CDM

Formosa Mine Superfund Site

Douglas County, Oregon

Final Sampling and Analysis Plan for Surface Water, Groundwater, and Surface Soil and Waste Rock Sampling

September 2009

Sampling & Analysis Plan

Response Action Contract
for Remedial, Enforcement Oversight, and Non-Time Critical Removal Activities at Sites of Release or Threatened Release of Hazardous Substances in EPA Region VIII

U.S. EPA Contract No. EP-W-05-049

Final Sampling and Analysis Plan for Surface Water, Groundwater, and Surface Soil and Waste Rock Sampling

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**Response Action Contract
for Remedial, Enforcement Oversight, and Non-Time Critical Removal
Activities at Sites of Release or Threatened Release of Hazardous
Substances in EPA Region 8**

U.S. EPA Contract No. EP-W-05-049

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Formosa Mine Superfund Site
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Work Assignment No. 221-RICO-10EL

September 4, 2009

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Acronyms

±	plus or minus
%	percent
ABA	acid base accounting
amsl	above mean sea level
ASTM	American Society for Testing and Materials
ARD	acid rock drainage
bgs	below ground surface
BLM	U.S. Bureau of Land Management
°C	degrees Celsius
CAR	Corrective Action Request
CDM	CDM Federal Programs Corporation
CLP	Contract Laboratory Program
COC	chain of custody
Cu_2S	chalcocite
Cu_5FeS_4	bornite
$CuFeS_2$	chalcopyrite
DO	dissolved oxygen
DOGAMI	Department of Geology and Mineral Industries
DQOs	Data Quality Objectives
EDD	electronic data deliverable
e.g.	for example
EPA	U.S. Environmental Protection Agency
Fe^{2+}	ferrous iron
FEI	Formosa Exploration Inc.
FeS_2	pyrite
FRC	Formosa Resources Corporation
FS	feasibility study
FSP	field sampling plan
ft	feet
FTL	field team leader
gpm	gallons per minute
GPS	global positioning system
HASP	health and safety plan
HC	Hart Crowser Inc.
HDPE	high density polyethylene
HHEBRA	human health and ecological baseline risk assessment
ICPES	inductively coupled plasma emission spectrometry
IDW	investigative-derived waste
i.e.	that is
IRAM	Interim Remedial Action Measure
µm	micrometer (micron)

LCS/LCSDs	laboratory control sample/laboratory control sample duplicates
mL	milliliters
MS/MSD	matrix spike/matrix spike duplicate
NAD	North American Datum
NFG	National Functional Guidelines
NPL	National Priorities List
ODEQ	Oregon Department of Environmental Quality
ORP	oxidation reduction potential
PARCC	precision, accuracy, representativeness, completeness, and comparability
PbS	galena
PCOC	preliminary contaminant of concern
PM	project manager
PPE	personal protective equipment
PRG	preliminary remediation goals
QA	quality assurance
QC	quality control
QAPP	quality assurance project plan
QMP	quality management plan
%R	percent recovery
RA	remedial action
RAC	remedial action contract
RBC	risk-based concentrations
RI	remedial investigation
RPD	relative percent difference
RPM	remedial project manager
SA	site assessment
SAP	Sampling and Analysis Plan
Site	Formosa Mine Superfund Site
SOP	standard operating procedure
SPLP	synthetic precipitation leaching procedure
START	Superfund Technical Assistance Response Team
$(Cu, Fe, Zn, Ag)_{12}As_4S_{13})$	tennantite
$(Cu, Fe, Zn, Ag)_{12}Sb_4S_{13})$	tetrahedrite
TDS	total dissolved solids
TSS	total suspended solids
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
WAAS	wide area augmentation system
ZnS	sphalerite

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Section 1
Introduction

CDM Federal Programs Corporation (CDM) will conduct field investigations at the Formosa Mine Superfund Site (Site). CDM will conduct this work for the U.S. Environmental Protection Agency (EPA) as part of work assignment no. 221-RICO-10EL under the EPA Response Action Contract (RAC) No. EP-W-05-049. This sampling and analysis plan (SAP) was developed specifically for the field investigation and data collection activities to support the completion of the remedial investigation (RI) and feasibility study (FS) for the Site.

