.0 MATERIALS AND EQUIPMENT

The following materials and equipment may be necessary for surface and shallow subsurface soil sampling:

- Sample containers: Gallon-sized zip top bags, Quart sized zip top bags, and glass jars
- Leather work gloves
- Nitrile disposable gloves
- Bound field logbook
- Sampling site location map, which provides property address, project specific Property ID, and identifies any DUs to be sampled for Mercury or to be sampled incrementally
- Completed access agreement(s) (if owner and occupant are different, both must have completed an access agreement)
- 100-foot survey tape
- Measuring device such as small tape measure or calibrated instrument to identify sample depth increments
- Soil sample field data sheets (Attachment A)
- Approximate 4 foot by 6 foot plastic sheeting
- Surveying stakes or pin flags for marking of grid nodes and/or sampling locations
- Monitoring equipment and personal protective equipment (PPE) as outlined in the HASP.
- Decontamination equipment and supplies (e.g., high pressure sprayer/washer, wash/rinse tubs, brushes, Alconox (or equivalent), plastic sheeting, paper towels, sponges, baby wipes, garden-type water sprayers, large plastic bags, potable water, and deionized or distilled water)

- Sharp cutting tool for removing turf layer, such as a curved knife
- Stainless steel scoops or spoons, knives, pick, and mixing bowls identified for each discrete depth interval to be sampled. Each bowl shall be clearly labeled with the sample depth interval.
- Decontaminated drive sampler device with spare stainless steel tips
- Slide hammer drive device
- Sample collection supplies (e.g., plastic re-closeable plastic bags or equivalent, waterproof markers, sample labels, chain of custody [COC] forms, cooler for sample storage, ice or ice substitute, clear plastic and strapping tape, custody seals, trash bags)
- Drums, 5-gallon buckets, or other approved containers for containing investigation derived waste (IDW) soil and water

Other materials and equipment may be needed based on field conditions.

4.0 PROCEDURES

After samplers have verified that they have all the necessary paperwork to enter the property, and they have completed a site walkthrough in accordance with the HASP, they will set up to sample.

Photograph the yard to document pre sampling conditions. Choose a safe location to set up the sample table during the site walkthrough. Lay out a tarp beneath the table and plastic sheeting over the table, and set up a three stage decontamination station in accordance with PWT-ENSE-424, Personnel and Equipment Decontamination. Set out sample containers, coolers, and bowls for combining the sample aliquots. Sample aliquots may be combined directly in the plastic sample bag, if desired.

4.1 Identification of Decision Units

In order to characterize the nature and extent of soil contamination at the property, each residential property sampled in the RI project will be divided in one or more discrete DUs. The specific DUs to be sampled at each property will be indentified in advance.

Generally, the homes have a drip line DU, which has been be defined as the exposed ground surface located immediately adjacent to the house out to a total width of 2 to 3 feet. At some homes with very narrow side yards (less than 5’ wide), the side yard will be considered part of the drip line DU. Front and back yards were the most common DUs identified at the DMA properties, and are expected to be common in the RI properties as well. Where a distinct play area or garden has been identified, it will be sampled as an independent DU.

Sampling sites specified for the RI project will be located by street address and property ID as listed on the property map and the access agreements.

Identification of DUs for the properties will be performed by the project team at a time between the property survey and the sample collection event. These decisions will be based on field observations of the property, and conversations with the occupants, when appropriate. DUs will be marked by the sampling crew on the property sketch. The sampling scheme described in the following sections should be methodically applied to each identified DU at each property.

4.2 Five-Point Composite Sample Collection

Five-point composite samples will be collected for the majority of surface and subsurface soil samples on this site. These samples are comprised of five sample cores collected at points spread around the yard area to be characterized.

The various yard components or DUs to be sampled will be identified on the property map and verified during the site walkthrough. The sample crew will identify approximate sample locations in pen on the property map, and will stake the locations in the yard using pin flags. This typically involves staking a 5 point pattern for the five sampling locations for a DU, but may involve a different layout if site specific factors make adjustment necessary (to avoid a yard feature like a concrete walkway, for example). Each composite surface soil sample will be collected as follows:

1. Use a pin flag to mark the approximate center of the DU, then place the remaining 4 pin flags in a cross or diamond pattern, or in another arrangement which generally covers the DU while avoiding features which would impede sampling (concrete walkways, etc).

2. Collecting a sample core. Leather work gloves are to be worn while using the sampling tool. Samples shall be collected by driving the slide hammer down to approximately 20 inches below ground surface with sharp blows, and then using the T-bar to twist the sampling tool out of the ground. Do not jerk the sample tool out of the ground, because the force can dislodge the sample. Carefully lay the sampling tool (which contains the first aliquot of each depth interval of the 5-point composite sample) on the table.

3. Remove leather work gloves and put on Nitrile gloves.

4. If the ground surface where the core was collected is generally bare of vegetation, measure 1” from the top of the sample, and then break, cut, or otherwise separate the recovered core at the 1” mark. If vegetative cover exists such that there is a substantial vegetative mat present, then measure the 1” from the base of the vegetative mat for the first sample core, and break, cut, or otherwise separate the recovered core at the 1” mark. The vegetative material shall be removed as a mat and lose soil particles removed by shaking inside the gallon-sized zip top plastic bag, discard vegetative material in the IDW bucket. Carefully transfer the soil aliquot into the sample bag labeled for the 0-1” interval. Repeat this process for the 1-6”, 6-12”, and 12-18” depth intervals. There will be some extra soil below the 18” mark. Discard this soil in the IDW bucket.

5. Repeat steps 2 through 4 at the remaining four pin flagged locations.

6. All sample cores for a given depth interval in a DU (five cores) are combined in a single sample bag.

7. After one five-point composite sample has been collected for each depth interval at the DU, it is sometimes necessary to repeat the process a second time to collect a sample for mercury analysis through an offsite laboratory. For collection of the mercury sample, soil cores should be collected approximately six inches away from each original pin flag. To prevent volatilization of mercury potentially present in the sample, sample cores should be exposed to air for the minimum amount of time necessary. Place sample aliquots in sample jars (rather than zip-top bags), and re-close the jars between aliquots. When all five aliquots are in the jar, mix using gloved hand or stainless steel spoon, then re-close the jar and place in a cooler on ice as soon as possible. Mercury samples will be

sent to the CLP lab without further sample preparation. Typically, additional volume for mercury analysis will be collected for 5% of the total samples. The frequency of mercury sampling is specified in the project-specific QAPP.

8. After one five-point composite sample has been collected for each depth interval at the DU, it is sometimes necessary to repeat the process a second time for a replicate sample, and a third time for a triplicate sample. For collection of the replicate samples, soil cores should be collected approximately 1 foot up and to the right of each pin flag. For the triplicate sample, soil cores should be collected approximately 1 foot up and to the left of each pin flag. Typically, replicates will be collected for 5% of the total samples. The frequency of replicate sampling is specified in the project-specific QAPP.

9. It is not necessary to mix or homogenize the aliquots, because the soil will be processed at the field soils laboratory.

10. Complete all fields on the Soil Sample form (Attachment A). Label and handle the containers as specified in the PWT Sample Handling SOP (PWT-ENSE-406).

11. Decontaminate the sampling equipment in accordance with the PWT Personnel and Equipment Decontamination SOP (PWT-ENSE-424).

12. Repeat the five-point composite soil sampling procedure for all DUs identified on the property sketch, unless one or more DUs have been identified to receive 30-pt incremental composite sampling.

4.3 Incremental Sample Collection

Incremental samples consist of approximately 30 sample aliquots collected on a grid and composited for laboratory chemical analysis. In cases where the property in question is significantly large, a 30-pt incremental sample will be considered. For this project, incremental samples will be combined in a single container in the field and mixed/homogenized at the field soils laboratory in accordance with the XRF Sample Preparation SOP (PWT-COS-302).

Incremental surface soil samples will be collected as follows:

1. After the DUs have been identified and designated for 30-pt incremental sampling on the property sketch, label the incremental sample bag with the appropriate sample ID for the first DU to be sampled.

2. Starting at a random point near the corner of the DU, establish a grid pattern appropriate for the size of the DU that accommodates the spacing necessary in order to obtain 30 aliquots.

3. A sample core will be collected to a depth of 18 inches at each pin flag location. These locations correspond to the approximate bottom center of each grid square. If there is significant vegetation, be sure to sample a full 18 inches of soil below the vegetative mat.

4. Collecting a sample core. Leather work gloves are to be worn while using the sampling tool. Samples shall be collected by driving the slide hammer down to approximately 20 inches below

ground surface with sharp blows, and then using the T-bar to twist the sampling tool out of the ground. Do not jerk the sample tool out of the ground, because the force can dislodge the sample. Carefully lay the sampling tool on the table. Because the sampling tool has a constant diameter core barrel, and samples from a given depth interval will be the same length, the sample aliquots obtained using the standard method will be of equal volume.

5. Remove leather work gloves and put on Nitrile gloves.

6. <u>If the ground surface where the core was collected is generally bare of vegetation, measure 1” from the top of the sample, and then break, cut, or otherwise separate the recovered core at the 1” mark. If vegetative cover exists such that there is a substantial vegetative mat present, then measure the 1” from the base of the vegetative mat for the first sample core, and break, cut, or otherwise separate the recovered core at the 1” mark</u>. The vegetative material shall be removed as a mat and lose soil particles removed by shaking inside the gallon-sized zip top plastic bag, discard vegetative material in the IDW bucket. Carefully transfer the soil aliquot into the sample bag labeled for the 0-1” interval. Repeat this process for the 1-6”, 6-12”, and 12-18” depth intervals. There will be some extra soil below the 18” mark. Discard this soil in the IDW bucket.

7. Repeat steps 4 through 6 at each of the 30 pin flag locations of the grid pattern.

8. After one incremental sample has been collected at the decision unit, it is sometimes necessary to repeat the process a second time for a replicate incremental sample, and a third time for a triplicate sample. For collection of the replicate sample, soil cores should be collected from the upper right hand corner of each imaginary grid square. For the triplicate sample, soil cores should be collected from the upper left hand corner of each imaginary grid square. Typically, replicates will be collected for 5% of the total samples. The frequency of replicate incremental sample collection is specified in the project-specific QAPP.

9. It is not necessary to mix or homogenize the incremental samples, because the soil will be processed at the field soils laboratory.

10. Complete all fields on the Soil Sample form (Attachment A). Label and handle the containers as specified in the PWT Sample Handling SOP (PWT-ENSE-406).

11. Decontaminate the sampling equipment in accordance with the PWT Personnel and Equipment Decontamination SOP (PWT-ENSE-424).

12. Repeat the incremental sampling procedure for any other DUs identified to receive incremental sampling on the property sketch.

4.4 Increment Volume Considerations

In order to appropriately represent the area sampled, without over-representing or under-representing any particular portion of the DU, it is important that each individual aliquot (or increment) of a particular sample has the same volume/mass. It is not necessary that aliquots of different samples be the same size.

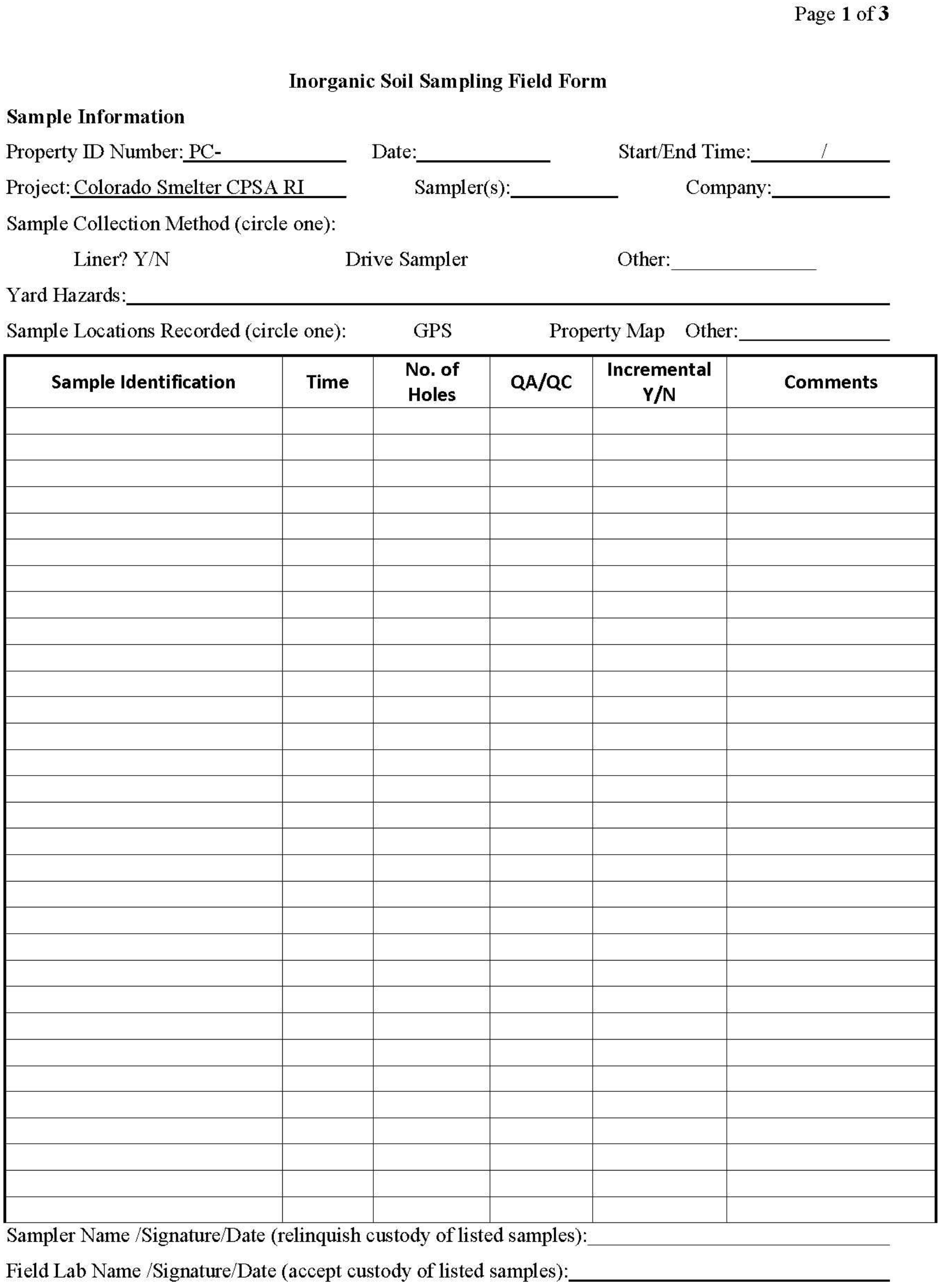
When the standard sample collection approach is used, the constant volume of the sample collection tool ensures each aliquot will have the same volume/mass.

5.0 DOCUMENTATION

Personnel collecting samples are responsible for documenting sampling activities in the field logbook and on the Surface Soil Sample Field Data Sheet (Attachment A). Discussions of sample documentation are provided in the PWT Sample Handling SOP and the Borehole Logging SOP.

ATTACHMENT A

Soil Sample Field Data Sheet



Page **1** of **3**

Inorganic Soil Sampling Field Form

Sample Information

Property ID Number: PC-____________ Date:____________ Start/End Time:______/______

Project: Colorado Smelter CPSA RI Sampler(s):__________ Company:__________

Sample Collection Method (circle one):

Liner? Y/N Drive Sampler Other:______________

Yard Hazards:____

Sample Locations Recorded (circle one): GPS Property Map Other:______________

Sample Identification	Time	No. of Holes	QA/QC	Incremental Y/N	Comments

Sampler Name /Signature/Date (relinquish custody of listed samples):____________________________

Field Lab Name /Signature/Date (accept custody of listed samples):____________________________

Inorganic Soil Sampling Field Form

Property Information

Property Contact Phone Number:____________________ Property Identification Code: PC-______

Property Owner:____

Property Address: ____

Present during sampling? (Y/N):Owner:_______ Occupant:___________

Type of Roof:____ Condition:__________

Type of Siding:____ Condition:__________

Type of Trim (windows, doors, eves):____

Outbuildings? Type?_____________________________________ Condition:__________

Porch/Other:____ Condition:__________

Gutters:____ Condition:__________

Sprinkler System present?:________________________________ Location:__________

Sample Containers: 4 oz glass jar 8 oz glass jar Ziptop bagged Other:______________

Number of Sample Containers:________ Preservative: 4°C ± 2°C none Other:________

Analyses: TAL by 6020B (ICP-MS); antimony, arsenic, cadmium, copper, lead, zinc by 6200 (XRF)____

Weather:____

Visitors:____

Comments/Observations:____

____

____

Samplers Name and Signature:____

Reviewer Name and Signature:____

A Yard Map prepared by the surveyors will be used as page 3 of the field sampling form.

PWT STANDARD OPERATING PROCEDURE

SPATIAL DATA SUBMITTALS Procedure No. PWT-ENSE-402
Revision 2
Date effective: 04/01/12
APPROVED: /s/ ____________ Page i of 21
PWT Project Manager, Date

TABLE OF CONTENTS

Section Page No.

List of Attachments

Attachment A: U.S. EPA Region 8 GIS Deliverable Guidance

REVISION LOG		
Revision Number	**Description**	**Date**
1.1	Original SOP	September 2002
2.0	QA Review and Update	April 2012

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**
2.0	Annual QA Review	August 2013

1.0 INTRODUCTION

This manual provides detailed instructions to allow contractors to submit spatial data to PWT in a format that can be used directly in PWT software and filing structure. All contractors will be provided with this document before contract initiation. No contractor will be allowed to submit any spatial data developed without adhering to the rules described in this document, unless agreed to before contract initiation. In addition, the contractor must generate the projects in 8.* and not 3.* for submittal to PWT. Should the contactor generate the project in 3.* then all functionality of a 8.* project must be created such that labels, etc. are associated with the layers and not included as graphics.

The National Geospatial Data Policy (NGDP) establishes principles, responsibilities, and requirements for collecting and managing geospatial data used by the U.S. Environmental Protection Agency (EPA). Within EPA Region 8, GIS file delivery formats for all materials developed in support of CERCLA related site work are specified in the GIS Deliverable Guidance in A. All geospatial data that is collected, acquired, or managed in conjunction with an EPA project must comply with the requirements specified in these documents.

2.0 ARCVIEW 8 (ESRI ARCGIS) COMPATIBILITY

All data submitted must adhere to the requirements described below to allow it to be viewed and manipulated in ESRI ArcView 8.X GIS. ArcView 8 is a member of the ESRI ArcGIS family of software products that enables PWT to use GIS for field, office, database, and internet-based applications. By providing PWT with data already prepared for use in ArcView 8, the contractor will enable PWT personnel to maximize work efficiency and more easily build new information by comparing and combining data from various submissions and contractors.