This SAP describes field investigation activities and details the support CDM will provide EPA during the initial phase of the RI field program. The purpose of this SAP is to describe the sampling objectives, locations, measurement methods, project schedule, and the quality assurance (QA) requirements for sampling and field investigation activities supporting the completion of the RI. This SAP specifically describes details for surface water, groundwater, and surface soil and waste rock sampling. The SAP is organized into a field sampling plan (FSP) and quality assurance project plan (QAPP) as follows:

- Section 1 - Introduction
- Section 2 - Site Background

SAP Part I: Field Sampling Plan

- Section 3 - Sampling Strategy, Locations, and Rationale
- Section 4 - Field Activity Methods and Procedures

SAP Part II: Quality Assurance Project Plan

- Section 5 - Project Management and Data Quality Objectives
- Section 6 - Measurement and Data Acquisition
- Section 7 - Assessment and Oversight
- Section 8 - Data Validation and Usability
- Section 9 - References
- Appendix A - CDM Federal Programs Corporation Technical Standard Operating Procedures
- Appendix B – Health and Safety Plan Form
- Appendix C – EPA Contract Laboratory Program Guidance for Field Samplers

- Appendix D – Field Forms

The QAPP, part II of this SAP, conforms to EPA's QA/R-5 QAPP requirements for quality assurance project plans (EPA 2001).

1.1 Objectives

The overall objective of the field investigations is to provide physical and chemical data necessary to support critical evaluations and decisions within the RI and FS. This SAP provides details for the initial phase of sampling at the Site, which includes surface water sampling, seep and spring surveys, groundwater sampling of existing wells, surface soil and waste rock sampling, and installation of in-stream flumes and data collection. The specific objectives are as follows:

- **Surface water sampling** will provide data regarding concentrations of preliminary contaminants of concern (PCOCs) to define the nature and extent of contamination in surface water.

- **Spring and seep surveys** will identify discharge locations and water quality to support definition of the groundwater potentiometric surface and provide information necessary to characterize the nature and extent of contamination.

- **Groundwater sampling of existing wells** will provide preliminary information at a limited number of locations regarding water quality and water levels to support definition of the nature and extent of contamination and the groundwater potentiometric surface.

- **Surface soil and waste rock sampling** will define geochemical characteristics of exposed mine waste rock and soils to delineate surficial source materials that contribute to acid generation and metals leaching

- **Installation of in-stream flumes and data collection** will provide continuous flow monitoring at three sites to define seasonal fluctuations in discharge of contaminated waters to support FS evaluations related to collection and treatment of water, and to provide information regarding contaminant generation and transport.

This SAP is focused on characterizing acid rock drainage (ARD) discharges to surface waters in the vicinity of the Site and evaluating the potential for mine waste materials at the Site to generate ARD. It is understood that additional data collection will be necessary to gain a complete understanding of the hydrogeological characteristics of the Site and to fully evaluate the extent of contamination at the Site for purposes of ecological and human health risk assessment and evaluation of contaminant fate and transport. Additional data needs to support these evaluations, such as subsurface soil sampling, stream sediment sampling, installation of additional monitoring wells and subsequent groundwater sampling, groundwater aquifer tests, and biological assessment and/or potential biota sampling will be addressed in later SAP(s).

1.2 Project Schedule and Deliverables

The RI activities described in this SAP are anticipated to be completed during the summer/fall of 2009, with monthly and quarterly surface water and groundwater sampling events continuing through the RI process. Sampling schedule and scope may be further refined in the future as additional objectives are defined for the RI. If requested by EPA, interim data summary reports or technical memoranda will be submitted that present the results of the sampling and analyses. Otherwise, data collected in accordance with this SAP will be compiled and reported in the RI report.

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Section 2
Site Background

This section provides summary information related to the site location and environmental setting.

2.1 Site Location and Description

The Site is an abandoned mine located in southwest Oregon in Douglas County, approximately 25 miles south of Roseburg, Oregon and 7 miles south of Riddle, Oregon, within Sections 23, 26, and 27, Township 31 South, Range 6, West Willamette Meridian. It is located in the Coast Range Klamath Mountains at elevations between 3,200 and 3,600 feet (ft) above mean sea level (amsl) near Silver Butte Peak (3,973 ft amsl). Surface terrain is characterized by steep mountains, narrow ridges, and deep valleys. The Site location is shown on Figure 2-1.

2.1.1 Land Ownership

The former mine area is mostly located on private land owned by Formosa Exploration Inc. (FEI), with some areas owned by U.S. Bureau of Land Management (BLM). BLM, as well as a mix of private timber companies, also own land adjacent to the mine area.

2.1.2 Watersheds and Drainages

The Site is located within the South Umpqua Basin, one of three sub-basins in the Umpqua Basin, and is situated near the top of a mountain ridge that divides several sub-watersheds. The Russell Creek-Cow Creek sub-watershed lies to the north of the Site, the Middle Creek sub-watershed lies to the west and south, and the Canyon Creek sub-watershed lies to the southeast and east. Russell Creek and West Fork Canyon Creek have headwaters near the Site, and are the main drainages in the Russell Creek-Cow Creek and Canyon Creek sub-watersheds. Within the Middle Creek sub-watershed, both Upper Middle Creek and South Fork Middle Creek have headwaters near the Site.

2.1.3 Vegetation

Native vegetation within the vicinity of the Site consists of old growth Douglas fir and western hemlock forest (i.e., greater than 80 years) and a mix of younger growth forest in various stages of re-growth after timber harvest. Old growth forest consists of large stands of Douglas fir and western hemlock and generally sparse undergrowth, with some deciduous trees such as golden chinkapin and Pacific madrone intermixed. Younger growth forest typically has more dense undergrowth of deciduous trees and brush, which is routinely slashed during later stages of growth of the merchantable coniferous timber.

2.1.4 Precipitation

Precipitation in the Klamath Mountain region can vary between 40 inches and 120 inches per year, dependent on the elevation and other surface features. Generally, precipitation can range from 50 inches to 120 inches per year at elevations greater than 3,200 ft amsl and from 40 inches to 55 inches at elevations less than 3,200 ft amsl (BLM 2002). Current available data indicates precipitation near the Site ranges from 30 to 55 inches per year. The bulk of precipitation falls during the winter months (November through March), which brings a high surface water flow that generally peaks around March and declines through the remainder of the spring, summer, and fall. Precipitation during winter months may fall as snow in higher elevations, especially above 3,200 ft amsl.

2.1.5 Site Features

Site features include five reclaimed adit portals (Formosa 1, Formosa 2, Formosa 3, Silver Butte 1, and 1090), the 404 adit (not reclaimed), the former mill site, former crusher, former million gallon tank, former water storage and tailings pond (now referred to as the encapsulation mound), various seeps located downslope from the encapsulation mound within the South Fork Middle Creek drainage basin, various seeps located downslope of the Formosa 1 adit within the Middle Creek drainage basin , access roads, various waste rock dumps and associated fills, and the Interim Remedial Action Measure (IRAM) adit water diversion system (installed in 2000). Site features are presented on Figure 2-2.

2.2 Site History

This section provides a brief Site history summarized from the *Data Summary Report, Formosa Mine Site Douglas County, Oregon* (CDM 2009a).

2.2.1 Early Mining and Exploration

Geologic exploration activities in the area of the Formosa and Silver Butte Mines (referred together as the Silver Peak Mine) were first conducted in 1910. By 1926, underground mining and shipping of ore had begun. Additional mining and shipping of ore continued from 1928 through 1931 and from 1936 through 1937. During these periods, the Silver Peak Mine produced 6,620 short tons (one short ton equals 2,000 pounds) of ore, which yielded 735,600 pounds of copper, 231,980 ounces of silver, and 490 ounces of gold. Waste rock from the underground mining was dumped on the hillsides adjacent to adit portals and roads, and may have been utilized to build roads. All mining was done above the Formosa 1 adit elevation, so that the workings could be drained of water by gravity through the Formosa 1 adit. As a result, ARD formed in the network of underground workings and then flowed out of the adit and into the headwaters of Middle Creek.

2.2.2 Modern Mining and Exploration

Later underground workings development work was conducted in 1952 and various geologic explorations were conducted in the late 1970s and through the 1980s, but no additional mining was conducted. In 1984, Formosa Resources Corporation (FRC [formerly Rand Ventures Inc.]) acquired a portion of the Silver Peak Mine and adjoining properties. From 1984 through 1989, FRC conducted an extensive geologic exploration program to further define the quantity and location of ore reserves. This work was first conducted both on claims that FEI owned and on claims leased from the Silver Butte Mining and Milling Company. In May 1987, FRC (incorporated in Canada) established a subsidiary company called Formosa Exploration Inc. (FEI) based in Roseburg, Oregon in order to further conduct exploration activities. In July 1987, the mineral claims owned by FRC and the mineral lease and option to purchase agreement with Silver Butte Mining and Milling Company were assigned to FEI.

Based on the FRC/FEI's extensive exploration, significant ore reserves were determined to be present and the company began to pursue opening an active mining operation at the Silver Peak Mine around 1988. As part of the permitting process, FEI conducted a baseline fisheries, water quality, and hydrology investigation in order to document environmental conditions prior to initiation of mining activities. This work was conducted in 1988 and 1989.