ArcView 8 consists of three separate, but integrated, applications: ArcCatalog, ArcMap and ArcToolbox. ArcCatalog is used to manage data in a Microsoft Windows Explorer-like environment. ArcCatalog functions include previewing and searching for data, generating and reviewing metadata, generating new files for data storage, and organizing folders. ArcMap is used to view, edit, analyze and map data. ArcToolbox includes 20+ tools for data conversion and management and permits batch processing.

3.0 SPATIAL DATA FORMAT

3.1 SHAPEFILE (*.shp, *.shx, *.dbf, *.prj)

All vector data sources (points, lines, or polygons) should be provided in ESRI shapefile format. ArcView 8 includes conversion tools in ArcCatalog and ArcToolbox that allow some other formats to be converted into shapefiles; however, to ensure maximum convertibility, it is best to generate new data directly as shapefiles when possible using ArcMap edit function. A shapefile actually consists of at least three files by the same name in the same directory that have different file extensions:

- <shapefile name>.shp – Map features
- <shapefile name>.shx – Index file to associate map features with attributes

- <shapefile name>.dbf – Tabular, feature attribute information
- <shapefile name>.prj – Spatial reference (projection) information

3.2 DEFINING SPATIAL REFERENCE INFORMATION

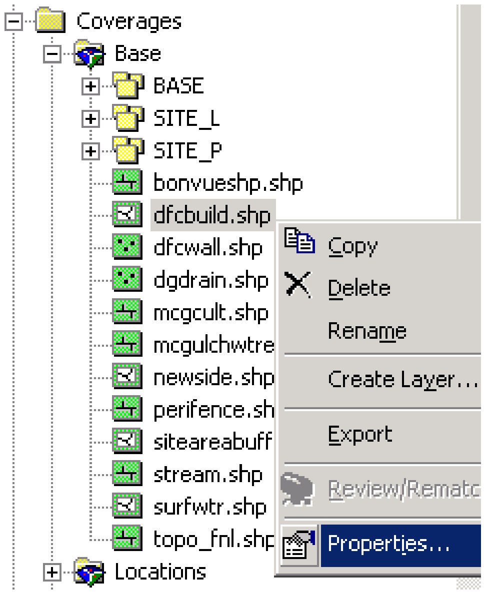
All data sources should use the State Plane Coordinate System with the following parameters:

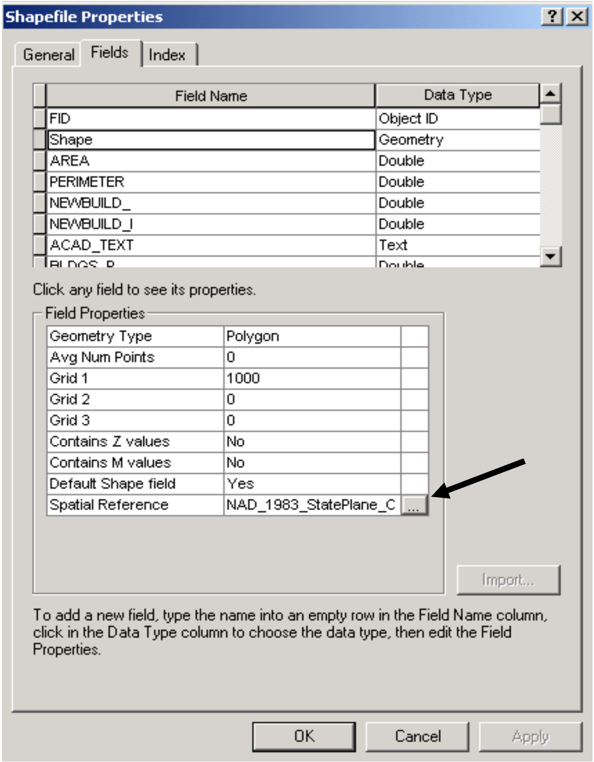
COORDINATE SYSTEM:	State Plane
ZONE:	State Specific [ex. Colorado Central (3476), (FIPSZONE : 502)]
DATUM:	NAD83
SPHEROID:	GRS80
UNITS:	Feet

Although older versions of ESRI ArcView software do not utilize the *.prj file associated with shapefiles, explicitly defining a shapefile's spatial reference information is imperative in ArcView 8. Without projection information, a shapefile added to ArcMap produces a warning message and may not work correctly in certain operations. There are two ways to define the projection of a shapefile in ArcView 8: 1) Using ArcCatalog (single shapefile), 2) Using ArcToolbox (multiple files).

3.2.1 Defining a Shapefile Projection Using ArcCatalog

1. Right –click on the shapefile of interest in the ArcCatalog *Table of Contents* and choose *Properties* from the context menu to access the *Shapefile Properties* dialog.
2. In the *Fields* tab, choose the record selector left of the *Shape* name in the list of *Field Names*.
3. Select the ellipses following the *Spatial Reference* property in *Field Properties* to produce the *Spatial Reference* dialog.





Field Name	Data Type
FID	Object ID
Shape	Geometry
AREA	Double
PERIMETER	Double
NEWBUILD_	Double
NEWBUILD_I	Double
ACAD_TEXT	Text
BLDGS_P	Double

Click any field to see its properties.

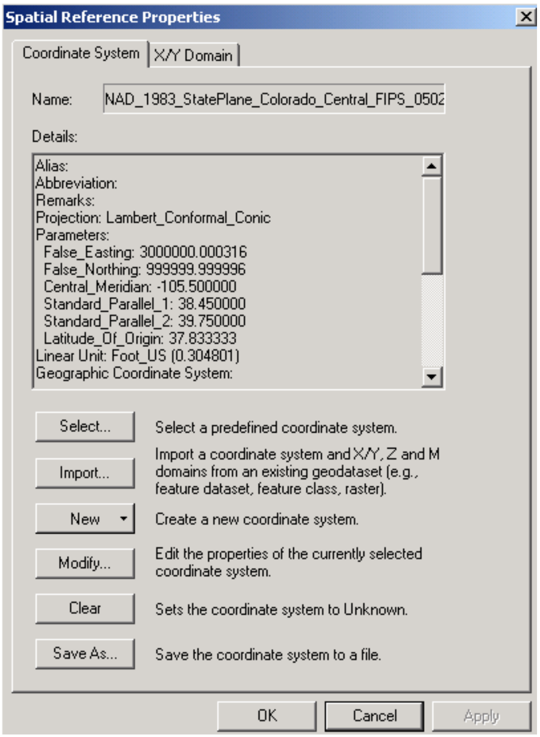
Field Properties

Geometry Type	Polygon
Avg Num Points	0
Grid 1	1000
Grid 2	0
Grid 3	0
Contains Z values	No
Contains M values	No
Default Shape field	Yes
Spatial Reference	NAD_1983_StatePlane_C

To add a new field, type the name into an empty row in the Field Name column, click in the Data Type column to choose the data type, then edit the Field Properties.

4. If no other spatial data source has yet had its projection defined, it will be necessary to choose the *Select…*option to select a predefined coordinate system (See 5a). If even one other data source has already had its projection defined that shares the same projection as the new data source to define, choose the *Import…* option (See 5b).

5a. Browse to the coordinate system definition, usually defined by a coordinate system, datum, units and location parameter (zone) that matches the coordinates the spatial data source is actually using. For DFC data, always make sure that you data is developed to allow it to be correctly defined with the *NAD 1983 State Plane Colorado Central GIPS 0502 (Feet).prj.*

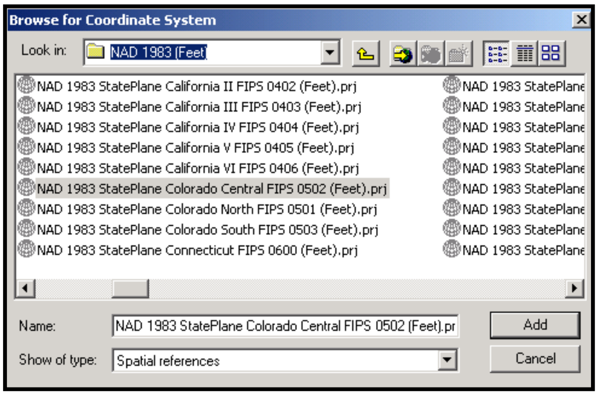


Name: NAD_1983_StatePlane_Colorado_Central_FIPS_0502

Details:

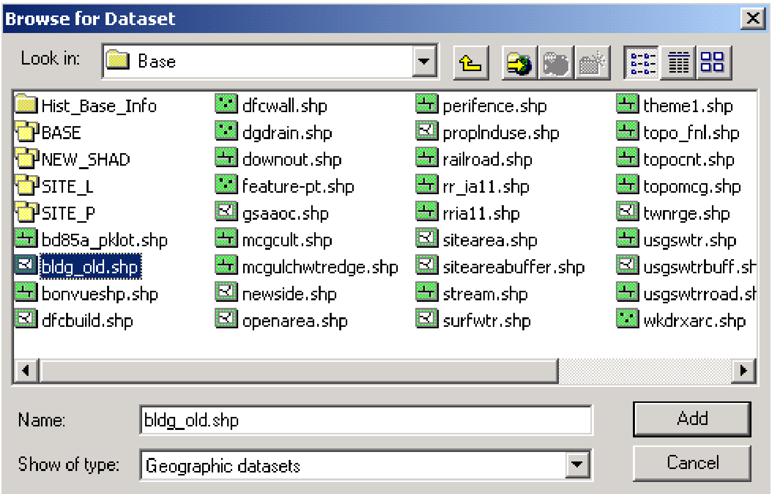
Alias:
Abbreviation:
Remarks:
Projection: Lambert_Conformal_Conic
Parameters:
False_Easting: 3000000.000316
False_Northing: 999999.999996
Central_Meridian: -105.500000
Standard_Parallel_1: 38.450000
Standard_Parallel_2: 39.750000
Latitude_Of_Origin: 37.833333
Linear Unit: Foot_US (0.304801)
Geographic Coordinate System:

Select...	Select a predefined coordinate system.
Import...	Import a coordinate system and X/Y, Z and M domains from an existing geodataset (e.g., feature dataset, feature class, raster).
New	Create a new coordinate system.
Modify...	Edit the properties of the currently selected coordinate system.
Clear	Sets the coordinate system to Unknown.
Save As...	Save the coordinate system to a file.



Name: NAD 1983 StatePlane Colorado Central FIPS 0502 (Feet).pr

Show of type: Spatial references



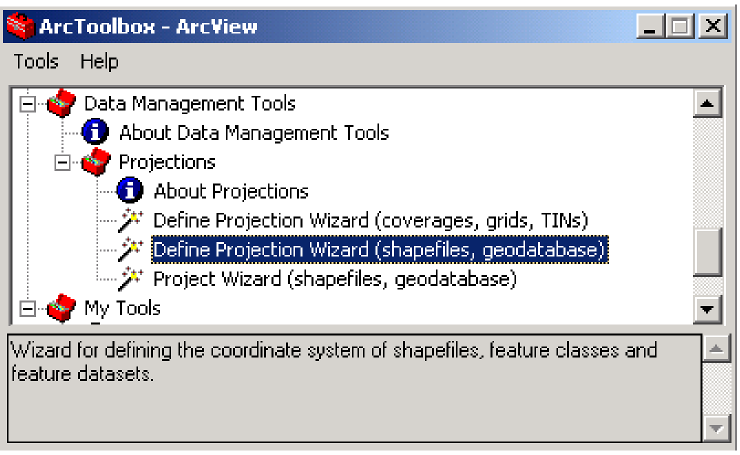
Name: bldg_old.shp

Show of type: Geographic datasets

5b. Browse to the data source that has already had its projection defined to automatically assign the same one to the data source of interest.

3.2.2 Defining a Shapefile Projection Using ArcToolbox

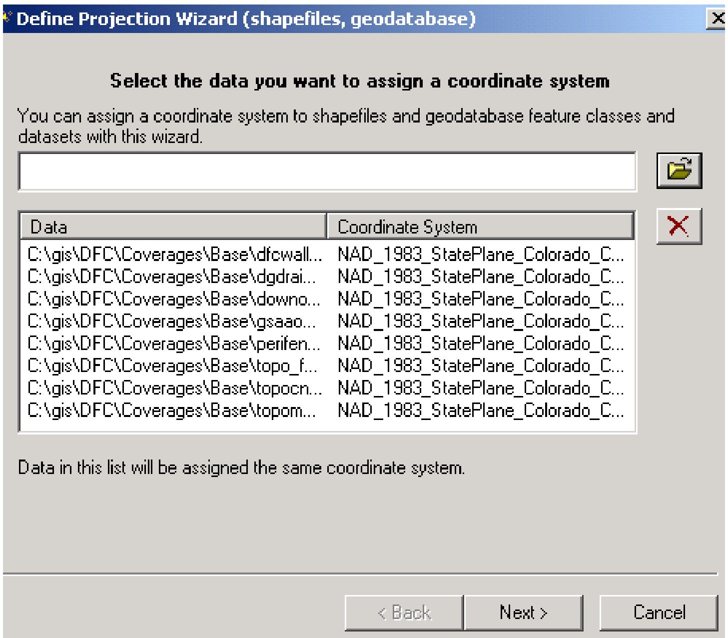
If more that one data source needs to have its spatial reference information defined, it is more efficient to use ArcToolbox to define the shared projection of multiple data sources at one time.



Wizard for defining the coordinate system of shapefiles, feature classes and feature datasets.

1. Choose the *Define Projection Wizard (shapefiles …)* option from the ArcToolbox *Data Management / Projections* tools.
2. Select all the data sources that share the same projection by browsing and holding down the <SHIFT> or <CTRL> keys to select multiple files.
3. Choose *Next*, then *Select Coordinate System* to launch the *Spatial References Properties* dialog.

4. As in the previous menu using ArcCatalog, choose *Select* … if the same projection has not been defined yet for any other data source, otherwise choose *Export* to export the projection information from the defined data source to all the other data sources in the projection list.
5. Choose *Next* to review the batch process information, then choose *Finish* to complete projection definition for all selected files.

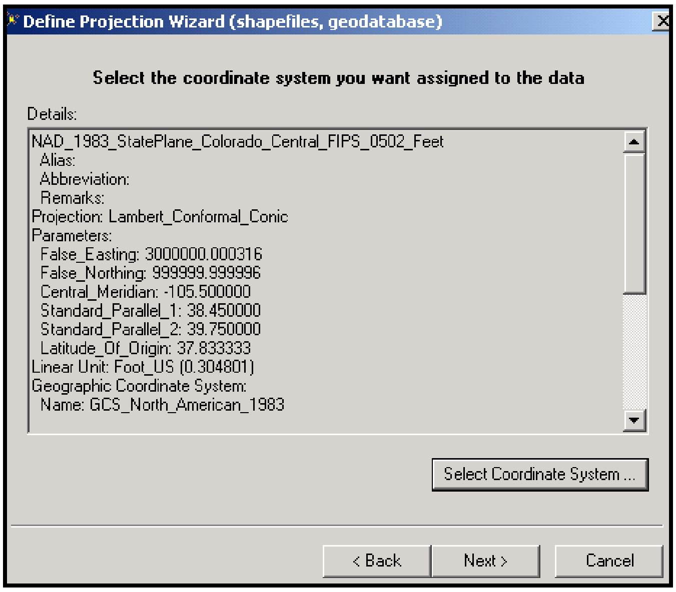


Select the data you want to assign a coordinate system

You can assign a coordinate system to shapefiles and geodatabase feature classes and datasets with this wizard.

Data	Coordinate System
C:\gis\DFC\Coverages\Base\dfcwall...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\dgdrai...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\downo...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\gsaao...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\perifen...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\topo_f...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\topocn...	NAD_1983_StatePlane_Colorado_C...
C:\gis\DFC\Coverages\Base\topom...	NAD_1983_StatePlane_Colorado_C...

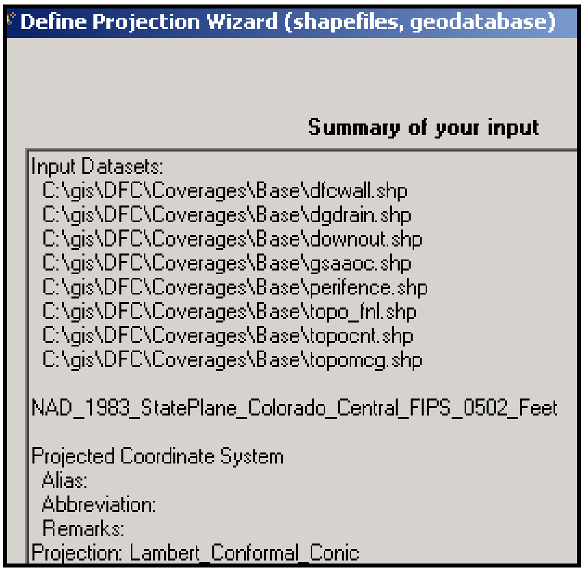
Data in this list will be assigned the same coordinate system.



Select the coordinate system you want assigned to the data

Details:

```
NAD_1983_StatePlane_Colorado_Central_FIPS_0502_Feet
  Alias:
  Abbreviation:
  Remarks:
Projection: Lambert_Conformal_Conic
Parameters:
  False_Easting: 3000000.000316
  False_Northing: 999999.999996
  Central_Meridian: -105.500000
  Standard_Parallel_1: 38.450000
  Standard_Parallel_2: 39.750000
  Latitude_Of_Origin: 37.833333
Linear Unit: Foot_US (0.304801)
Geographic Coordinate System:
  Name: GCS_North_American_1983
```



Summary of your input

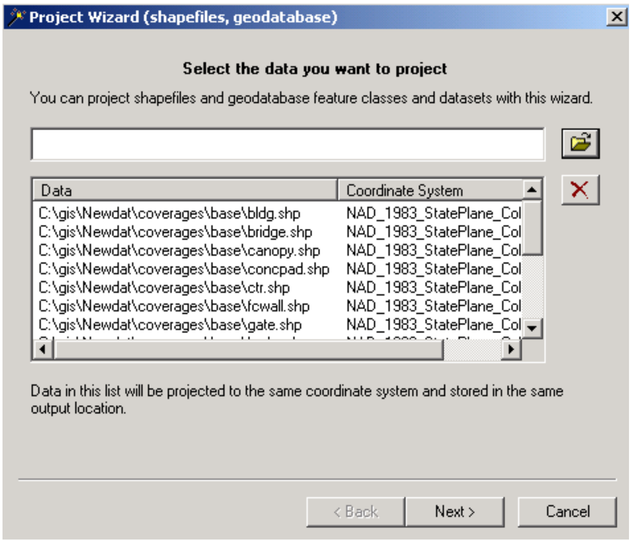
```
Input Datasets:
  C:\gis\DFC\Coverages\Base\dfcwall.shp
  C:\gis\DFC\Coverages\Base\dgdrain.shp
  C:\gis\DFC\Coverages\Base\downout.shp
  C:\gis\DFC\Coverages\Base\gsaaoc.shp
  C:\gis\DFC\Coverages\Base\perifence.shp
  C:\gis\DFC\Coverages\Base\topo_fnl.shp
  C:\gis\DFC\Coverages\Base\topocnt.shp
  C:\gis\DFC\Coverages\Base\topomcg.shp

NAD_1983_StatePlane_Colorado_Central_FIPS_0502_Feet

Projected Coordinate System
  Alias:
  Abbreviation:
  Remarks:
Projection: Lambert_Conformal_Conic
```

3.2.3 Reprojecting a Shapefile from One Spatial Reference System to Another

The two previous sections described methods to *define* the *existing* projection of a data source. However, in many cases data sources will not already be stored in the State Plane, Colorado Central, NAD83, feet coordinate system used at the Denver Federal Center. In such instances, it will be necessary to change the underlying projection of the data to make it consistent with these standards. To reproject data, use the *Project Wizard (shapefiles, geodatabase)* found in *Data Management Tools* in ArcToolbox.