In spring of 1990, Oregon Department of Geology and Mineral Industries (DOGAMI) approved FEI's mine operating permit. Underground mining was conducted by FEI from early summer 1990 until August 1993. Ore was crushed, screened, and sent to a flotation mill located onsite to produce zinc and copper concentrates. Copper concentrates were shipped to Japan for smelting and zinc concentrates were stockpiled onsite, but never shipped to a smelter due to the low volumes produced and low zinc prices. Waste tailings from the flotation process were backfilled into the mine workings and stored onsite within the 2-acre lined process water pond. Waste tailings consisted of finely ground (i.e., less than 38 micrometers [µm] [400 mesh]) pyrite, gangue minerals such as quartz, barite, and sericite, and varying amounts of chalcopyrite (copper-bearing sulfide) and sphalerite (zinc-bearing sulfide) not removed by the flotation process. On August 1, 1993, the mine officially ceased operations.

2.2.3 Mine Reclamation and Adit Water Diversion System

The majority of Site reclamation was conducted by FEI from August 1993 through August 1994. Reclamation activities included removal of the crusher and stockpiled ore, removal of a zinc concentrate storage site, cleanup of diesel fuel spills, removal of sulfide tailings from upper Middle Creek, backfilling mine workings with crushed ore and tailings, reclamation of the adit portals, removal of the mill building and processing equipment, backfilling and capping of the water and tailings storage pond, removal of crib wall fill and wood wall structures, and removal of the million-gallon tank used for process water storage during operations.

Maintenance on the adit water diversion system has continued since initial construction (1994) until present day. Through this period, the intent of the adit water diversion system was to collect water from the Formosa 1 and Silver Butte 1 adits and divert the water into drainage fields away from the upper headwaters of Middle

Creek, but never to treat the water. Regular maintenance has been required on the pipelines as a result of iron-precipitate scale formation in the pipes and other physical and hydrological events such as falling rocks and surface erosion. Scale buildup in the diversion pipelines became a constant problem starting in 1995 and required regular cleaning in order to keep the adit water draining properly. Over the years, intermittent periods occurred where the pipes became completely clogged and adit water drained directly into Middle Creek. As a result, the diversion system has been completely rebuilt and sections of pipe have been replaced several times.

In 2000 Hart Crowser Inc. (HC) was hired by the Oregon Department Environmental of Environmental Quality (ODEQ) to conduct an investigation at the Site and to design and build the IRAM adit diversion and treatment system. A removal assessment report was prepared by HC in September 2000 (HC 2000), and construction of the adit collection system portion of the IRAM began in the fall of 2000 and was completed by November. However, dispute over private land ownership prevented a passive wetland treatment system from being built as designed, so collected adit water was diverted into a drainfield as was done previously. This diversion system remains in place to current day and consists of a receiving basin for Formosa 1 adit and Silver Butte 1 adit water, followed by cascading aeration tiers, and several hundred of feet of 12-inch corrugated high density polyethylene (HDPE) pipe (minimum slope of 10 percent). Two concrete sedimentation vaults are present in series just downslope of the cascading aeration tiers. This diversion system has also required significant maintenance over the years for the same reasons mentioned above.

2.2.4 Previous Investigations and Current Site Status

Starting in June 1999, BLM in cooperation with ODEQ began an extensive baseline RI at the Site. A baseline RI report was prepared in June 2000 (BLM 2000). BLM also hired Dynamac Corp. (Dynamac) to conduct a site assessment (SA) in October 1999. The SA report was prepared by Dynamac in February 2000 (Dynamac 2000).

After the baseline RI and SA, HC conducted a data evaluation and a supplemental RI. The data evaluation report was prepared by HC in September 2001 (HC 2001) and the supplemental RI report was prepared in December 2002 (HC 2002). After the Supplemental RI, HC completed a FS and a human health and ecological baseline risk assessment (HHEBRA). Both the FS and HHEBRA were completed and their associated reports were published in 2004 (HC 2004a and 2004b).

Since completion of the HHEBRA and FS, sporadic surface water sampling has been conducted by ODEQ and BLM. In 2005, citizens petitioned the EPA to consider adding the Site to the National Priorities List (NPL). In 2006, the Site was proposed for listing on the NPL, and in 2007 was officially added to the NPL. In the summer of 2006, the USEPA Superfund Technical Assistance & Response Contract 3 (START-3) team conducted a removal assessment at the Site. The START-3 removal assessment report was prepared in March 2007 (START-3 2007).

2.3 Geology

This section provides a brief description of Site geology summarized from the *Data Summary Report, Formosa Mine Site Douglas County, Oregon* (CDM 2009a).

The rock units in the direct vicinity of the Formosa mine consist of the following units:

- Basalt flows and tuffs
- Dacite tuffs
- Foliated tuff
- Bedded tuff
- Basaltic tuff

These rock units are generally composed of subaqueously deposited volcanic rocks that are spatially and genetically associated with the massive sulfide mineralization at the Silver Peak deposit.

The mineralogy of the ore bodies and associated rocks intersected by mine workings is an important aspect controlling ARD at the Site. The Silver Peak deposit is classified as a volcanogenic massive sulfide deposit. This type of deposit contains very high concentration of sulfide minerals, and therefore the deposit has a very high potential for acid generation. This is exacerbated by a lack of acid neutralizing carbonate minerals in the country rocks surrounding the mine.

The ore bodies and portions of the foliated tuff unit contain high concentrations of numerous sulfide minerals including pyrite (FeS_2), chalcopyrite ($CuFeS_2$), sphalerite (ZnS), bornite (Cu_5FeS_4), tennantite ($(Cu, Fe, Zn, Ag)_{12}As_4S_{13}$), tetrahedrite ($(Cu, Fe, Zn, Ag)_{12}Sb_4S_{13}$), galena ($PbS$), and chalcocite ($Cu_2S$) (FRC 1987). Pyrite is a major contributor to ARD generation at mine sites worldwide, and it is important at the Silver Peak Mine both in terms of direct ARD generation by pyrite and the effect of the products of pyrite oxidation on oxidation of other sulfide minerals.

There are four rock units containing sulfide mineralization at the Silver Butte deposit, all of which are contained within the foliated tuff unit. These units consist of:

- Quartz-sericite-pyrite foliated tuff
- Quartz-sulfide tuff
- Sulfide lapilli tuff
- Massive sulfide

The quartz-sericite-pyrite foliated tuff is the thickest of the three units, and is up to approximately 10 meters thick in the mine area. It is grey to white in color and consists of sand-sized grains of quartz and pyrite with varying amounts of platy sericite. Pyrite is detrital when in grains exceeding 0.1 millimeter in diameter, as evidenced by abraded grains. Trace chalcopyrite and sphalerite are also present in this unit. Based on 11 samples of this unit, the estimated sulfur content ranges from

4.98 to 19.20 percent, which corresponds to pyrite content in the rock ranging from approximately 10 to 40 percent. This rock is highly acid generating.

The quartz-sulfide tuff occurs in the footwall of the massive sulfide zones. This unit is dense and siliceous and not strongly foliated. It contains sphalerite and chalcopyrite in addition to pyrite.

Sulfide lapilli tuff consists of cream colored tuff containing scattered lapilli size fragments of sulfides including pyrite, chalcopyrite, tennantite, and sphalerite. The sulfide lapilli tuff occurs in the hanging wall of the massive sulfide mineralization. This unit contains up to 10 percent sulfide minerals in a fine grained well-indurated matrix.

Massive sulfide at the Silver Peak Mine occurs in 4 distinct lenticular bodies. The massive sulfide lenses are relatively small in overall size, but they contain large accumulations of sulfide minerals. The massive sulfide lenses range from less than 1 meter to approximately 5 meters thick. The strike extent of the massive sulfide lenses ranges from 20 to 90 meters, with a down-dip extent of approximately 100 meters.

Massive sulfide mineralization at Silver Butte is predominantly pyrite with chalcopyrite, sphalerite and local bornite, tennantite, galena, and chalcocite. Barite and quartz occur within the massive sulfide lenses as gangue minerals (minerals contained within the ore body that are not valuable).

The massive sulfide mineralization occurs within an approximately 150 to 200 meter thick sequence of foliated tuff. The fabric of the foliated tuff includes a well defined foliation or cleavage sub-parallel to bedding. This foliation is absent in adjacent dacite and basalt tuff units. FRC (1987) believes that this foliation is an expression of shearing deformation, which occurred in the general plane of the foliated tuff units (including zones of massive sulfide mineralization). The foliation is generally parallel to the strike of the rock units (strike 035 to 050 degrees, dip 60-75 southeast) and to the bedding and lamination of the massive sulfide units.

Cross-cutting structures are also present on various geological maps of the site. A fault offsetting ore mineralization is present on a series of plan maps at various depths through the mine developed by FRC (1987). This structure is located approximately 30 meters south of the Formosa #1 Adit. The structure is a right-lateral fault which displaces the ore zone by approximately 30 meters. The trend of this structure is generally west to northwest towards the Middle Creek drainage. Several other faults of similar orientation are provided on maps included in Derkey and Matsueda (1989) in the general area of the Silver Peak mine. These data have not yet been compiled.