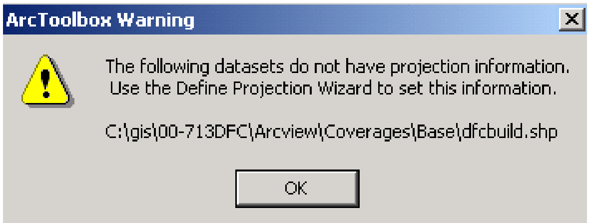
Project Wizard (shapefiles, geodatabase)

Select the data you want to project

You can project shapefiles and geodatabase feature classes and datasets with this wizard.

Data	Coordinate System
C:\gis\Newdat\coverages\base\bldg.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\bridge.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\canopy.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\concpad.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\ctr.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\fcwall.shp	NAD_1983_StatePlane_Col
C:\gis\Newdat\coverages\base\gate.shp	NAD_1983_StatePlane_Col

Data in this list will be projected to the same coordinate system and stored in the same output location.

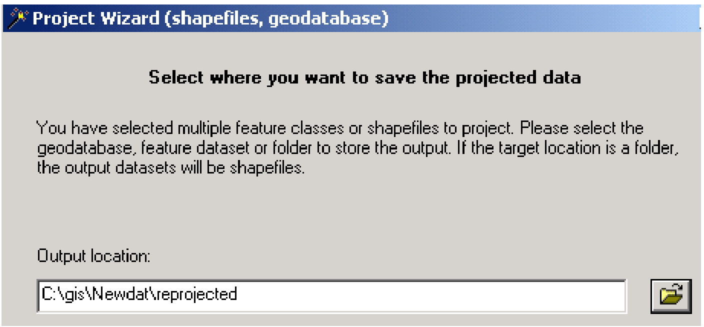


ArcToolbox Warning

The following datasets do not have projection information.
Use the Define Projection Wizard to set this information.

C:\gis\00-713DFC\Arcview\Coverages\Base\dfcbuild.shp

1. Browse to the files that you wish to reproject. (Warning: The spatial reference system of all files to reproject must already have been defined using one of the projection definition methods described previously. A warning will display if any of the data sources you choose still needs to have its projection defined.)



Project Wizard (shapefiles, geodatabase)

Select where you want to save the projected data

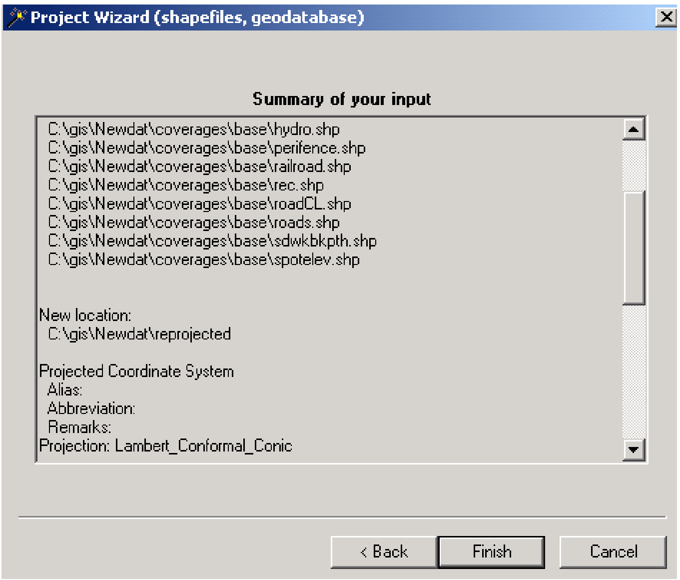
You have selected multiple feature classes or shapefiles to project. Please select the geodatabase, feature dataset or folder to store the output. If the target location is a folder, the output datasets will be shapefiles.

Output location: C:\gis\Newdat\reprojected

2. Next, choose an output location to store the results. If you choose the same output location as your input location, all original files will be overwritten without a warning.
3. Choose the new coordinate system into which to project all data sources selected. In some instances, you will be asked to select a transformation to use to convert from one datum to another. Then, select all input files that are in the same projection, choose the *Set Transform* button and pick one

from the standard list.

4. If the exact extents of your data sources is known, the can be entered in the next frame of the project wizard. A desired precision can also be set at this point.
5. After reviewing a summary of the wizard input, choose *Finish* to regenerate all input into the new projection you defined.

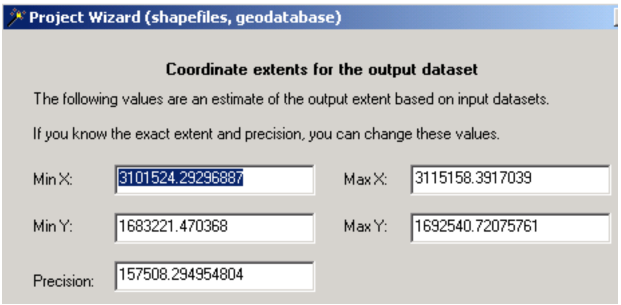


Summary of your input

C:\gis\Newdat\coverages\base\hydro.shp
C:\gis\Newdat\coverages\base\perifence.shp
C:\gis\Newdat\coverages\base\railroad.shp
C:\gis\Newdat\coverages\base\rec.shp
C:\gis\Newdat\coverages\base\roadCL.shp
C:\gis\Newdat\coverages\base\roads.shp
C:\gis\Newdat\coverages\base\sdwkbkpth.shp
C:\gis\Newdat\coverages\base\spotelev.shp

New location:
C:\gis\Newdat\reprojected

Projected Coordinate System
Alias:
Abbreviation:
Remarks:
Projection: Lambert_Conformal_Conic

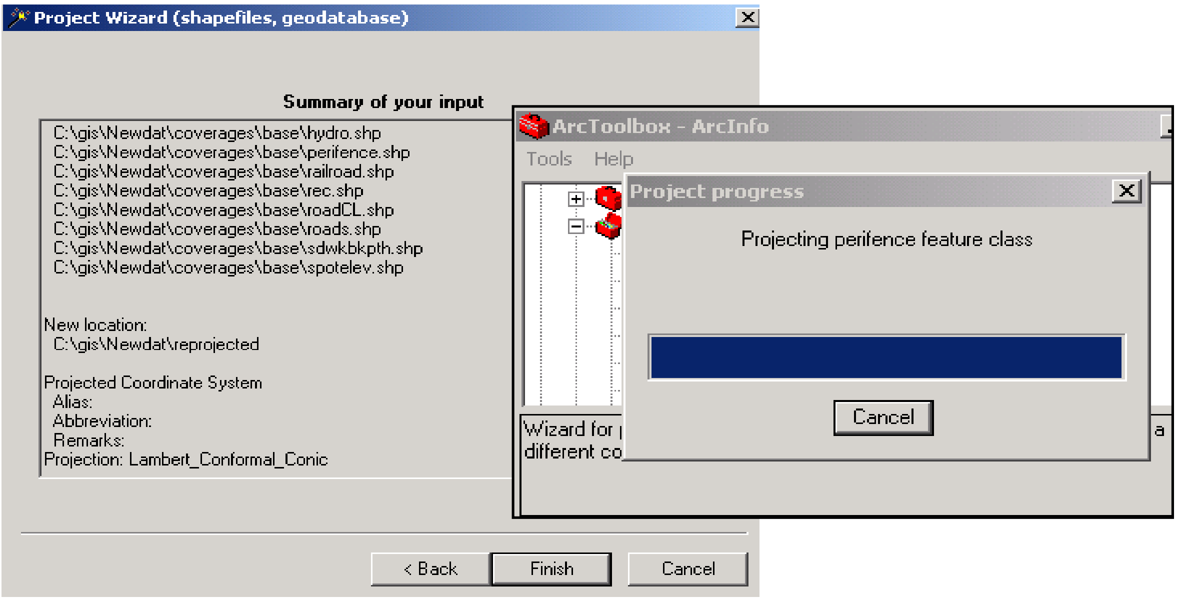


Coordinate extents for the output dataset

The following values are an estimate of the output extent based on input datasets.

If you know the exact extent and precision, you can change these values.

Min X: 3101524.29296887
Max X: 3115158.3917039
Min Y: 1683221.470368
Max Y: 1692540.72075761
Precision: 157508.294954804



Summary of your input

C:\gis\Newdat\coverages\base\hydro.shp
C:\gis\Newdat\coverages\base\perifence.shp
C:\gis\Newdat\coverages\base\railroad.shp
C:\gis\Newdat\coverages\base\rec.shp
C:\gis\Newdat\coverages\base\roadCL.shp
C:\gis\Newdat\coverages\base\roads.shp
C:\gis\Newdat\coverages\base\sdwkbkpth.shp
C:\gis\Newdat\coverages\base\spotelev.shp

New location:
C:\gis\Newdat\reprojected

Projected Coordinate System
Alias:
Abbreviation:
Remarks:
Projection: Lambert_Conformal_Conic

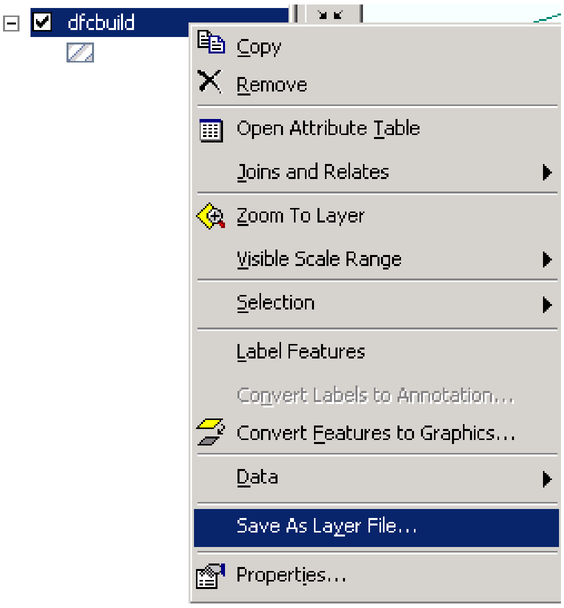
Projecting perifence feature class

3.3 NON-VECTOR DATA

Image data should be provided in TIF file format (*.tif, *.tfw). A worldfile that provides spatial reference information (*.tfw) should accompany each TIFF file (*.tif). Digital elevation models or other grid-based data should be provided in ESRI ArcInfo GRID file format, which is stored in a named directory and always accompanied by an INFO directory at the same level in the directory structure.

3.4 SAVING A LAYER FILE REPRESENTATION (*.lyr) OF EACH DATA SOURCE

For every data source that is used as a layer in an ArcView map document, a layer file should be saved in the same location with the data source to preserve symbology, labeling, and other rendering properties. To save a layer file, choose each layer in turn in the *Table of Contents* in ArcMap, right click to expose the layer context menu, and choose *Save as Layer File*. Name the layer file the same name as its source if only one layer file will ever be needed (symbology and labeling will not need to be different for different uses). Otherwise call the new layer file the same name as its source file with a descriptor following the name such as roadscl14pt for 14 point labels on the center line roads layer.



4.0 FILE NAMING CONVENTIONS

File naming conventions need to be consistent to allow PWT staff to easily find related files for comparison, integration, or duplicate elimination. Each data source filename should include a prefix labeling its general content, a more explicit descriptor, and finally a suffix that describes version or series information. Typically, do not include project area information in the filename, since this will be determine by the directory within which the data is stored.

4.1 PREFIX – CATEGORY

Include one of the following categorical prefixes to classify each data source. If a data source fits two categories or falls into a category not yet defined, the contractor should work with PWT personnel to create a new or combined class.

ast – above-ground storage tank

BD### – building number to proceed name of environmental samples collected within a building

bh – borehole
blg – building
bnd – boundary
ctr – contours
ele – electrical system features
fnc – fence
gs - gas
gw – groundwater
IA##O – site identifier (such as IA14N), proceeds environmental sample names
ophoto – orthophoto
rd – road
rec – recreation
rr – railroad
sdwk – sidewalk
sol – soil
spot – point elevation
str – stream
sw – surface water
swr – sewer collection system features
stm – storm water collection system features
tel – telecommunication system features
ust – underground storage tank
utl – utility
veg – vegetation
wl - well
wall – wall
wtr – water distribution system features (e.g. domestic water line)
zon – zone

4.2 NAME – DESCRIPTION

Include an abbreviation for the name or identifier for data sources representing a single object, such as a stream (i.e. strMcGulch.shp). Typically do not include project area designators in the name, since the project directory in which the data source is stored will determine this. The exception is environmental samples, which should include a site or building designator prefix as described above and a date stamp suffix as described below.

4.3 SUFFIX – SERIES, VERSION, SOURCE

For periodically collected environmental sample data, a suffix should be added to distinguish one data source from another. For example, for quarterly samples, the year and quarter should be added as YYQ#, or 02Q1 for the first quarterly sample collected in 2002. For sporadically collected samples, a date stamp YYMM should be used, such as 0202 for samples collected in February 2002. For a sample type that will not to be sampled again, no date stamp is needed since it is already a unique data source.

Do not use words like new and old to describe versions. If existing data must be edited, then a dash followed by the edit date should be added to the name to indicate which version it is. Once all previous versions have been discarded, PWT personnel can decide how to reconcile any edits and drop the date suffix from the final version that results.

If it is necessary to distinguish a data source developed by an outside entity for public use from one developed for PWT directly, a suffix can be added to distinguish the source. For example, USGS could be added to a stream filename to indicate it is a US Geological Survey version of the stream, or LKWD could be appended to the name of files obtained from the City of Lakewood. However, if more than one or two files are going to be used from an outside source, it is better to place these data sources in their correct location in the directory structure in a subdirectory labeled with the name of the data provider.

5.0 DIRECTORY STRUCTURE

5.1 BASEWIDE DATA AND MAP DOCUMENTS

All data sources in shapefile format that cover the entire area of the installation or at least large portions of it or represent a single entity like a stream that traverses the installation should be stored in the ***Coverages*** directory. Within the *Coverages* directory, data sources should be placed in one of the following subdirectories based on their purpose:

- **Base –** base map layers like roads, buildings, etc
- **Locations –** environmental sampling data
- **IS-CS –** environmental site boundaries and area of concern polygons
- **Offsite –** areas adjacent to DFC but not within the boundaries of the compound
- **Utilities –**water, storm water, sewer, electrical, etc.

All map documents should be placed in the ***Projects*** directory. Since each ArcView 8 map document (*.mxd) file contains a single map, an abbreviation of the map title and page size should be used to describe it. For example, a basewide utilities map could be called wtrswrele36x24.mxd to indicate that it contains just water, sewer and electrical utilities (as opposed to all utilities) on a 36 inch wide by 24 inch tall map. If a map contains only site specific data, the title of the map should be prefixed with the site number (e.g. IA14N02Q1envchem17x11.mxd).

5.1.1 CAD and Image Files

All data sources stored in Computer-Aided Design (CAD) format should be places in the ***Cadfiles*** directory. Orthorectified photos should be placed in the ***Image/Airphoto*** directory. Pictures or photos of buildings should be placed in the ***Image/Bldg*** directory. Maps of project areas should be placed in the ***Image/Maps*** directory. Company logos and other types of images should be placed in the ***Image/Other*** directory. Cadfiles or image files that represent buildings should be named by their building number and an appropriate descriptive prefix (UTL – utility, Mod – modification, BH – borehole, etc.).

5.1.2 Project-specific Data

Project-specific data should be stored in a directory labeled with its IA or other location identifier within the Coverages directory described previously. Within each project directory, subdirectories should be established to organize all spatial data layers (coverages, cadfiles, etc.). To make it easier to load map documents, even project specific ArcView 8 map documents (*.mxd) should still be stored in the ***Projects*** subdirectory at the root level.

6.0 DATA DICTIONARY

A simple, but complete data dictionary must be submitted with each spatial data submittal that briefly describes each spatial data source included. The data dictionary should be submitted in an easy-to-read tabular or report format that includes the following headings:

<u>FILENAME</u> – if data files are submitted in more than one directory, include the full path

<u>DESCRIPTION</u> – provide a brief but clear description of content and use

<u>FORMAT</u> – list both the type of data (point, line, polygon, image, grid, drawing, etc.) and the file format along with its characteristic extension (e.g. shapefile - *.shp)

<u>DATE CREATED</u> – include the day, month and year the data was generated

7.0 METADATA

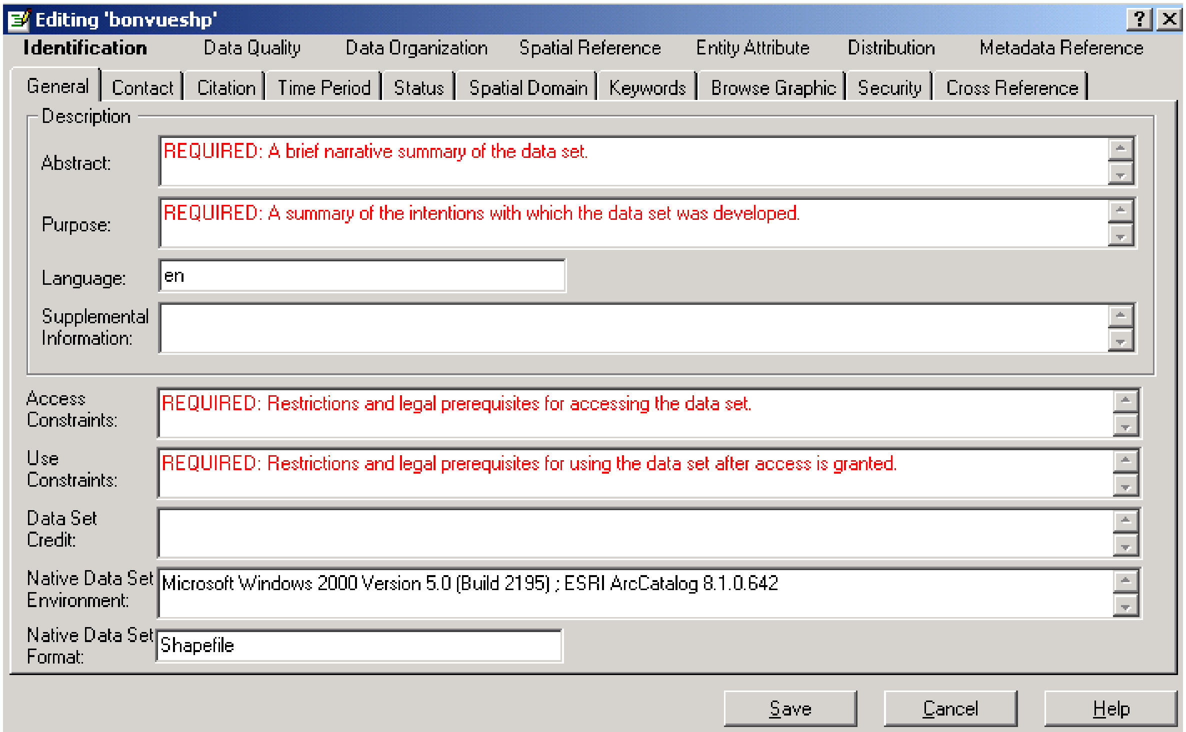
7.1 ARCCATALOG-BASED XML FORMAT

Each spatial data source must be accompanied by an ArcView 8-based XML file that describes its content. This file can be automatically generated in part by choosing the data source name listed in the table of contents in ArcCatalog then selecting the *metadata* tab. To edit this metadata file to include other required information:

1. click on the metadata tab

Stylesheet: ESRI

2. choose the edit button
3. click on one of the 7 sections of FGDC metadata to begin modifying
4. click on the tab within the section that describes the type of information you wish to update
5. update information in each field (trying particularly hard to fill in all red lettered sections that include the word REQUIRED at the beginning of the text string)



Abstract: REQUIRED: A brief narrative summary of the data set.