2.4 Groundwater

The upper portions of Silver Butte Peak and the associated ridge system are likely areas of groundwater recharge by precipitation. The topography of the area is very steep, and groundwater likely moves down a hydraulic gradient that is generally coincident with topography. Groundwater then discharges at springs that are located in steep tributary systems such as upper Middle Creek and the upper reaches of the South Fork of Middle Creek. These tributary drainages appear to be gaining streams as they flow from the Silver Peak area towards lower portions of the Middle Creek and the South Fork of Middle Creek, suggesting continued discharge of groundwater to surface water.

Groundwater flow within the tuff units may be associated with both primary intergranular porosity as well as secondary porosity. The general geological framework of the area generally consists of a sequence of various types of flows and tuffs of basaltic to dacitic composition. The flows are crystalline igneous rocks and groundwater flow within these unit flows is likely associated with secondary porosity in the form of fractures, faults and shears. Tuffs are granular rocks and the level of induration of the tuffs ranges from soft weakly indurated rocks to hard well indurated rocks. The level of induration of the rock units ranges laterally within individual rock units as well as vertically within the stratigraphic sequence.

It is likely that the underground mine markedly affects the local groundwater flow system. The underground mine workings may act as a conduit system conveying groundwater from upper portions of the system to discharge points located in Middle Creek or other areas. The underground workings may also connect otherwise isolated fracture systems, and thereby increase the rate of groundwater flow in close proximity of the mine.

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Section 3
Sampling Strategy, Locations, and Rationale

The FSP is included in Sections 3 and 4. This section describes the overall strategy for the initial RI field program. Overviews of the surface soil, surface water, and groundwater sampling activities are provided in this section. Field activities and procedures are presented in Section 4.

3.1 Overall Sampling Strategy

The overall sampling strategy for the RI field program is to evaluate the nature and extent of contamination within various geological materials, surface water, and groundwater to support development and assessment of remedial alternatives during the FS. The strategy includes several components:

- Mine waste rock and surface soil sampling to characterize exposed sources of acid rock drainage and metals;
- Seep and spring surveys to identify all areas where ARD-affected waters discharge from groundwater to the surface, and to provide information regarding seasonal fluctuations in the groundwater potentiometric surface;
- Surface water sampling to evaluate the flux of ARD-related contaminants from the site and to evaluate the extent of contamination in downstream surface water;
- Groundwater sampling from existing wells to evaluate the extent of contamination in the groundwater system and develop information regarding groundwater surface water interactions; and
- Installation of flumes and automated flow and water quality monitoring equipment to quantify the seasonal ARD discharge rates and discharge quality.

In order to mitigate release of ARD from the site, it is necessary to understand the discharge points for ARD-affected waters and the sources of ARD generation. The previous work described in Section 2 has generally characterized these issues. However, detailed data are necessary to develop and critically evaluate mitigation strategies in the FS. Data planned for collection during this field effort will be used to supplement historical data collected from the Site; to this end, surface water and groundwater data will be collected from established sampling locations in order to provide correlation with data previously collected. In addition, this field effort will attempt to identify currently unknown sources of ARD discharges at the Site through springs and seeps in the vicinity of the Formosa Mine in order to adequately account for other potential sources of ARD that contribute to surface water degradation.

It is understood that additional data collection will be necessary to gain a complete understanding of the hydrogeological characteristics and to fully evaluate the extent of contamination for purposes of ecological and human health risk assessment and evaluation of contaminant fate and transport. Additional data needs to support these evaluations, such as subsurface soil sampling, stream sediment sampling, installation of additional monitoring wells and subsequent groundwater sampling, groundwater aquifer tests, and biological assessment and/or potential biota sampling will be addressed in later SAP(s).

3.2 Mine Waste Rock and Surface Soil Sampling

This section describes the sampling rationale, locations, and analysis of surface waste rock and soil at the Site.

3.2.1 Sampling Rationale

Numerous surface disturbance areas exist at the Site, and many of these areas potentially contain ARD generating source materials. Previous investigation data from the various areas indicate elevated concentrations of metals and potential for acid generating material. There is also potential that various roads and ancillary surface areas near the mine were constructed with mine waste material, which may be potentially acid generating or contain elevated concentrations of metals. Visual observations indicate widespread presence of pyrite-containing materials in many surface disturbance areas, including roads. The lack of vegetation in disturbed areas and the presence of potentially acid-generating materials may provide a continuous source of contaminated surface runoff, and may lead to contaminated subsurface flow.

In order to achieve the objectives of the RI, it is necessary to understand both the geochemical characteristics of surface disturbance material and the extent of this material. Although previous investigations show that some material is problematic in terms of ARD generation, insufficient information is available to delineate the extent and volume of this material. This SAP focuses on delineating the surface geochemical characteristics and the horizontal extent of those characteristics. A later SAP will focus on the subsurface to determine the vertical extent (volume) and related geochemical characteristics. Together, both surface and subsurface data regarding the extent and volume of ARD generating and metals-contaminated materials will be used to support the FS for various Site remediation options, including waste consolidation, containment, capping, or disposal in a repository. Surface material sampling data will also be used for evaluation of human-health risk at the Site.

3.2.2 Sampling Locations and Analyses

In order to assess ARD generation potential of the surface materials at the site, CDM will collect numerous surface material (soil/waste rock) samples for measurement of field paste pH and conductivity. Paste pH and conductivity analyses will be utilized to assess whether soils and waste rock contain vestigial acidity (a product of ARD generation), and will allow for decisions to be made in the field regarding locations where samples will be submitted for laboratory analysis for acid-base accounting (ABA), modified synthetic precipitation leaching procedure (SPLP) analysis, and total metals analysis. ABA analyses will be used to more fully evaluate the acid-producing potential of the soil and waste rock at the Site, and modified SPLP analyses will be used to evaluate the potential for leaching of metals from soil and waste rock due to precipitation.

Figure 3-1 indicates areas where surface material samples will be collected during the paste pH and conductivity survey. Paste pH and conductivity samples will be generally collected on a grid pattern over large surface disturbance areas (e.g. waste rock dumps and encapsulation mound) and on a generally linear sampling pattern along roadways within and surrounding the Formosa Mine. Within surface disturbance areas and waste rock piles, an approximate grid pattern (on approximately 100-foot centers) will be utilized for the collection of paste pH and conductivity measurements. In areas where elevated paste pH values are observed at planned investigation boundaries, the boundaries will be expanded to adequately delineate the extent of surface materials associated with ARD generation. Along roadways indicated in Figure 3-1, sample locations will be spaced at approximately 100-foot intervals along the roadway, and will alternate between road centerline and shoulders/swales on both sides of the road as determined by the field team leader. The specific locations of paste pH and conductivity sampling will be modified in the field as necessary based on visual observation of lithology, the presence of sulfide minerals, and the presence of secondary alteration minerals that are associated with ARD generation.

Table 3-1 indicates the estimated quantity of samples and sampling strategy to be employed during the paste pH and conductivity survey. The proposed sampling plan will result in a total of approximately 220 paste pH and conductivity sample locations. This number is a preliminary estimate, and additional paste pH and conductivity samples will likely be collected. Additional samples will likely be necessary due to actual field conditions, such as a larger extent of waste rock material than indicated on Figure 3-1 or areas where grid spacing needs to be decreased to adequately characterize the location. A field lithologic log will be prepared for each paste pH and conductivity sample, and the specific location of the sample will be recorded using global positioning system methods (GPS) or other suitable field surveying methods.

Based on observations during the paste pH and conductivity survey, a subset of locations (approximately 20 percent, no more than 40 samples) will have surface material (i.e., 0 – 6 inches below ground surface) samples collected for laboratory analysis to evaluate the presence of contaminants of concern (i.e. metals) and the potential for ARD generation and leaching of contaminants from the soil and waste rock materials into the subsurface and/or surface waters. Surface material samples will be submitted to analytical laboratories for analysis for total metals (EPA Contract Laboratory Program [CLP] Inorganics), ABA parameters (Sobek 1978, modified), and modified SPLP (modified EPA Method 1312) procedures. Details regarding sample collection procedures are presented in Section 4.7, and sample containers, holding times, and QA/QC requirements are described in Section 5.

In order to facilitate interpretation of ABA laboratory data, select samples will also be submitted for electron microprobe analysis to gather detailed data regarding the mineralogy of the waste rock materials, specifically the types of acid generating and acid neutralizing minerals present in the sample. The subset percentage of samples will be determined in the field, but will be no more than 10 percent.

In addition to supporting FS activities, analytical data collected from surface material sampling will be utilized to support a human-health risk assessment for the Site. In order to support risk assessment activities, surface material samples for total metals analyses will be collected and sieved using a 60-mesh (250 μm) screen, and materials smaller than 250 μm will be analyzed for total metals as described in Section 5.4.4.

3.3 Seep and Spring Surveys

This section describes the sampling rationale, locations, and analysis for seep and spring surveys.