Purpose: REQUIRED: A summary of the intentions with which the data set was developed.

Language: en

Supplemental Information:

Access Constraints: REQUIRED: Restrictions and legal prerequisites for accessing the data set.

Use Constraints: REQUIRED: Restrictions and legal prerequisites for using the data set after access is granted.

Data Set Credit:

Native Data Set Environment: Microsoft Windows 2000 Version 5.0 (Build 2195) ; ESRI ArcCatalog 8.1.0.642

Native Data Set Format: Shapefile

NOTE: A metadata text file that includes standard sections such as access and use constraints is included on the CD that accompanies this document. This can be imported into the metadata using the *Import Metadata* button found on the metadata toolbar when the *Metadata* tab is active. Each contractor can add their contact information and other repetitive data then use the *Export Metadata* button to create a more complete, general purpose metadata file. Significant time can be saved by importing this descriptive information into the metadata for each data source before conducting further metadata edits. If this method is followed, it is possible that only the file's purpose and abstract and specific descriptive information about feature attributes associated with the map features will still need to be described.

7.2 SPATIAL REFERENCE INFORMATION MUST BE DEFINED

Once you define the spatial reference information of a data source using the ArcCatalog or ArcToolbox method described in an earlier section, ArcView 8 will automatically include this in the metadata. This is also true of all other information that ArcView 8 can determine from the data itself, such as extent, feature type and number of features, etc. To view all automatically recalculated metadata entries, review the *Spatial* tab of the *ESRI Stylesheet* for the data source of interest.

7.3 MINIMUM REQUIREMENTS

The following descriptive information is required for each spatial data source submitted. Including additional information is encouraged to enable the metadata to meet Federal Geographic Data Committee (FGDC) standards as well as possible. The three levels of the outline below relate to the ArcView 8 Metadata Editor dialog and indicate the menu, tab or button popup dialog, and finally the actual information field that must be completed shown in bold type.

- **Identification**
  - Description
    - **Abstract, Purpose**
  - **Access and Use Constraints**
  - Contact
    - **Person, Organization, Telephone, E-mail, Address**
  - Citation Information
    - **Title, Originator, Publication Date**
- **Spatial Reference** (automatically added once defined)
- Entity Attribute
  - Attribute
    - **Label, definition, units** (if applicable) for each user-defined attribute field
- Metadata Reference
  - Contact Information
    - **Person** (rest not necessary if it is the same as in the identification section)

8.0 MAP DOCUMENT

8.1 THE MAP DOCUMENT (*.mxd)

An ArcView ArcMap map document (*.mxd) will be generated for each map produced for a project. All map documents should be stored in a ***Projects*** directory, either at the root level of the directory structure for basewide projects, or within a subdirectory labeled with its project area (e.g. IA14N). Metadata should be generated for each map, but only needs to include the purpose, abstract, and complete contact information listing the person who actually designed the map rather than the project manager. The metadata should indicate if any symbols or map elements were used that are not found in the PWT map style and if a PWT-approved map template did

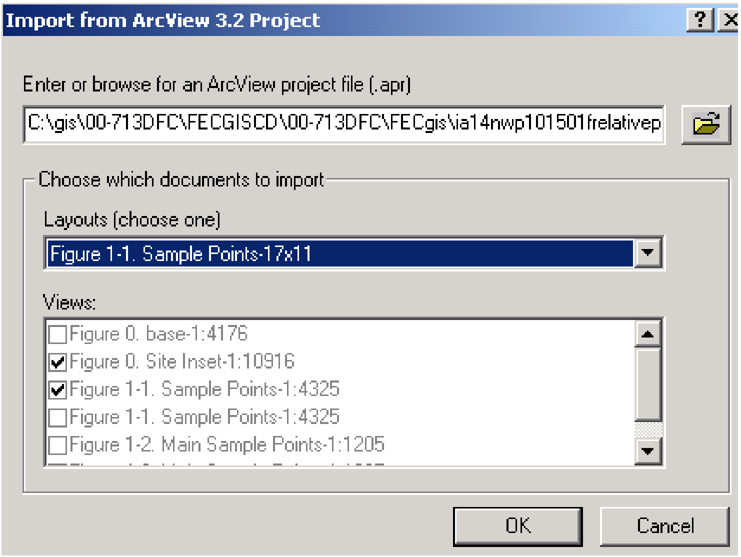
NOT serve as the basis for the map. This will enable PWT personnel to add new symbols and map elements to the PWT style if necessary and review Layout View effectively to check for product consistency.

9.0 IMPORTING ARCVIEW 3.X PROJECTS INTO ARCVIEW 8

There are two methods for importing Layout and View documents from an ArcView 3.X project file (*.apr) into ArcView 8 map documents (*.mxd). Each map document is comprised of a single map (layout) containing one or more data frames – a data frame in ArcView 8.X is analogous to a View in ArcView 3.X. An ArcView 3.X project file often contains multiple layouts, so typically one *.apr is imported into several single-map map documents. If only the data and symbology is desired, instead of a final map presentation, the user can import selected Views instead of having Views selected for import automatically based on which Layout is to be imported. ArcView 3.X charts, tables, scripts and dialogs cannot be imported into ArcView 8. Tabular joins and links are also lost during the conversion. Therefore, any themes based on an Event Theme or relying on joins for symbology or labeling in ArcView 3.X will not appear correctly in ArcView 8. Sometimes it may be easier to open an ArcView 3.X and fix it to eliminate dependencies that ArcView 8 will not recognize before proceeding with the import process. Data source paths in the *.apr file to import should not be relative (start with a ./) or utilize a variable in the pathname, because only full paths to data sources will be read correctly by the Import tool. The first step to importing an ArcView 3.X project is to launch the *Import ArcView 3.X Project* option from the *File* menu in ArcMap. Browse to the ArcView 3.X project file (*.apr) file that you wish to import. Views and Layouts found in the project will appear in their respective lists as soon as you choose an ArcView project file.

9.1 METHOD 1. IMPORTING BY LAYOUT

Choose a Layout from the list of all the Layouts found in the current ArcView project file to automatically import it and all of its associated Views into an ArcView 8 map document (*.mxd). After choosing a layout, the View Selector window will become grayed out and Views associated with the layout will automatically become check marked for import. Usually no map will be converted perfectly, so review the *Correcting Import Errors* section below.



Import from ArcView 3.2 Project

Enter or browse for an ArcView project file (.apr)

C:\gis\00-713DFC\FECGISCD\00-713DFC\FECgis\ia14nwp101501frelativep

Choose which documents to import

Layouts (choose one)

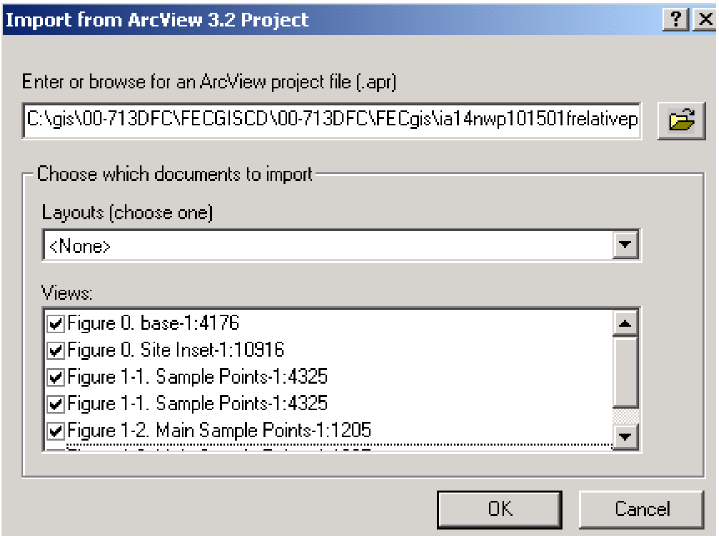
Figure 1-1. Sample Points-17x11

Views:

☐ Figure 0. base-1:4176
☑ Figure 0. Site Inset-1:10916
☑ Figure 1-1. Sample Points-1:4325
☐ Figure 1-1. Sample Points-1:4325
☐ Figure 1-2. Main Sample Points-1:1205

9.2 METHOD 2. IMPORTING SELECTED VIEWS

Since the approved ArcView 8 map templates may differ substantially from map layouts used in ArcView 3.2, in many cases it will be preferable to just import Views by selecting the *None* option for *Layouts* to import. Then just check mark the Views needed to construct a single map. Use one of the project-specific map templates to generate a new map using the *Change Layout* button on the *Layout* toolbar. After adding a template, adjust the text and map elements if necessary to match important features in the original ArcView 3.2 layout.



Import from ArcView 3.2 Project

Enter or browse for an ArcView project file (.apr)

C:\gis\00-713DFC\FECGISCD\00-713DFC\FECgis\ia14nwp101501relativep

Choose which documents to import

Layouts (choose one)

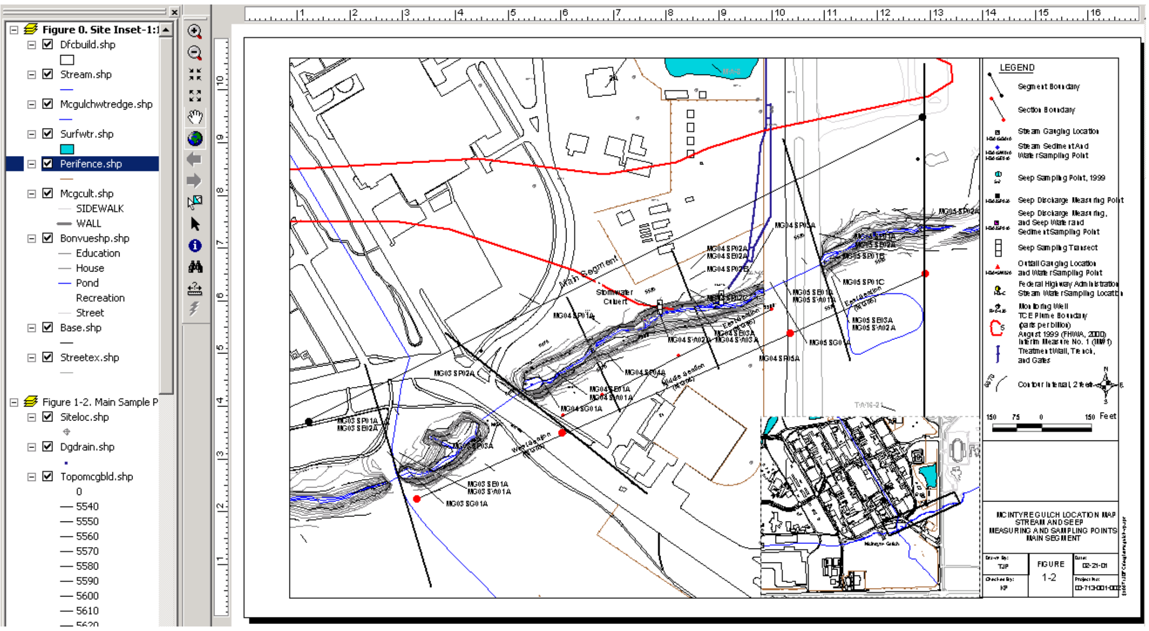
<None>

Views:

☑ Figure 0. base-1:4176
☑ Figure 0. Site Inset-1:10916
☑ Figure 1-1. Sample Points-1:4325
☑ Figure 1-1. Sample Points-1:4325
☑ Figure 1-2. Main Sample Points-1:1205

9.3 CORRECTING IMPORT ERRORS

After importing ArcView 3.X information in ArcView 8, it will be necessary to reestablish tabular joins and links and recreate event themes. The graphing tool accessed with the *Tools>Graphs>Create* option can be used to reconstruct any charts that had been present. Click on the *Source* tab in the *Table of Contents* and choose the *Add Data* button to import tabular data that had resided in an ArcView 3.X table document. Not all map elements translate correctly from ArcView 3.2 into ArcView 8. Therefore, it important to examine north arrows, scale bars, legends, etc. and replace them with ArcView 8 elements where conversion has not been effective. Sometimes text formats may need to be adjusted and neatlines reset, too. If the map resulting from an imported project is not consistent with approved PWT ArcView 8 map templates, map deliverables will NOT be accepted. Therefore, if a contractor's ArcView 3.2 layouts differ more than slightly from PWT ArcView 8 standards, it is better to import Views only and use an approved PWT map template to reconstruct the map.



ATTACHMENT A

U.S. EPA Region 8 GIS Deliverable Guidance

U.S. EPA Region 8
GIS Deliverable Guidance
(January 2010)

Introduction and Scope

This document is intended to specify GIS file delivery formats for all materials developed in support of CERCLA related site work within EPA Region 8. It is the intent of EPA Region 8 to acquire, catalog and manage all site specific GIS files comprehensively across all active CERCLA sites to: 1) ensure future use and access to EPA, 2) provide an archive of work accomplished, 3) maintain and serve files that spatially represent all sites, and 4) provide a basis for on-going and future activities such as Five Year Review.

While the initial emphasis will be to ensure all GIS files for NPL sites are captured and managed, we consider capturing all GIS materials developed that support any of the Superfund Pipeline process under the requirements of this standard. These include GIS and imagery files that support Site Assessment, NPL Listing, Removal, Remedial, Enforcement, and Five Year Review.

GIS Data Files

All final version spatially enabled files acquired or developed to support mapping and/or spatial analysis at a site are considered property of the EPA Region 8 Superfund Program and are required to be submitted to EPA. This includes but is not limited to all GIS, CAD, and image formatted files used to develop maps for any scoping or decision document developed for EPA, as well as any spatial file used to inform a decision on site management or development. Only final versions of each layer are required for delivery to EPA, and must be in an approved format as specified in this document. In addition, all electronic geospatial data, whether vector or raster, must be project defined (have a projection defined and embedded in or associated with the data file), and in the case of CAD data must NOT be in page space or a custom site-specific projection. All CAD data should be in known real world coordinate space, ideally in geographic/decimal degrees/NAD83. Should tabular data be appropriate to connect location information with attribute information, then documentation specifying the primary and foreign keys is required. Should coordinate information be provided in tabular format it should contain at minimum the following fields:

ID – a unique identifier given to each feature
Latitude – the Y coordinate in decimal degrees
Longitude – the X coordinate in decimal degrees
Horizontal Datum – the datum of the coordinates.

Additionally all static maps that appear in a Superfund document should be in an electronic Adobe PDF format with fonts embedded and at a resolution of 300 dots per inch (dpi) or greater. Finally, all ArcMap documents (.mxd) or equivalent map document formats used in final map production are also required for delivery to EPA with accompanying data in a stand-alone directory structure. Map document formats also need to be configured to use relative paths and not be set to use a printer-specific paper setting.

Metadata and Projection Requirements

All GIS files developed for EPA are required by Executive Order 12906 to have associated metadata. EPA requires FGDC compliant metadata on all GIS files developed for site support. Region 8 also requires that all dynamic maps (ArcMap documents) have metadata completed. The Content Standard for Digital Geospatial Metadata can be found at www.fgdc.gov. Metadata, including information about the data's projection, can be developed using one of several built-in or add on tools within a GIS, and typically is associated with the geometry file as an XML file. EPA region 8 Program Support staff will be happy to consult and advise on development of required metadata.

All GIS files submitted to EPA must have spatial reference information that describes the projection, datum, and where applicable the collection methods. The EPA requests that all vector data be submitted in geographic coordinate system, decimal degree units, and NAD83 datum. Raster data, such as aerial photographs may be submitted in their native projection, and maps should be in the appropriate projection/coordinate system for the area depicted.

Delivery Requirements and Standard Organizational Structures
EPA will accept data delivered on CD-Rom, DVD, or external hard drive, as well as direct electronic submission via email or FTP site. Other delivery methods may be allowed if those requirements present a significant burden or as technology changes.

If the project is complex, a directory structure and readme text file in the upper level directory that describes the structure are required. Because EPA will be managing data across many sites, it is important to make your submittals as understandable as possible. A recommended directory structure is as follows:

<**Project_Name**>
    |_ **Docs** (reports, SOPs, correspondence, and other such documents)
    |_ **Images** (aerial photos, satellite imagery, logos, DEMs, and other raster type data)
    |_ **Maps** (MXDs and PDFs. Map names should use the project name as a prefix)
    |_ **Shapes** (geodatabases, shape files, and other approved vector data formats)
    |_ **Source** (original unmodified data that may have been acquired from external/internal sources)
    |_ **Tables** (MS-Access databases, spreadsheets, delimited text files, or other such tabular data not stored in a geodatabase)

File naming conventions should be logical, consistent, and contain no spaces or special characters. An underscore may be used in lieu of a space.

EPA Acceptable Data Formats
The following file formats are considered acceptable and all maps and data must include an associated metadata document:

DATA
Vector - **projected to geographic, decimal degrees, NAD83**
Shape File (.shp, .shx, .dbf, .prj, .sbx, .sbn)
File Geodatabase (.gdb)
Personal Geodatabase (.mdb)
Oracle Dump (.dmp)
XML Workspace Document with dependencies clearly documented (.xml)
Raster – **native projection acceptable**
TIFF image with world reference file or as a GeoTIFF (.tif, .tfw)
JPEG image with world reference file (.jpg, .jpw)
ERDAS Imagine image with pyramid file (.img, .rrd)
MrSid image (.sid)
ESRI Grid
DEM
TINs – **appropriate projection/coordinate system for the area depicted**
ESRI TIN
CAD - **projected to geographic, decimal degrees, NAD83**
DXF layer separates (.dxf)
Tabular – **primary keys should be clearly identified/documented**
MS-Access database (.mdb)
MS-Excel spreadsheet (.xls)
Delimited text file (.txt, .csv)
MAPS
Static
Adobe PDF at 300 dpi or better with embedded fonts (.pdf)
Dynamic
ArcMap document with associated data files in a stand-alone directory structure using relative paths (.mxd)

FGDC Compliant METADATA
XML (.xml)
FGDC CSDGM XML (.xml)
FGDC CSDGM SGML (.sgml)
FGDC CSDGM TXT (.txt)

U.S. EPA Region 8 GIS Contact
John Wieber
wieber.john@epa.gov
(303) 312-6118

CHECKLIST

The following checklist may be used to assist in complying with these standards:

DATA

- ☐ Is each vector file, CAD included, in geographic, decimal degrees, NAD83?
- ☐ Is each raster file in its native projection?
- ☐ Is each data file one of the EPA acceptable formats?
- ☐ Does each data file have FGDC compliant metadata in an associated file?
- ☐ Are the primary and foreign keys documented for tabular data?
- ☐ Is a README text file included with a directory structure explaining how the structure is organized?

MAPS

- ☐ Is each static map provided in an electronic format at a resolution of 300 dpi or higher?
- ☐ Does each static map have fonts embedded?
- ☐ Has the page and print setup for map documents been configured to NOT use printer-specific paper settings?
- ☐ Are map documents set to use relative paths?
- ☐ Are map names prefixed with the project name?
- ☐ Are map documents accompanied with their relevant data in a stand-alone directory structure?
- ☐ Does each map have FGDC compliant metadata in an associated file?

PWT STANDARD OPERATING PROCEDURE

SAMPLE HANDLING

Procedure No. PWT-ENSE-406
Revision 2
Date effective: 03/01/12

APPROVED: ________________/s/____________________ __________
PWT Project Manager, Date

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List of Attachments

Attachment A Example Chain of Custody Form

Attachment B Example Custody Seal

REVISION LOG		
Revision Number	**Description**	**Date**
1.0	Original SOP	July 2011
2.0	QA Review and Update	March 2012

PWT STANDARD OPERATING PROCEDURE

SAMPLE HANDLING Procedure No. PWT-ENSE-406
Revision 2
Date effective: 03/01/12
APPROVED: __________________/s/______________________ ___________
PWT Project Manager, Date

ANNUAL REVIEW LOG

Revision Reviewed	Description	Date
2.0	Annual QA Review	August 2013
2.0	Annual QA Review	November 2014

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to handle environmental samples (such as: soil, groundwater, surface water, sediment, waste, and air samples) during environmental investigations. This SOP serves as a supplement to site-wide and investigation area specific workplans and the site-specific Quality Assurance Project Plan (QAPP) and may be used in conjunction with other SOPs.

2.0 REQUIREMENTS

The following sections identify the requirements for Quality Assurance / Quality Control (QA/QC), health and safety, and personnel qualifications for sample handling.

2.1. Quality Assurance / Quality Control

Follow all QA/QC requirements identified for the project as identified in approved project planning document(s).

2.2. Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan, Job Safety Analyses (JSAs), any applicable Task-Specific Health and Safety Plans prepared by PWT Subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.3. Personnel Qualifications

Personnel performing sample handling activities will have knowledge and experience in the equipment and procedures used, or will work under the direct field supervision of knowledgeable and experienced personnel. Sample handling will be directed by a PWT field sample manager responsible for ensuring proper handling and shipment of samples. The field sample manager will be knowledgeable and experienced in handling and shipping of environmental samples.

3.0 MATERIALS AND EQUIPMENT

The following materials and equipment may be needed for sample handling, packaging, and shipping:

- Monitoring equipment and personal protective equipment (PPE) as specified in the HASP.
- Appropriate clean sample containers as specified for each analytical method being tested. Sample containers will contain appropriate preservatives, according to method specifications. Sample containers will be provided by the analytical laboratory, unless otherwise specified in the QAPP.
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, Alconox, plastic sheeting, paper towels, sponges, baby wipes, garden-type water sprayers, large plastic bags, potable water, distilled water and/or deionized water).
- Sample handling supplies (e.g., recloseable plastic bags, waterproof markers and sample labels, cooler for sample storage, ice or ice substitute).
- Sample management supplies (e.g., soil sample field data sheets, chain-of-custody [COC] forms). An example COC form is included as Attachment A.
- Sample shipping supplies (shipping coolers, recloseable plastic bags, shipping labels, shipping forms [provided by shipping courier], bubble wrap, tape [e.g., clear tape, packing tape, and custody seal tape]).

Other materials and equipment may be needed based on field conditions.

4.0 PROCEDURES

4.1 Sample Identification

Samples collected during investigation activities will be identified using a pre-determined sample identification (ID) scheme described in the project or investigation –specific sampling plan.

Typically, sample ID numbers consist of two main components:

- The investigation location site identifier, which may include numbers, letters, or a combination of the two, and which corresponds to the investigation location at which the sample was collected
- Sample-specific information, such as the sample collection method, sample depth interval, sample type and sequential sample number

4.2 Sample Labeling

Sample labels will be filled out to the extent possible before field sampling activities begin. However, the date, time, sample depth, and sampler's initials or signature will typically not be completed until the time of sample collection. Sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Company’s name
- Project name/site location
- Sample ID
- Date and time of sample collection
- Method of preservation (if any) used
- Analyses required
- Sample matrix (e.g., soil, water)
- Sampler initials

4.3 Sample Handling

This section discusses proper sample containers, preservatives, and handling and shipping procedures.

4.3.1 Sample Containers

Unless otherwise specified in the QAPP, clean sample containers will be obtained from the subcontracted analytical laboratory performing the analyses. Extra containers will be ordered to account for the possibility of breakage during shipment or sample collection. To the extent possible, required preservatives will be prepared and placed in the bottles at the laboratory before shipment to the site. Project-specific sample containers will be identified in the site-specific QAPP.

4.3.2 Sample Preservation

Samples will be preserved in accordance with the site-specific QAPP. Chemical preservatives, if necessary, will be added to the sample containers by the laboratory (or vendor) before shipment to the field. Samples will be stored at appropriate temperatures as specified in the site-specific QAPP.

4.3.3 Sample Handling and Shipping

Sample containers will be packaged properly to prevent breakage of containers and leakage of contents. The following procedures will be followed during the packaging and shipping process:

1. Place sample containers in recloseable plastic bags.
2. If sample container is glass, wrap individual sample containers with bubble wrap.
3. Place sufficient amounts of bubble wrap in the bottom and sides of the shipping cooler to prevent movement of contents.
4. Add enough ice (in double bags) or ice substitute to the cooler to maintain proper preservation temperature in accordance with the QAPP.
5. Line the inside of the cooler with a plastic trash bag, place the samples and additional ice as necessary inside, and tie the bag shut.
6. Fill any void space in the cooler with packing material (e.g., bubble wrap) to prevent movement of sample containers.
7. Place the original COC form inside a recloseable plastic bag, and tape the bag to the inside of the cooler lid.
8. Close the cooler lid, and seal the cooler and the cooler drain spout with appropriate packaging tape.
9. Place two custody seals (tampering seals) on the cooler in separate areas over (across) the seal between the lid and the cooler base. Example custody seals are included as Attachment B.

A shipping bill should be completed for the shipper and taped to the top of the cooler using the envelope provided by the shipper. The following markings may also be placed on the top of the cooler:

- This end up
- Fragile
- Laboratory delivery address
- Sender's return address

A copy of the shipping bill will be retained by the field sample manager for attachment to the corresponding COC form. Samples will be hand delivered or shipped by express courier for delivery to the analytical laboratory.

The field sample manager or field team leader is responsible for verifying that samples collected by the field team(s) have been properly identified, preserved, and packaged, and for verifying the accuracy and completeness of sample labels, COC forms, and applicable sample field data sheets and logbook entries.

The following is a summary of steps to be performed by the field sample manager:

- Verify sample labels.
- Verify samples were collected and preserved in accordance with the site-specific FSP and QAPP.
- Check or complete the COC form, photocopy, and retain a copy for the project files.
- Pack samples in shipping containers and verify labels and shipping forms meet shipping requirements.
- Send original COC form to the laboratory.
- Retain a copy of the shipping bill and staple it to the corresponding COC copy.
- Send copies of sample field data sheets and photocopied pages of field logbooks to the project manager.

Close coordination will be maintained between the field sample manager and the analytical laboratory during sample collection and shipment. The laboratory will be instructed to report any handling or preservation issues immediately to the field sample manager (or other designated person) so that corrections can be made to field procedures, if necessary.

4.3.4 Sample Container Tampering

If, at any time after samples have been secured, custody seals on the cooler are identified as having been tampered with, the following procedures will be conducted to ensure that sample integrity has not been compromised:

- Check with personnel having access to sample coolers to assess the possibility of inadvertent breakage of custody seals.
- Inspect sample containers for signs of tampering, such as loose lids, foreign objects in containers, or broken or leaking containers.
- Review sample packaging and handling procedures.
- Document findings of the incident in the sample management logbook.

If it is determined that intentional tampering of samples has occurred, or it is believed that sample integrity has been compromised in any way, the Quality Assurance Officer and appropriate project managers will be notified.

4.3.5 Holding Times and Analyses

Samples will be shipped to the analytical laboratory for analysis as soon as practical following collection. At a minimum, samples will be shipped daily with the following exception. For small projects, samples may be collected over a period of several days at the discretion of the project managers, and then collectively shipped. No samples will be shipped on Friday for weekend delivery unless receipt and analysis procedures are pre-coordinated with the analytical laboratory. Allowable holding times for specific samples will be specified in the site-specific QAPP.

5.0 DOCUMENTATION

Documentation of sample handling is critical to project defensibility. The field sample manager will be responsible for ensuring all sample collection and handling documentation is complete and accurate.

5.1 Sample Management Logbook

The field sample manager will maintain a complete and accurate sample management logbook documenting sample handling procedures and observations. The logbook will be a permanently bound weatherproof field logbook with consecutively numbered pages. The field sample manager will also maintain a complete and accurate sample management file containing copies of all sample field data sheets, sampling crew logbooks, COC forms, shipping documentation, and written logs of correspondence or communications with the laboratory and other pertinent correspondence and communications. The sample management logbook will contain sufficiently detailed information to allow all significant sampling issues to be reconstructed without relying on the memory of sampling personnel.

The sample management logbook will contain daily entries for the following information:

- Project name
- Sampling activities performed that day
- Sampling crews and affiliations

- Sample location identifications
- List of samples collected, including sample IDs, collection time/date, media, analysis methods, and associated COC and shipping documentation
- QA/QC samples collected and submitted for analysis
- Field observations
- Instrument calibration information
- Correspondence and communications
- Field sample manager's signature

Changes or deletions in the logbook will be lined out with a single strike mark, initialed and dated by the person making the change. Sufficient information should be recorded to allow the reason for the change to be reconstructed without relying on the memory of field personnel.

At the end of each day, the field sample manager will prepare copies of the sample management logbook, sample field data sheets, and field crew logbooks for the project manager. The field sample manager will coordinate with the project manager on the required frequency of transmittal of this information to the client. The client will expect this information to be available, accurate, and complete on a daily basis for possible inspection by the client, quality assurance personnel, the project manager or the regulatory agency.

5.2 Chain of Custody

Written documentation of the proper and secure handling of samples from the time samples are collected until laboratory data are issued is critical to project defensibility. The chain of custody of the physical sample and its corresponding documentation will be maintained throughout the handling of the sample. Sample custody applies to both the field and laboratory operations. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. An example COC form is provided as Attachment A. The COC form may consist of a triplicate, pressure-sensitive form or other form prepared by the contract laboratory, or the COC form may be electronically generated in the SCRIBE software. The COC form may vary depending on investigation activities. The investigation contractor will select an appropriate COC form subject to approval by the client.

A sample is under custody if it is in:

- The possession of the sampler/analyst.
- The view, after being in the possession, of the sampler/analyst.
- A sealed shipping container being carried by a designated commercial carrier.
- A designated secure area.

The sampling team will be responsible for initiating the original COC form and will sign and date the COC form when relinquishing sample custody to another person (e.g., the field sample manager) or to the analytical laboratory. The COC form and sample labels will be checked by the field sample manager to verify that samples are accounted for and in good condition, and that no errors were made.

The COC form will include the following information:

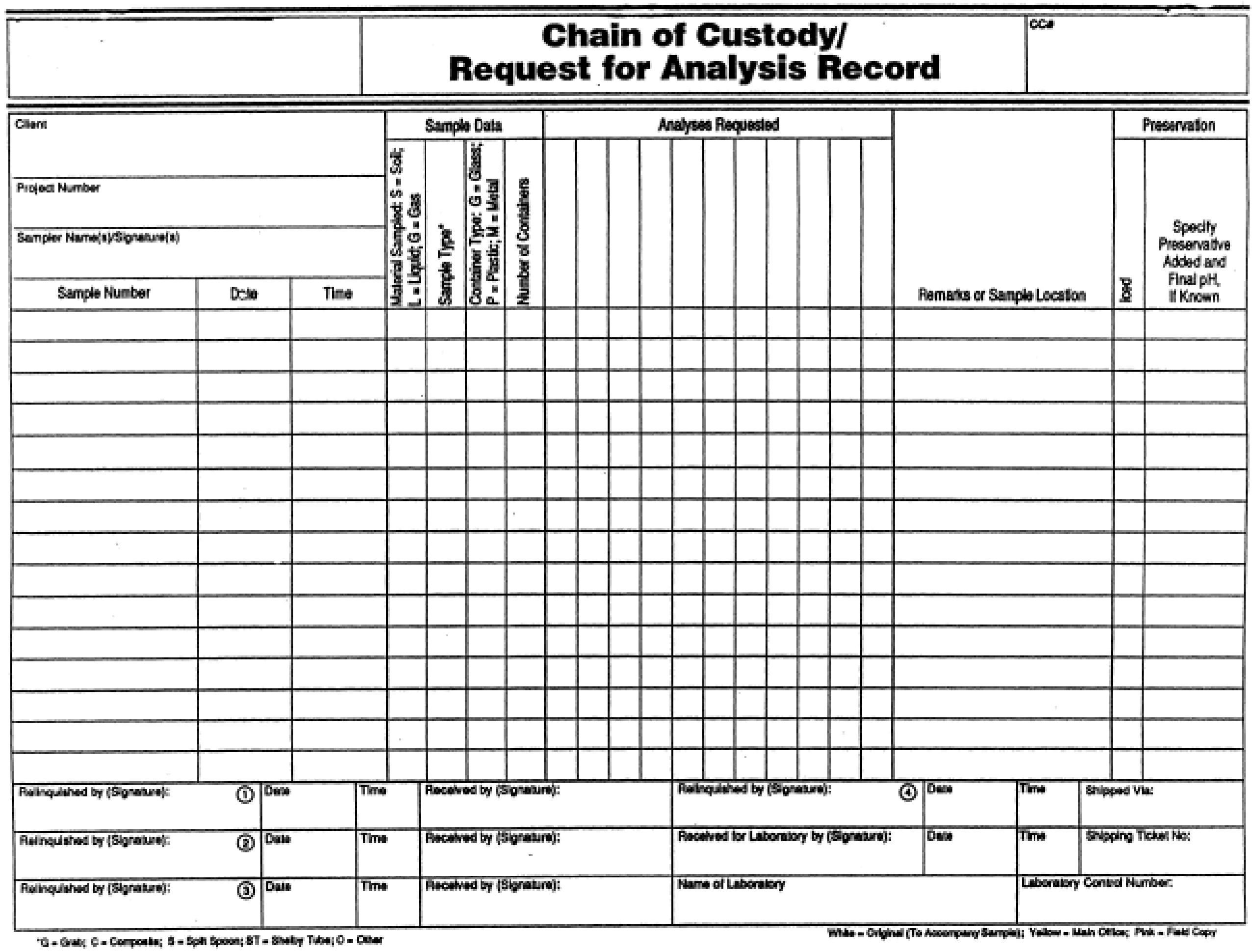
- COC number (unique, sequential number on the upper right corner of the form)
- Project name and number
- Sample ID number

- Sample preservatives
- Number of containers
- Sample collection date and time
- Sample matrix
- Requested analyses
- Signature and date blocks for personnel relinquishing or receiving sample custody
- Name and phone number of contractor contact person

Transfer of samples to the analytical laboratory may be via commercial carrier. The field sample manager will verify the proper packaging and shipment of samples. Prior to shipping, the field sample manager will officially transfer sample custody to the commercial carrier or analytical laboratory and secure the COC form inside the shipping container. Shipping containers transferred via commercial carrier will be sealed with strapping tape and with two custody seals. An example custody seal format is provided as Attachment B. Receipts of bills of lading from the carrier will be maintained as part of the custody record. Commercial carriers are not required to sign the COC form as long as the COC form is sealed inside the shipping container and the custody seals remain intact.

Upon receipt at the laboratory, the person receiving the samples will sign the COC form accepting transfer of custody to the laboratory. The laboratory will return a copy of the signed COC form to the designated investigation contractor personnel (i.e., project chemist, field sample manager, or project manager), and will retain a copy on file at the laboratory. The original COC form will remain with the samples until final disposition of the samples by the laboratory in accordance with the site-specific QAPP. After sample disposal, a copy of the original COC will be sent by the analytical laboratory to the investigation contractor.

ATTACHMENT A
EXAMPLE CHAIN OF CUSTODY FORM



Chain of Custody/ Request for Analysis Record

CC#

Client

Project Number

Sampler Name(s)/Signature(s)

			Sample Data				Analyses Requested												Preservation	
Sample Number	Date	Time	Material Sampled: S = Soil; L = Liquid; G = Gas	Sample Type*	Container Type: G = Glass; P = Plastic; M = Metal	Number of Containers												Remarks or Sample Location	Iced	Specify Preservative Added and Final pH, If Known

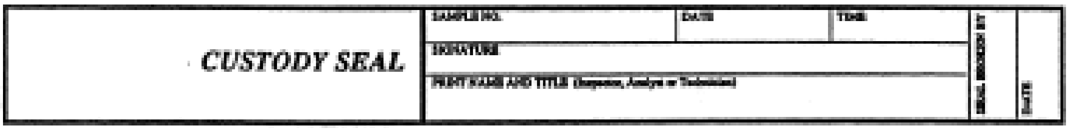
Relinquished by (Signature): ①	Date	Time	Received by (Signature):	Relinquished by (Signature): ④	Date	Time	Shipped Via:
Relinquished by (Signature): ②	Date	Time	Received by (Signature):	Received for Laboratory by (Signature):	Date	Time	Shipping Ticket No:
Relinquished by (Signature): ③	Date	Time	Received by (Signature):	Name of Laboratory		Laboratory Control Number:	

*G = Grab; C = Composite; S = Split Spoon; ST = Shelby Tube; O = Other

White = Original (To Accompany Sample); Yellow = Main Office; Pink = Field Copy

ATTACHMENT B

EXAMPLE CUSTODY SEAL



CUSTODY SEAL

SAMPLE NO.

DATE

TIME

SIGNATURE

PRINT NAME AND TITLE (Inspector, Analyst or Technician)

SEAL BROKEN BY

DATE

Custody Seal

PWT STANDARD OPERATING PROCEDURE

UTILITY CLEARANCE

Procedure No. PWT-ENSE-413
Revision 1
Date effective: 03/01/12
Page i of 2

APPROVED: _________________/s/_____________________ ___________
PWT Project Manager, Date

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Revision Number	**Description**	**Date**
0.0	Original SOP	July 2011
1.0	QA Review and Update	March 2012

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**
2.0	Annual QA Review	August 2013
2.0	Annual QA Review	November 2014

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides technical guidance and procedures for utility clearances at project sites. This SOP serves as a supplement to site-wide and investigation area specific workplans and the site-specific Quality Assurance Project Plan (QAPP) and may be used in conjunction with other SOPs.

2.0 REQUIREMENTS

2.1 Quality Assurance / Quality Control

Follow all QA/QC requirements identified for the project as identified in the approved project planning document(s).

2.2 Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable Task-Specific HASPs prepared by PWT Subcontractors, and the associated Activity Hazard Analyses (AHAs).

3.0 RESPONSIBLE PERSONNEL

The project manager has the overall responsibility for implementing this SOP. The project manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel. The field team leader is responsible for ensuring that the appropriate utility clearances have been performed prior to any intrusive field activities. All utility clearances will comply with applicable portions of the Site-Specific HASP.

4.0 PROCEDURES

Locations selected for intrusive field activities (e.g. borehole drilling, trenching) will be cleared of utilities before field activities begin. Utilities may be located below ground or above ground. Before intrusive field activities can be performed each location will be cleared for the following utilities; natural gas, telecommunications, water and sewer, electrical, fiber optics and cable. At some locations additional utilities that may require clearance include petroleum service lines, irrigation lines, and building foundations. Locations selected for intrusive work must be visually cleared for overhead utilities by the project manager or designee. This overhead utility check shall be recorded in the field logbook. Location of underground utilities will require additional steps, as described below.

It is the responsibility of the project manager to contact utility organizations directly for utility clearance at least one week in advance of scheduled intrusive work. Some utility companies guarantee that they will be present at the scheduled meet time. Other utility companies may call to reschedule at a different time or day or reschedule the day of the scheduled utility meet. If possible the utility clearance should be done a few days prior to intrusive work to allow enough time for utilities companies to clear their lines. The utility companies will identify their utilities with spray paint on the ground. They also may leave a map or sketch at the location with their lines identified. In addition to the project manager (or designee), each subcontractor performing the actual intrusive work is required to attend the utility clearance, to pose any necessary questions. The subcontractors should request the same meet time that the PWT project manager has set up. A representative from each of the subcontractors is required to be present at the utility meet.

5.0 DOCUMENTATION

Underground and overhead utility clearance activities will be documented in the field logbook by the project manager, field team leader or rig geologist. The documentation will include the utility locator service sign-off, personnel present for the locate, the final project-site representative approval (if requested), and any current and historical maps used in locating utilities (or references to locations of maps for future reference).

PWT STANDARD OPERATING PROCEDURE

INVESTIGATION DERIVED WASTE MANAGEMENT
Procedure No. PWT-ENSE-423
Revision 1
Date effective: 03/01/12
APPROVED: /s/ ____________ Page i of 5
PWT Project Manager, Date

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List of Attachments

Attachment A	Waste Inventory Tracking Form
Attachment B	Maximum Concentration of Contaminants for the Toxicity Characteristic

REVISION LOG		
Revision Number	**Description**	**Date**
0.0	Original SOP No. GW.105	01/23/12
1.0	QA Review and Update	03/01/12

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**
2.0	Annual QA Review	August 2013
2.0	Annual QA Review	November 2014

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for the handling, management, and disposal of investigation derived waste (IDW) encountered or generated during environmental field activities. This SOP serves as a supplement to the investigation area-specific work plans and QAPPs, and is intended to be used with other activity-specific SOPs. IDW management personnel are also referred to *Management of Investigation-Derived Wastes During Site Inspections* (EPA 1991), *Guide to Management of Investigation-Derived Wastes* (EPA 1992) and applicable state and federal requirements.

2.0 REQUIREMENTS

The following sections identify the requirements for Quality Assurance / Quality Control (QA/QC), health and safety, and personnel qualifications for IDW management.

2.1 Quality Assurance / Quality Control

Follow all QA/QC requirements identified for the project as identified in the approved project planning document(s).

2.2 Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable Task-Specific HASPs prepared by PWT Subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.3 Personnel Qualifications

Personnel overseeing the handling and disposal of IDW will have IDW management knowledge and experience, or will work under the direct field supervision of knowledgeable and experienced personnel.

3.0 MATERIALS AND EQUIPMENT

The following materials and equipment may be needed for IDW management:

- Personal protective equipment (PPE) as outlined in the HASP
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, alconox, plastic sheeting, paper towels, sponges, baby wipes, garden-type water sprayers, large plastic bags (minimum 0.85 mil), potable water, distilled water and/or deionized water)
- Department of Transportation (DOT)-rated 55-gallon drums or other approved containers for containing soil cuttings, decontamination water, and formation water
- Drum/bung wrench and drum funnel
- Heavy equipment forklift or vehicle with drum grappler
- Laboratory-supplied sample containers
- Photoionization detector (PID) or flame ionization detector (FID)
- Wood pallets

- Non-porous (e.g., stainless steel) shovels
- Hazardous Waste Labels
- Soil roll-off bins with liners and covers (if warranted)
- Polyethylene tank (if warranted)
- Waterproof and permanent marking pens

4.0 PROCEDURES

Environmental field activities may generate IDW that poses a risk to human health and the environment. It is anticipated that both non-liquid and liquid IDW will be generated or encountered during environmental field activities.

Non-liquid IDW may include:

- Drill cuttings from soil borings
- Sludges (from soil borings in the saturated zone and from development water)
- Excavated soil from trenches
- Construction debris (e.g., concrete and asphalt)
- Buried landfill materials (e.g., burned wood, desks, and metal objects)
- PPE
- Disposable investigation equipment (i.e., bailers, twine, discarded sample bottles, preservative containers, paper towels, aluminum foil)
- Empty drums

Liquid IDW may include:

- Well development water
- Purge water (from monitor wells)
- Well abandonment water
- Decontamination water

4.1 Non Liquid IDW

4.1.1 Soil IDW

- Soil cuttings generated during drilling and soil sampling will be placed into DOT-rated 55-gallon drums, or appropriately sized containers at the point of generation.
- Mixing of the cuttings from several borings or sampling locations is permissible in order to fill the drums. The splitting of cuttings from one boring into several drums should be avoided.
- When drums are full, or daily activities are completed, the drum lids and rings will be fastened. Full drums will be transported to a designated IDW accumulation area on a regular basis to avoid

accumulation of drums at investigation sites for extended periods of time. Alternative temporary IDW accumulation areas can be used as specified in the investigation-specific work plan.

- If large volumes of soil IDW will be generated, soil IDW will be transferred from the drums into roll-off bins (lined and covered) located within the designated IDW accumulation area.
- If only a small volume of soil IDW will be generated, DOT-rated 55-gallon drums can be used for the temporary storage of soil IDW pending analysis. Drums will be stored on pallets at the designated IDW accumulation area. Drums from individual sites will be segregated from each other as much as possible. The drums will be sealed and labeled with permanent markings (using paint pens or drum labels) with the following information:
  1. Source: the boring(s), well, or site identification number
  2. Matrix (e.g., soil, water)
  3. Sample interval (e.g., 0–20 ft or well screen depth) (multiple drums of development or purge water will be numbered consecutively as they are filled)
  4. Fill date
  5. Drum identification number
  6. Contractor
  7. The EPA or PWT designee point of contact with phone number
  8. "Contents Pending Analysis"

Soil IDW in drums will typically be characterized and disposed of based on the characterization of associated investigation sample results (if collected and analyzed).

If no associated investigation sample results exist, a composite soil sample will be collected from the soil IDW drums by collecting a drive or hand auger sample from each of the drums associated with a specific field activity. The sample material from all of the drums will be composited into a single sample that will be used to characterized and dispose of the soil IDW.

4.1.2 Excavated Soil from Trenches

Most trenching operations will generate substantial volumes of excavated soil.

Large volumes of excavated soil IDW will be placed directly into roll-off bins (lined and covered) at the excavation site. This procedure will minimize concerns resulting from stock piling the soil IDW, such as wind dispersion and contamination of the ground surface.

- Small volumes of excavated soil can be placed in drums at the excavation site. Drums will be labeled and stored as described in Section 4.1.1.
- Soil IDW in drums will be sampled (if warranted), characterized, and disposed of as described in Section 4.1.1 above.

Soil IDW placed on the ground surface prior to placement into drums or roll-off bins, must be placed on plastic sheeting covering the ground surface. The soil IDW must be transferred to drums or roll-off bins before completion of the days activities.

4.1.3 Construction Debris and Landfill Material

- Small pieces of construction debris or landfill materials, that do not, and have not, contained controlled substances may be placed in the soil IDW roll-off bins or drums. For example, small amounts of wood, concrete, rebar, and paper do not require segregation from the soil IDW.
- Large volumes of the materials listed above, and large objects, such as desks or large metal objects, will be segregated separately from the soil IDW.
  - If the associated soil IDW is characterized as nonhazardous, these materials can be disposed of as nonhazardous solid waste.
  - If the associated soil IDW is characterized as hazardous, potential surface contamination will be removed from the large objects with nonporous surfaces by brushing off, or using small amounts of water to scrub off, gross potential contamination. After decontamination, these objects can be disposed of as nonhazardous solid waste.
  - If the associated soil IDW is characterized as hazardous, large objects with porous surfaces may require disposal as hazardous waste. Consult the IDW disposal contractor.
- Containers that may contain or potentially contained controlled substances (e.g., paint cans, drums) will be segregated from the materials described above and placed in appropriately sized containers.
  - Consult the IDW disposal contractor for the appropriate disposal requirements for these materials.

4.1.4 PPE and Disposable Investigation Equipment

- PPE and disposable investigation equipment will be segregated separately and placed in dedicated heavy duty (minimum 0.85 mil) plastic bags or containers (e.g., drums).
- Potentially contaminated PPE or disposable investigation equipment will be decontaminated prior to placement in the plastic bags or containers, if warranted.
- Decontamination procedures consist of brushing off, or using small amounts of water to scrub off, gross potential contamination.
- PPE and disposable investigation equipment that have been decontaminated, if warranted, are considered refuse and do not require characterization prior to disposal as nonhazardous solid waste.

4.2 Liquid IDW

- Well development, purge, abandonment, and decontamination water will be contained in DOT-rated drums, or appropriately sized water-tight containers, at the point of generation. When drums are full, or daily activities are completed, the drum lids and rings will be fastened, and the drums will be transported to the designated temporary IDW accumulation area as described in Section 4.2 of Attachment B. Alternative temporary IDW accumulation areas can be used as specified in the activity-specific work plan.
- If large volumes of water will be generated, the water will be transferred into an appropriately sized polyethylene tank. The liquid IDW in the polyethylene tank will be characterized based on the analytical results of the well or wells sampled, or from a representative grab sample collected from the tank. The sample will be collected using a colliwasa, disposable point source bailer, or bomb sampler for discrete interval sampling within the polyethylene tank.

- After analytical data for the liquid IDW are obtained from the laboratory, the data will be directly compared to the hazardous waste concentrations presented in Table 1 in 40 CFR §261.24 (Attachment A). The liquid IDW will then be removed, and treated and disposed of by a certified hazardous waste contractor in accordance with the applicable waste characterization (Section 5.0).
- If only a small volume of water IDW will be generated, DOT-rated 55-gallon drums can be used for the temporary storage of water IDW pending analysis. Water IDW drums will be labeled and stored as described in Section 1.1.1, Soil IDW above.
- Water IDW in drums will be characterized and disposed of based on the characterization of associated investigation sample results (if collected and analyzed).
- If no associated investigation sample results exist, a composite water sample will be collected from each of the water IDW drums associated with a specific field activity. The sample will be used to characterize and dispose of the water IDW.
- The list of chemicals to be analyzed for is the same as the list for soil characterization (Attachment A).

5.0 DOCUMENTATION

Project staff are responsible for thoroughly documenting IDW handling and disposal activities. IDW personnel will be responsible for documenting the collection, transportation, labeling (if applicable), and staging or disposition of IDW. The documentation will be recorded with waterproof ink on a Waste Inventory Tracking Form (Attachment A) or in the sampler's field notebook with consecutively numbered pages. The information entered concerning IDW should include the following:

- Project Name
- PWT and subcontractor personnel
- Site location
- Type of activities
- Date waste generated
- Boring, well, or site number(s)
- Matrix
- Type of container(s) and identification number(s)
- Estimated volume
- Disposition of contents (roll-off/location, tank/location, temporary staging area)
- Waste characterization
- Comments (field evidence of contamination [e.g., PID reading, odors])

ATTACHMENT A

Waste Inventory Tracking Form

WASTE INVENTORY TRACKING FORM

Project Name: ____

PWT and Subcontractor Personnel:__________________________________

Site Location: ____

Type of Activities:____

Date Waste Generated	Borehole, Well, or Site #	Matrix	Type of Container (Plus ID#, if applicable)	Estimated Volume	Disposition of Contents	Waste Characterization	Comments (Field Evidence of Contamination [e.g., PID reading, odors])

Signature:____

ATTACHMENT B

Maximum Concentration of Contaminants for the Toxicity Characteristic

Maximum Concentration of Contaminants for the Toxicity Characteristic

EPA Hazardous Waste Number	Contaminant	Regulator Level (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	(1) 200.0
D024	m-Cresol	(1) 200.0
D025	p-Cresol	(1) 200.0
D026	Cresol	(1) 200.0
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13
D012	Endrin	0.02
D031	Heptachlor (and its epoxide)	0.008
D032	Hexachlorobenzene	0.13
D033	Hexachlorobutadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D013	Lindane	0.4
D009	Mercury	0.2
D014	Methoxychlor	10.0
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D015	Toxaphene	0.5
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP (Silvex)	1.0
D043	Vinyl chloride	0.2

Notes:

(1)If o-, m-, and p- Cresol concentrations cannot be differentiated, the total cresol (DO26) concentration is used. The regulatory level of total cresol is 200 mg/L.

Source: 40 CFR 261.24 and WHWRR, Chapter 2, Section 3 (e)(ii).

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1.0	Original SOP	July 2011
2.0	QA Review and Update	March 2012

ANNUAL REVIEW LOG		
Revision Reviewed	**Description**	**Date**
2.0	Annual QA Review	August 2013
2.0	Annual QA Review	November 2014

1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to conduct decontamination of personnel and investigation equipment during environmental investigations. This SOP serves as a supplement to site-wide and investigation area specific workplans and the site-specific Quality Assurance Project Plan (QAPP) and may be used in conjunction with other SOPs.

2.0 REQUIREMENTS

The following sections identify the requirements for Quality Assurance / Quality Control (QA/QC), health and safety, and personnel qualifications for personnel and equipment decontamination.

2.1. Quality Assurance / Quality Control

Follow all QA/QC requirements identified for the project as identified in the approved project planning document(s).

2.2. Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable Task-Specific HASPs prepared by PWT Subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.3. Personnel Qualifications

Personnel overseeing and performing decontamination activities will have knowledge and experience in the equipment and methods proposed, or will work under the direct field supervision of knowledgeable and experienced personnel.

3.0 MATERIALS AND EQUIPMENT

The following materials and equipment may be needed for personnel and equipment decontamination:

- Monitoring equipment and personal protective equipment (PPE) as outlined in the HASP.
- Decontamination equipment and supplies (e.g., wash/rinse tubs, nitrile disposable gloves, brushes, Alconox, plastic sheeting, paper towels, sponges, baby wipes, garden-type water sprayers, large plastic bags, potable water, distilled water and/or deionized water
- High pressure washer/steamer
- Four-foot long capped PVC casing for decontamination of submersible pumps
- Drums or other approved water-tight containers for containing decontamination sediment and fluids
- Materials necessary to construct an investigation site-specific decontamination facility, if required (e.g., heavy plastic sheeting, berming materials, sump pump, water tanks, roll-off bins)

4.0 PROCEDURES

This procedure describes the method for physically removing contaminants. It applies to chemical and radioactive decontamination of personnel and equipment used in field investigations. All equipment must be decontaminated before use at the project site, prior to sample collection, and before being removed from the project site. Decontamination of personnel, sampling equipment (e.g., soil sampling equipment and submersible pumps) and heavy equipment (e.g., hollow stem auger rigs, backhoes) is required to ensure the health and safety of personnel, reduce the potential for sample cross-contamination, and reduce the potential for contamination to enter or leave the project site on personnel or equipment.

4.1 Decontamination

4.1.1 Location of Decontamination Activities

Decontamination activities may take place either in the exclusion zone of the investigation site or at a decontamination facility designed to contain larger volumes of potentially contaminated fluids and materials, or at a combination of the two. Decontamination activities conducted in the exclusion zone will be limited to washing of personnel and small sampling equipment using wash tubs or wipes. Scraping of PPE and large equipment to remove adhered clumps of soil will also be performed in the exclusion zone.

Decontamination of heavy equipment or equipment requiring high-pressure washing will be performed at a decontamination facility designed to contain large volumes of washing fluids. The decontamination facility may consist of an investigation area-specific temporary facility constructed near the investigation site, or a decontamination facility central to the project site that may be used for multiple investigations. If a central decontamination facility is used, sufficient decontamination of equipment will be performed in the exclusion zone prior to moving to the central facility to reduce the potential for deposition of contaminated materials on roadways between the investigation area and decontamination facility.

Decontamination facilities will be constructed to limit the potential for contact of potentially contaminated materials (decontamination sediment and fluids) with environmental media (i.e., soil or water) in the decontamination area. This will be accomplished by performing decontamination activities in lined and bermed areas, and by containing decontamination sediment and fluids as they are generated.

4.1.2 Personnel Decontamination

The following steps will be used to perform personnel decontamination:

- Soil adhering to boots, apparel and equipment will be scraped off at the sampling or excavation site.
- Boots and outer apparel that will not be damaged by water will be washed with Alconox low-sudsing detergent and potable water and scrubbed with a bristle brush or similar utensil (if possible). Apparel will be rinsed with potable water.
- Coveralls removed (if used).
- Hard hat and other safety equipment removed and washed with Alconox and rinsed with potable water.
- Gloves and respirator (if used) removed.
- Personnel shall wash hands, face, and forearms before eating/drinking.
- Following decontamination, apparel will be placed in a clean area, on clean plastic sheeting to prevent contact with contaminated soil. If the apparel is not used immediately, the equipment will be stored in plastic sheeting or heavy duty trash bags.

- Disposable PPE will be handled in accordance with Section 4.1.1 of the PWT Investigation Derived Waste Management SOP.

4.1.3 Small Sampling Equipment Decontamination

Small sampling equipment consists of split spoons, sample bowls, scoops, hand augers, filtering devices, non-dedicated pumps, water level meters, and other such small equipment used in the exclusion zone or the immediate vicinity of the sample collection location. Small sampling equipment is designed to be decontaminated at the sampling location using small wash tubs. Decontamination of small sampling equipment does not require high-pressure washing or steam cleaning, or result in production of large volumes of decontamination sediment or fluids.

The following steps will be used to decontaminate small sampling equipment:

- To reduce personal exposure, personnel will dress in suitable PPE in accordance with the HASP.
- Soil adhering to equipment will be scraped off at the sampling site and containerized.
- Equipment that will not be damaged by water will be placed in a wash tub containing Alconox or equivalent detergent and potable water and scrubbed with a brush. Equipment will then be rinsed initially with potable tap water and then with distilled water.
- Equipment that cannot be submerged in water (e.g., air monitoring devices, electronic devices) will be carefully wiped clean using a sponge and detergent water or baby wipes.
- Wash and potable rinse water should be replaced frequently. Decontamination sediment and water will be handled as investigation derived waste (IDW) (see Section 4.1.6).
- Disposable sampling equipment will be handled in accordance with PWT's Investigation Derived Waste Management SOP.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting. If the equipment is not used immediately, the equipment will be covered or wrapped in plastic sheeting or trash bags.

4.1.4 Decontamination of Submersible Pumps

Submersible pumps used to conduct groundwater sampling will be decontaminated before being placed in the well. A decontaminated four-foot length of polyvinyl chloride (PVC) capped on one end will be utilized for this procedure. The following steps will be used to decontaminate submersible pumps:

- To reduce personal exposure, personnel will dress in suitable PPE in accordance with the HASP.
- Scrub the outside of the pump with a solution of Alconox or equivalent detergent and potable water and then rinse with potable water and distilled water.
- Fill the PVC tube with Alconox/potable water solution.
- Pump the solution through the submersible pump by lowering the intake tube of the pump to the bottom of the PVC tube. Be careful not to uncover the intake of the pump to prevent damage to the pump.
- Rinse the inside of the PVC tube with potable water to remove detergent and then fill the PVC tube with potable water.
- Pump the potable water through the pump.
- Repeat the rinse procedure with distilled water.

- Decontamination sediment and water will be handled as IDW (see Section 4.1.6 below).

Following decontamination, the pump will be wrapped in plastic sheeting or trash bags and placed in a clean area.

4.1.5 Heavy Equipment Decontamination

Heavy equipment used within the exclusion zone and/or for intrusive activities (e.g., drill rigs and associated heavy drilling and sampling equipment, backhoes, sampling-related vehicles) will be decontaminated upon arrival at the project site, between investigation locations (i.e., between boreholes and test pits), and prior to leaving the project site. The following steps will be used to decontaminate heavy equipment:

- To reduce personal exposure, personnel will dress in suitable PPE in accordance with the HASP.
- Prior to use at the project site and between investigation locations (i.e., between boreholes, test pits), the portion of the equipment directly exposed to potential contamination (e.g., augers, drill rods, backhoe bucket) will be decontaminated by pressure washing the equipment at the decontamination facility.
- Drill rigs and vehicles will not require pressure washing between investigation locations unless they have become substantially dirty as a result of drilling or investigation activities.
- Prior to leaving the project site, the portions of the heavy equipment potentially exposed to contamination will be pressure washed using potable water at the decontamination facility. Special attention will be given to removing any soil or other site-related foreign materials on the equipment.
- Decontamination sediment and water will be handled as IDW as described in Section 4.1.6 below.

4.1.6 Decontamination Sediment and Fluids

Sediment and fluids from decontamination activities will be initially contained and stored in approved water-tight containers at the sampling site or decontamination facility. Each container will be labeled with its contents and the date using a paint pen, or permanent marker. As soon as practical, decontamination sediment and fluids will be transferred from the sampling site to a designated IDW management area. Handling of IDW is addressed by PWT's Investigation Derived Waste Management SOP.

4.2 Equipment Rinsate Sampling

Equipment rinsate blank samples may be collected to verify the effectiveness of the decontamination procedures. Equipment rinsate blank sampling is usually performed for small sampling equipment, rather than heavy equipment. The frequency of rinsate blank sample collection, as well as the analysis methods, will be specified in the investigation-specific QAPP. In general, the rinsate blank sample collection procedure will consist of rinsing decontaminated equipment with laboratory-grade deionized water and collecting the rinsate water in sample bottles provided by the analytical laboratory. Special attention will be given to rinsing the portions of the equipment exposed to environmental samples or potential contamination. Rinsate samples will be handled in the same manner as environmental and other QA/QC samples in accordance with PWT's Sample Handling SOP. Rinsate sample collection will be documented in the same manner as environmental and other QA/QC samples.

5.0 DECONTAMINATION DOCUMENTATION

Field personnel will be responsible for documenting proper sampling equipment and heavy equipment decontamination. The purpose of documentation is to demonstrate in the written field record that decontamination was performed in accordance with this SOP. Decontamination activities will be documented at least each day they are performed. The documentation will be recorded in a logbook or on appropriate project forms (i.e., boring log, sample field data sheets). The information recorded concerning decontamination will include:

- Date and times of decontamination
- Location of decontamination activities (i.e., sample site, central decontamination facility)
- Decontamination personnel and materials
- Decontamination steps/observations
- Other applicable information

PWT STANDARD OPERATING PROCEDURE

Indoor and Attic Dust Sampling

Procedure No. PWT-ENSE-430
Revision 0
Date effective: 9/10/2015
APPROVED: /s Page i of 12
PWT Program Manager, Date

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List of Attachments

REVISION LOG

Revision Number	Description	Date
0	Original SOP	September 2015

ANNUAL REVIEW LOG

Revision Reviewed	Description	Date

PWT STANDARD OPERATING PROCEDURE

Indoor and Attic Dust Sampling

Procedure No. PWT-ENSE-430
Revision 0
Date effective: 9/10/2015
APPROVED: /s Page 1 of 12
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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for collection of indoor dust samples for chemical analysis during environmental investigations performed during the Remedial Investigation (RI) in the Community Properties Study Area (CPSA) of the Colorado Smelter Site. This procedure applies to collection of dust from a variety of indoor living space and attic surfaces, including level loop and plush pile carpets and bare floors (wood, tile, or other). Attic sample collection procedures vary slightly from collection of other indoor dust samples, and are discussed separately. This SOP serves as a supplement to site-specific Health and Safety plans and the site-specific CPSA RI Quality Assurance Project Plan (QAPP).

This SOP is intended to be used in conjunction with other SOPs produced by Pacific Western Technologies, Ltd. (PWT) for environmental support operations on contracts for the United States Environmental Protection Agency (USEPA).

2.0 REQUIREMENTS

The following sections identify the requirements for collection of indoor dust samples.

2.1 Key Words

Indoor Dust; Attic Dust; Dust Sampling; Residential Sampling.

2.2 Quality Assurance / Quality Control (QA/QC)

Follow all QA/QC requirements as identified in the approved project planning document(s) such as the CPSA RI QAPP and this SOP. Guidance documents referenced during SOP development are identified in Section 2.6.

2.3 Health and Safety

Follow health and safety requirements identified in the Site-Specific Health and Safety Plan (HASP), Job Safety Analyses (JSAs), any applicable task health and safety plans prepared by PWT subcontractors, and the associated Activity Hazard Analyses (AHAs).

2.4 Personnel Qualifications

Personnel planning to perform indoor or attic dust sampling activities will have knowledge and experience in the required equipment and methods, or will work under the direct supervision of knowledgeable and experienced personnel.

2.5 Definition

The dust sampling approach described in this SOP uses a High Volume Small Surface Sampler (HVS3). This specialized vacuum is designed to collect dust samples for chemical analysis, and is shown in Figure 1. Attic sampling will be completed using a specialized attic sampling attachment for the HVS3.

2.6 Guidance Documents and Reference SOPs

The following PWT SOPs should be used in conjunction with this Indoor and Attic Dust Sampling procedure:

• PWT-ENSE-402	Spatial Data Submittals
• PWT-ENSE-406	Sample Handling

- PWT-ENSE-423 Investigation Derived Waste Management
- PWT-ENSE-424 Personnel and Equipment Decontamination

In addition to the listed SOPs, this indoor dust sampling procedure is consistent with USEPA's Guidance for the Sampling and Analysis of Lead in Indoor Residential Dust for Use in the IEUBK Model (USEPA, 2008). The following supplemental information was also considered in development of PWT-ENSE-430, Indoor and Attic Dust Sampling.

- ASTM D5438-11: Standard Practice for Collection of Floor Dust for Chemical Analysis
- CS3-Inc.: High Volume Small Surface Sampler (HVS3) Operation Manual.

3.0 MATERIALS AND EQUIPMENT

This procedure is intended for use with the CS3 HVS3 unit. A schematic of the HVS3 is shown in Figure 1. The equipment consists of the following components:

- Nozzle – The edges and corners of the sampling nozzle are rounded and smooth. This prevents the nozzle from snagging on any carpeted material which may be encountered. Nozzle construction allows for sufficient suction to separate loose particles from the bare floor or carpeted surface and carry them to the cyclone. The nozzle is 12.5 centimeters (cm) long, and 1 cm wide, with a 13-millimeter (mm) flange which tapers to the nozzle tubing at an angle equal to or less than 30 degrees. This configuration allows the nozzle to perform with the appropriate velocities when operated correctly.
- Cyclone – The cyclone is constructed such that the air flow allows for separation of particles of 5-microns in diameter (or larger). The cyclone shall be made of aluminum or stainless steel. A spare cyclone should be kept on hand if possible.
- Catch Bottle – The catch bottle will be purchased from an appropriate environmental supply company, and shall meet the requirements of the analytical laboratory. Catch bottles must be transparent so that the operator can see the sample as it is collected. Bottles should be 250-mL low-density polyethylene (LDPE) or fluorinated ethylene propylene.
- Flow Control System – The flow control system allows for substantial volume adjustment. The suction source is capable of drawing 12 liters per second (L/s) through the system with no restrictions other than the connected nozzle, cyclone, and flow control system. A commercial vacuum cleaner may be modified for this purpose by the HVS3 manufacturer.
- Gaskets – Gaskets in joints will be made of an inert material appropriate to avoid sample contamination, and to prevent air leakage.
- Flow Measuring and Suction Gages – Magnehelic gages are used to measure the pressure drop at the nozzle and for control of the flow rate for the entire system.

Other equipment and materials necessary to perform the work described in the SOP include:

- Digital scale accurate to 0.1 grams, for weighing samples
- Stopwatch
- Two measuring tapes for sampling area layout, OR pre-cut, plastic templates for delineating sampling areas. Template size may vary, but a 2-foot by 2-foot template is recommended
- Masking tape (painter type masking tape is suggested, to allow for easy and damage free removal)

- Marking pens
- Nitrile gloves
- Safety glasses
- Manila envelope of file folder for leak check
- Thermometer
- Relative humidity meter
- Inclined manometer for instrument calibration
- Alconox (or equivalent) and brush for decontamination
- Squeeze bottle containing deionized water
- Squeeze bottle containing soap solution (Alconox or equivalent)
- Squeeze bottle containing deionized water
- Fine silica for blanks
- Kim-wipes
- Hand tools (screw driver, wrenches, etc)
- Extra sample catch bottles and caps
- Zip-top plastic bags
- Stainless steel tray or clean sheets of paper/foil
- Digital camera
- Sample labels
- Appropriate field forms and SOPs

Additional equipment for attic sampling includes:

- HVS3 Microvac Attic Sampling attachment
- Tyvek protective suit

4.0 PRIOR TO SAMPLING

4.1 Indoor Dust Sampling Methodology

This SOP describes the use of the HVS3 to collect indoor dust samples for chemical analysis. Surface dust particles are collected from the carpet or the bare floor by means of vacuum-induced suction. Particles enter the HVS3 through the sampling nozzle. The recommended pressure and flow rate are dependent on the type of surface being sampled, but must be sufficient to generate the velocity required to liberate the dust particles from carpeted and bare floor surfaces into the sampler air stream. The nozzle is designed to move across the floor with minimal resistance while still maintaining a seal to collect the sample.

Dust flows into the cyclone, which collects most particles larger than 5 microns in diameter. Sample collection utilizes centrifugal force. Larger (heavier) particles move to the outside wall of the cyclone and then slide down into the catch bottle (sample container) threaded onto the bottom of the cyclone. The sample container may then be capped and labeled for sample storage and shipment. Refer to PWT-ENSE-406, Sample Handling for details on sample labeling, storage, and shipment. Smaller particles remain in the air stream and flow out the exhaust tube. The cyclone collects an average of 99 percent of the surface dust picked up by the nozzle. Any dust that is not captured in the sample container moves through the fan and is retained in the vacuum cleaner bag. This material will not be sent for chemical analysis.

4.2 Equipment Calibration

The HVS3 sampling process does not require any internal calibrated flow devices. The cyclone is designed to create separation of particles at various flow rates throughout the range of operational flowrates the system can produce. As a result, there is not a requirement to regularly calibrate the HVS3. Pressure gages (Magnehelic gages) should be calibrated against a primary standard at the start of each day they will be used for sampling. Adjust the flow rate and the nozzle pressure drop to values that approximate those given in Section 6.2 of this SOP.

Pressure gages shall be calibrated against an inclined manometer or other primary standard. One means of checking a Magnehelic gage is to set a flow rate through the sampling system with a manometer, then switch to the Magnehelic gage. This process should be repeated at two different flow rates. If the difference in the readings is more than 3%, the gage is leaking, or is in need of repair or recalibration. The gage should be tagged "DO NOT USE" and taken out of service. Results of calibration should be recorded in the field logbook.

4.3 Leak Check

Prior to using the HVS3 to collect samples, a leak check shall be performed to verify that the equipment has been assembled correctly. The leak check shall be completed as follows:

- Place a thick manila envelope or a file folder underneath the nozzle to seal off the opening.
- Turn on the HVS3. The flow Magnehelic gage should read 0-0.02 inches of water to ensure the system is not leaking.
- If leakage is suspected, and the gage reads more than 0.02 inches of water, check all gaskets and check tightness of clamps, catch bottle, and material covering the nozzle opening.
- Once all connections have been verified, recheck the flow to the Magnehelic gage to make sure it reads less than 0-0.02 inches of water before beginning sampling.
- If the HVS3 is unable to pass the leak check after connections have been verified, tag the equipment "DO NOT USE" and contact the project manager for instructions.

4.4 Pre-Sampling Questionnaire and Pre-Test Survey

Owners and/or occupants as appropriate (hereafter referred to as "residents") of properties identified for indoor dust sampling will be contacted in advance to schedule a time for indoor sampling to occur. At the time that the sampling is scheduled, residents will be asked to maintain normal cleaning routines prior to sampling.

Upon arrival at the home for indoor sampling, a member of the field team will discuss the work to be completed with the residents. Through this discussion, the field sampler will identify appropriate sampling locations within the home, based on the information provided about how the space is used. The sampler will confirm the most frequently occupied areas of the home, the most frequently used doors to the outside, and whether any children sleep in the home (children's bedrooms will be sampled if available).

In order to better understand variables which are known to impact indoor dust, an Indoor Dust questionnaire (see Attachment 1) will be completed as part of dust sampling activities. One of the samplers will complete the questionnaire with the resident head-of-household if available, or with another resident of the house if necessary. Completion of the questionnaire is required prior to selection of sampling areas within the home. Some of the factors known to impact indoor dust include pets, occupation, smoking habits, age of residence, primary heating source, floor surface (carpet vs hard surfaces), cleaning equipment, cleaning habits, and resident hobbies.

4.5 Selection of Indoor Dust Sampling Locations

Sample collection locations are specified in the QAPP to include the main entryway (most frequently used entryway), the floor area of the most frequently occupied room (usually the kitchen or living room), and the floor of a child's bedroom (or any bedroom if there is not a child living in the home). A minimum of 3 and a maximum of 5 samples will be collected in each home.

The total floor area vacuumed to obtain dust for each sample will depend on the amount of dust present. The floor area sampled will be measured and recorded on the sampling form to allow calculation of the metals loading rate for each sample from the resulting analytical data. Sampling efforts at a location will continue until a minimum of 20 grams of sample is collected, or at least enough dust to completely cover the sample container. If the initially defined sampling area (or the template, if one is used) do not provide enough sample material, a second area immediately adjacent to the first should be defined, and sampled. The sampling form should indicate the total area sampled (the initial area which yielded an insufficient sample + the additional area, typically equal to the initial area times 2). If not enough dust is present in the individual room samples, samples from multiple living areas in the home may be composited. However, attic samples (see below) will not be composited with discrete or composite samples from living areas under any circumstances.

Attic dust sampling will be conducted only at those residences where the attic can be routinely accessed (e.g., by stairway, ladder/trap door, etc.). One composite sample of attic dust will be collected in each home where the attic is accessible.

5.0 DOCUMENTATION

All forms required are provided as attachments to this SOP. Other documentation, such as information to be recorded in field log books, is described in this section of the SOP.

5.1 Sample Forms

The pre-sampling questionnaire must be completed prior to selection of sampling locations. The questionnaire may have some lines completed prior to samplers arriving at the house, if the information was obtained from the homeowner or resident over the telephone while scheduling sampling. This information should be verified on the day of sampling.

In addition to the Pre-Sampling Questionnaire, samplers will start an Indoor Dust Sample Information Form immediately prior to sampling. This form will be completed during sampling for each area sampled.

For all field documentation: All lines on the forms must be filled in. In cases where a given item may not apply, mark that space "N/A". Forms should be completed in accordance with PWT-ENSE-406.

5.1 Sample Identification

The sample identification scheme for indoor dust samples is presented in the CPSA RI QAPP, and is summarized here for sampler convenience.

The first part of the sample name is a letter designating the matrix sampled, D for indoor dust, followed by a unique four digit parcel code assigned by the PWT Team. The second part of the sample name identifies the feature sampled at the property. The final part of the sample name is a letter to designate other sample information, such as QC sample type.

For example, the sample name D1402-E-DUP refers to a dust sample collected from the main entryway at property 1402. The sample is a duplicate/replicate sample, as indicated by the trailing letters "DUP".

The features which might be sampled and the associated feature codes assigned are as follows:

For Dust:

E = main entryway

K = kitchen

L = living room

B = bedroom, if more than one bedroom is sampled, expand to B1, B2, etc.

C = residence living area composite sample (in case sufficient material could not be obtained for discrete samples)

A = attic

A unique CLP number will be assigned to each sample in addition to its sample identification as described above. Both identifications will be recorded on the sample label and the chain-of-custody.

6.0 FLOOR DUST SAMPLING PROCEDURE

Indoor Dust Sampling activities shall be conducted as follows.

6.1 Preparing the Sampling Area

The areas to be sampled will have been determined during completion of the Pre-Sampling Questionnaire. First, mark off the area to be sampled. This may be done by one of two methods. Regardless of which method is used, the sampled area should be at least 3 feet from any outside door, and the dimensions of the area will be recorded on the field form. When laying out the sampling area, it is important to leave enough space around the perimeter of the sampling area to allow for samplers to move and for operation of the HVS3 to the full extent of the sampled area.

A pre-made sampling template may be used or the area may be measured and taped with masking tape. If a pre-made sampling template is to be used, wipe the template with a clean laboratory tissue and place the template on the floor in the area to be sampled. Use masking tape to temporarily hold the template still during sampling.

To sample from a measured area, instead of a pre-made template, the procedure is as follows. Place two measuring tapes on the floor parallel to each other on either side of the main traffic path through the area. The tapes should be approximately 2 feet to 5 feet apart and be extended as far as the space will permit. Masking tape will be placed along the tape measures for a distance of approximately 3.5 feet for carpet or rugs, and as large as possible for bare floors, (this distance may be increased (space permitting) if sufficient sample volume cannot be collected in the initial area).

If a pre-made sampling template is used, distance marks will already be available. If a template is not used, begin at the same end of each piece of masking tape, and use a permanent marker to make a small mark every 3 inches and a larger mark every 12 inches along the tape. Individual sampling strips are determined by the size of the HVS3 nozzle, and are approximately 3 inches wide.

6.2 Adjusting the HVS3 Nozzle Suction and Flow Rate

Clean the wheels and nozzle tip of the HVS3 with a clean laboratory tissue before sampling. Place the HVS3 sampler in the lower left corner of the sampling area. Adjust the flow rate and pressure at the nozzle according to the surface to be sampled.

The pressure at the nozzle is a function of the flow rate and the distance between the surface and the nozzle. The nozzle position is regulated by the height control knob on the back of the HVS3 and the nozzle level adjustment knob on the front side of the nozzle. A butterfly valve located on the control tube downstream of the cyclone regulates the flow rate, which is measured by the pressure across the cyclone. Higher flow rates produce higher pressures. The nozzle position adjustment allows for the complete system to be regulated.

To use the HVS3 on hard surfaces or level loop carpet (typical commercial type carpeting), adjust the height of the nozzle until the bubble level is centered. If the HVS3 is close to the position required, but the bubble is not quite centered, use the nozzle level adjustment knob to fine tune the adjustment. Then, set the flow rate with the butterfly valve. To check the flow rate, tip the HVS3 unit forward and check the flow on the Magnehelic gage. The flow should read at least 5 cubic feet per minute (cfm).

Next, read the pressure across the nozzle. The pressure should be approximately 9 inches of water. If the pressure reading is not 9 inches, recheck the flow and/or check that the nozzle is still level and make adjustments accordingly.

To use the HVS3 unit on plush or shag carpet, read the pressure across the nozzle and set the pressure to approximately 9.5 inches on the nozzle gage. The pressure can be set by using the height adjustment knob and the level knob to keep the nozzle level. Next, set the flow rate with the butterfly valve for approximately 20 cfm, 8 inches of water. Then re-check the pressure across the nozzle. The pressure has likely increased due to the increased flow rate. Reset the pressure to 9.5 inches of water using the height adjustment knob. Then recheck the flow rate and reset it to 20 cfm, 8 inches of water. It may take multiple small adjustments to achieve the targeted flow rate of 20 cfm, 8 inches of water, and nozzle pressure of 9.5 to 10 inches of water.

Once the pressure and flow rate have been properly adjusted and verified, attach the sample container to the HVS3.

The manometer fluid should be replaced at least annually per manufacturer instructions.

6.3 Operating the HVS3 Unit

The HVS3 unit functions best when the handle is locked in the fixed position at a 45 degree angle. This is done using the level at the bottom of the handle. This will allow the HVS3 unit to move forward and backward in a smooth motion.

Starting at the bottom left corner of the sampling area, collect the sample by moving the nozzle forward in a straight line from one end of the sample area to the other at a speed of about 2 feet per second. When the first pass is complete, the unit is pulled directly backwards over the same strip of floor. This is repeated 4 times for each strip of the sampling area. For the next strip, the nozzle is angled slightly to the right to the adjacent section of floor and the HVS3 is moved forward and backward 4 times. This is repeated until all strips have been sampled, or there is enough sample in the catch bottle (sample container).

After sampling the floor area within the pre-made template or the pre-measured floor area, check the amount of dust in the catch bottle. At a minimum, there must be enough dust to completely cover the bottom of the sample container. If possible, 20 grams of dust should be collected. This quantity of dust is needed to allow for loss during sieving at the laboratory and to provide sufficient volume for laboratory duplicate, QA/QC, or re-analysis. Hair, carpet fibers, and other large objects should be excluded from consideration when visually evaluating how much dust has been collected.

If the sample volume is insufficient, sampling personnel will designate/mark another sample location immediately adjacent (if possible). If an adjacent area is not available to be sampled, then a similar high traffic area, frequent occupancy room, or bedroom should be selected to provide the additional sample volume.

The additional material will be collected using the same method, as described above. When a sufficient amount of dust has been collected, turn off the HVS3 unit. Remove the sample container and attach the screw on lid. Record the total dimensions of the sampled area on the Sample Information form. Weighing the dust sample will follow the procedure described in Section 10.

6.4 Cleaning the HVS3 Unit

The HVS3 unit will be decontaminated after collection of all dust samples at a residence (including both Living Space samples and the Attic sample). If the attic will not be sampled, follow this decontamination procedure after completion of indoor dust sampling at a residence and before beginning sampling at the next residence.

Rubber/nitrile gloves and safety glasses shall be worn while cleaning the HVS3 unit. With the sample container removed and safely stored, open the flow control valve to maximum flow, tip the sampler back so the nozzle is approximately 2 inches off the floor, and switch the vacuum on. Place a hand covered by a clean rubber glove on the bottom of the cyclone and alternate closing and opening the cyclone for 10 seconds to free any loose material adhering to the walls of the cyclone and tubing.

Remove the HVS3 unit to a well ventilated area free of dust (e.g. field truck or van, field office) for wet cleaning. Remove the cyclone and elbow at the top of the nozzle tubing from the sampling unit. Hold each section of the HVS3 over a waste container and rinse with deionized water using a squeeze bottle. After rinsing, use Kim-wipes wetted with deionized water and a brush to clean each section of the sampler. Then use Kim-wipes wetted with deionized water to clean the gaskets and connections between each section of the tube. Use Kim-wipes wetted with deionized water to clean the previously used cleaning brush.

Allow all equipment to air dry. The equipment must be completely dry before sampling again. The clean sections of the HVS3 unit can be placed in or on a clean container to air dry. Once the inside of the individual sections are dry, re-assemble the HVS3 unit. Conduct a leak test at the next sample location to ensure all clamps and gaskets have been assembled correctly.

An equipment blank will be collected every 20 decontaminations. Equipment blank sample collection will follow the procedure described in Section 9.

7.0 ATTIC DUST SAMPLING

Attic Dust Sampling activities shall be conducted in generally the same manner as living space dust samples. **Never composite Attic dust with Living Space dust.**

Attic dust will only be sampled in homes where the attic can be routinely accessed (by stairs, ladder/trapdoor, etc). If vermiculite or asbestos is identified in the attic, no sampling work will be conducted. Dust will be collected directly from exposed horizontal surfaces in the attic, such as rafter tops or flooring. The dust will be collected from an area of the attic not likely to have been disturbed over time (if possible). Attach the attic dust sampling attachment to the HVS3 unit. Complete a leak test at the nozzle, as described in Section 4.3. After a satisfactory leak check, attach a clean sample container.

The attic dust sampling procedure is as follows:

Sampled areas in the attic will be measured and areas will be calculated and recorded on the Sample Information Form. It is anticipated that space in attics will be limited, and it may be difficult to identify a suitable area for sampling. Areas to be sampled should be carefully measured and recorded on the field form. Pre-made templates may be sized to fit in typical attic spaces and used to delineate sampling areas. Once the space to be sampled has been identified and delineated with masking tape and/or the pre-made attic sampling template, sampling can proceed in accordance with the floor sampling procedure described in Section 6. Sampling should continue until adequate sample volume has been obtained, or until there are no more suitable locations to sample within the attic. Decontamination of the HVS3 and the HVS3 attic sampling extension will be completed as described in Section 6.4.

8.0 SAMPLE HANDLING

Samples will be preserved, stored, and handled in accordance with the project specific QAPP and PWT-ENSE-406, Sample Handling.

9.0 EQUIPMENT BLANKS

Equipment blanks or rinse blank samples will be collected after completing decontamination procedures as described in Section 6.4. For this project, Equipment blanks shall be collected at the rate of one blank for every 20 decontaminations performed. Equipment blanks will be collected by vacuuming fine silica or powder through the collection device into a sample container. The material will then be submitted to the laboratory for the same analysis as the investigative samples.

10.0 SIDE BY SIDE REPLICATES

Replicate dust samples will be collected at a frequency of one per 20 homes sampled. The replicate sample will be collected using the same procedure used for the investigative sample (as described in Section 6), from a floor area immediately adjacent to the investigative sample. Replicate samples will have the same identifier as investigative samples, with the addition of a trailing letter “D” to indicate it is a replicate/duplicate sample (as described in Section 4.1).

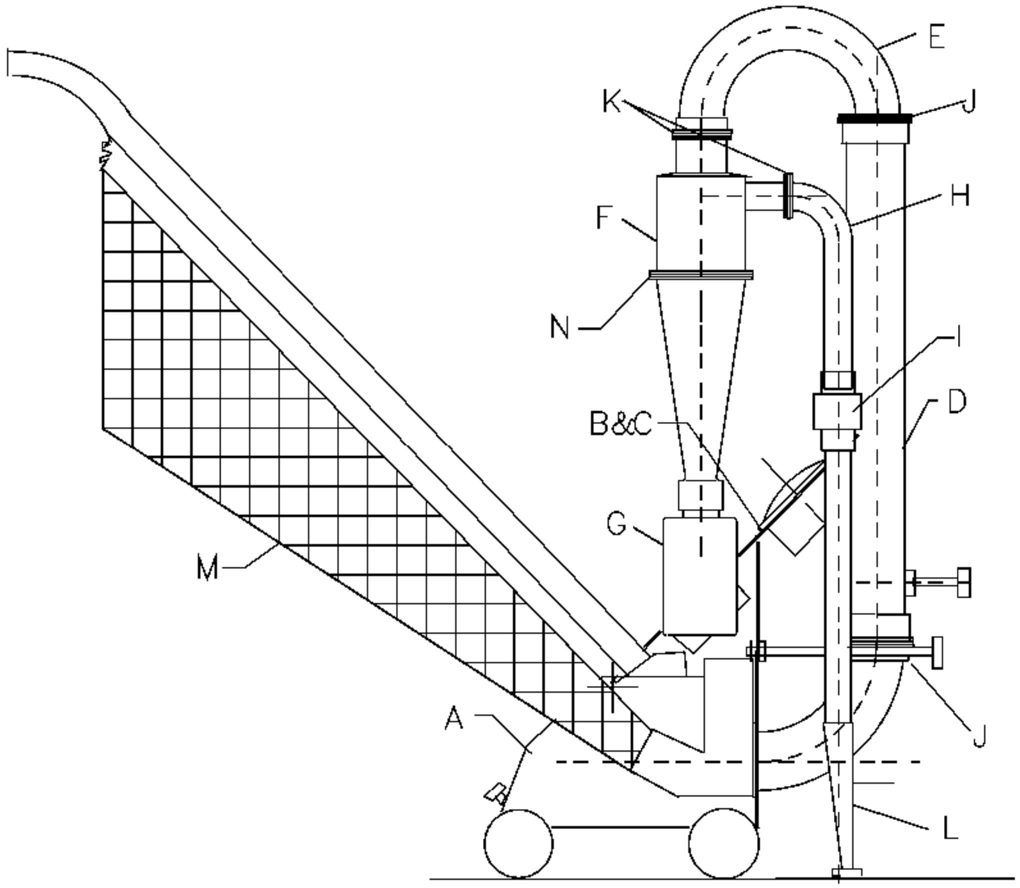
11.0 REFERENCES

ASTM-D5438-11, 2011. Standard Practice for Collection of Floor Dust for Chemical Analysis. American Society of Testing and Materials (ASTM) International. August.

CS3, Inc., 2001. High Volume Small Surface Sampler (HVS3) Operation Manual. Jack Hirsch.

US Environmental Protection Agency (USEPA), 2008. Guidance for Sampling and Analysis of Lead in Indoor Residential Dust for Use in the Integrated Exposure Uptake Biokenetic Model (IEUBK). Technical Review Workgroup for Metals and Asbestos, Lead Committee. OSWER 9285.7-81. December.

Figure 1 – High Volume Small Surface Sampler (HVS3) Schematic



* Refer to parts description Table on following page for identification of parts A through N

HVS3 Parts Description Table

Part #	Qty.	Description
A	1	Model 1020D Vacuum Platform
B	1	Mounting Plate with Magnehelic mount
C	2	Magnehelic gages, 0-15" & 0-10"
D	1	Control valve tube
E	1	U-Tube
F	1	3"diameter Aluminum Cyclone
G	1	P.E. or (F.E.P.) Catch Bottle
H	1	Cyclone Inlet Elbow
I	1	Tygon or (F.E.P) Flex Joint
J	2	2" clamps with gaskets
K	2	11/2” clamps with gaskets
L	1	Suction Nozzle with level
M	1	Vacuum Filter Bag
N	1	3" clamp with gasket

ATTACHMENT A

Field Forms

Indoor Dust Sampling Field Forms

Resident Questionnaire

Samplers:____ Date:______________

Property Code	PC-
Property Address	
Most frequently used entry	Front Door Back Door Side Door Other:___________
Most frequently occupied room	Living Room Kitchen Other:________________
Attic access method	No Access Stairs trapdoor w/ ladder trapdoor w/out ladder
Attic access frequency	1 time/wk 1 time/month 1-2 times/year Less than 1/year
Is the attic used for storage?	Yes / No
Is the attic used for living space? If Yes, Describe use	
Number of occupants (inc ages)	
Dwelling type (circle)	Single Family MultiFamily Mobile Home Other:___________
Year Built (inc dates for fences and outbuildings, if known)	
Name of Resident Interviewed	
Resident Occupation	
Own or Rent?	
Name of property owner	
Construction characteristics	Foundation type, etc
Remodel/Renovation history (project/date)	
When were interior walls/trip last painted?	
Years lived in home	
Years owned home	
List pets	
Where do pets sleep?	
Smoking habits	
Fireplace/wood stove use	
Primary heat source	
"Shoes off" policy in the house	
Vacuuming habits (typical and most recent)	
Type of vacuum	
Aware of attic dust entering house? (if yes, describe)	
Aware of holes where attic dust might enter house? (if yes, describe)	

Indoor Dust Sampling Field Forms

Sample Information

Property ID Number: PC-____________ Date:____________ Start/End Time:______/______

Project: Colorado Smelter CSSA RI Sampler(s):__________ Company:___________

Sample ID:			Sample Type:	Living Space	Attic	
Sample Location (room or entryway sampled)		Floor Type (carpet, wood, concrete, vinyl, tile, other)		Rug Type (Plush, level loop, flat, multilevel, shag or area rug)		Wall-to-wall carpet or Area Rug
Area Sampled (SqFt)	Sample Time	Weight Before (grams)	Weight After (grams)	Sample Weight (grams)	QA/QC QC (Sample ID or NA)	Vacuum Sampling Duration (sec)

Sample ID:			Sample Type:	Living Space	Attic	
Sample Location (room or entryway sampled)		Floor Type (carpet, wood, concrete, vinyl, tile, other)		Rug Type (Plush, level loop, flat, multilevel, shag or area rug)		Wall-to-wall carpet or Area Rug
Area Sampled (SqFt)	Sample Time	Weight Before (grams)	Weight After (grams)	Sample Weight (grams)	QA/QC QC (Sample ID or NA)	Vacuum Sampling Duration (sec)

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Sample Location (room or entryway sampled)		Floor Type (carpet, wood, concrete, vinyl, tile, other)		Rug Type (Plush, level loop, flat, multilevel, shag or area rug)		Wall-to-wall carpet or Area Rug
Area Sampled (SqFt)	Sample Time	Weight Before (grams)	Weight After (grams)	Sample Weight (grams)	QA/QC QC (Sample ID or NA)	Vacuum Sampling Duration (sec)

Indoor Dust Sampling Field Forms

Sampling Equipment Information

Property ID Number: PC-_____________ Date:_________

Sample Equipment: HVS3

Leak Check (Yes/No):________ 10-second cleaning after sampling (Yes/No):__________

Nozzle Flow Rate:____________ Nozzle Pressure Drop:________

Calibration Verification:

Magnehelic Reading:_________ inches water Manometer Reading:_________ inches water

Sample Equipment: HVS3 Connected to Attic Sampling Extension (NA if Attic not sampled)

Leak Check (Yes/No):________ 10-second cleaning after sampling (Yes/No):__________

Nozzle Flow Rate:____________ Nozzle Pressure Drop:________

Calibration Verification:

Magnehelic Reading:_________ inches water Manometer Reading:_________ inches water

Analyses: Total Metals by 6020B (ICP-MS) and Mercury by 7470 (CVAA)________________________

Visitors:____

Comments/Observations:____

____

____

____

____

Sampler Name and Signature:____

Reviewer Name and Signature:____

Appendix B

Validation Checklists

PWT Validation Checklist **Metals Laboratory Analysis**

SDG's: ____________________
Dates Analyzed: ____________________

Narrative: ____________________

Analyte List: ____________________
Holding Times: ____________________

LCS (Check Sample Recovery): ____________________
Batch: ID:
Batch: ID:
MS/MSD:
Date/Time: ID:
Date/Time: ID:
Serial Dilution:
Date/Time: ID:
Date/Time: ID:
PDS:
Date/Time: ID:
Date/Time: ID:
Method Blank:
Date/Time: ID:
Date/Time: ID:
ICB:
Date/Time: ID:
Date/Time: ID:
CCBs:
Date/Time: ID:
Date/Time: ID:
Date/Time: ID:
Date/Time: ID:
ICAL: Date/Time: ID:
Date/Time: ID:
Standards:
Linearity:
CRDL Std:
Date/Time: ID:
Hi/Lo Std:
Date/Time: ID:
Date/Time: ID:
ICV:
Date/Time: ID:
CCVs:
Date/Time: ID:
Date/Time: ID:
Date/Time: ID:
SAMPLES:

QUALIFIERS:

PWT Validation Checklist **Metals Laboratory XRF Analysis**

Sample IDs:

Dates Analyzed:

Relevant comments from Lab notebook:

XRF Target Analyte List:

Holding Times:

LCS (Check Sample Recovery):

Intial Control Charting:

Arsenic

Lead

Interference Checks

Date/Time:

Date/Time:

Blank Analysis

Frequency

Results

Instrument Duplicates

Frequency

Results

XRF Calibration

Date/Time:

Date/Time:

XRF Sample Precision Measurements

Date/Time: ID:

Date/Time: ID:

Date/Time: ID:

Date/Time: ID:

Comments

Qualifiers