3.3.1 Sampling Rationale

CDM currently plans to conduct two seep and spring surveys at the Site. The purpose of these surveys is to identify any areas of ARD discharge and to identify areas of unaffected groundwater discharge. Efforts will include verification of previously mapped seeps and springs, as well as identification of unmapped discharges. Identifying areas of ARD discharge or seepage from uncontaminated areas will be used in support of hydrogeological evaluations at the Site and to define the nature and extent of contamination. Comparison of analytical data from seeps and from groundwater wells will be useful to evaluate whether these discharges are connected to the area impacted by the underground mine workings or if they are part of a separate hydrogeological system. Topographic and access limitations at the Site may prevent installation of groundwater wells in some areas, which may result in a data gap for understanding the hydrogeological framework. Comprehensive seep and spring surveys may help to fill these potential data gaps.

One survey will be conducted in a relatively dry season (August – October), and one survey will be conducted in a relatively wet season (December – March). Data from these two surveys will provide information regarding the seasonal variability in seep flow, as well as seasonal variations in the locations of seeps with respect to topography. In addition to these two surveys, seep and spring sampling may also be conducted in conjunction with other surface water sampling events as needed to understand the Site hydrogeology and hydrology.

3.3.2 Sampling Locations and Analysis

The Upper Middle Creek, Upper South Fork Middle Creek, West Fork Canyon Creek, and Upper Russell Creek drainages will be inspected during the two main surveys to identify the presence of any potential unidentified ARD-affected discharges.

The process of seep and spring surveys will consist of visual inspections, beginning within drainage areas and expanding to attempt to identify all seeps and springs present in the drainages identified above. Seeps and springs will be tracked to their origin. If seeps or springs are identified, the water will be sampled for field parameters (i.e., pH, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and temperature). Estimates of flow rate will be made and locations of the seeps and springs will be logged using a GPS unit or other methods outlined in Section 4.6. Water samples may be collected from seeps and springs identified for laboratory analysis, and these locations may subsequently be added to the routine surface water monitoring program for the Site, as described in Section 3.4. If samples are collected for laboratory analysis, the parameters to be measured will be the same as for surface water samples, as described in Section 3.4 below.

3.4 Adit Drainage and Surface Water Sampling

This section describes the sampling rationale, locations, and analysis for adit drainage and surface water sampling.

3.4.1 Sampling Rationale

The surface water monitoring program is designed to accomplish two primary purposes:

1. Provide detailed surface water quality data in close proximity to the mine to facilitate characterization of seasonal variations in discharge water quality and flow to support the RI and FS.

2. Provide updated water quality data at downstream locations to supplement historical data and facilitate human health and ecological risk assessments.

3. Provide information to refine the conceptual site model for the Formosa Mine Site.

Sampling within close proximity of the mine is primarily designed to collect data to facilitate development and assessment of remedial alternatives in the FS. In order to accomplish FS goals, it is necessary to understand the discharge points for ARD-affected waters. This understanding must include seasonal fluctuations in both flow and water quality. This initial program is focused on sampling at established surface water locations to leverage the investigation with information developed during previous Site investigations conducted by ODEQ, BLM and others.

Sampling at downstream locations along South Fork and Lower Middle Creek are intended to provide information to facilitate ecological and human health risk assessment. One goal of this work is to identify the maximum extent of downstream effects to surface water from the mine. An additional goal of downstream sampling in Cow Creek is to determine if discharge from the mine may have any human health risk for consumption of drinking water.

3.4.2 Sampling Locations and Analyses

The proposed locations for surface water monitoring are presented in Figures 3-2 through 3-4. The frequency of sampling is planned to be monthly for locations in close proximity of the mine as indicated on Figure 3-2. Figures 3-3 and 3-4 indicate surface water locations to be sampled as part of the quarterly sampling program. The specific dates for quarterly sampling at downstream sampling locations will be determined by reviewing historical and current flow records at U.S. Geological Survey (USGS) flow gauging stations in Cow Creek. An attempt will be made to collect quarterly samples near the peak of high flow, at the lowest flow of the year, and in between the high and low flow.

The surface water sampling program assumes that the previous investigations have identified the primary discharge locations for ARD affected waters at the Site. A seep and spring survey to be conducted at the Site was described in Section 3.3. This survey will include detailed inspection of tributaries draining the mine area to identify any previously unknown locations of ARD discharge. Based on the results of this survey, other visual observations collected during monthly and quarterly sampling events, and consultation with EPA, new surface water locations may added and/or historic sampling locations may be removed from the sampling list to better meet the project objectives.

In general, surface water samples will be collected as grab samples from the center of the stream channel, at locations where the stream is wadeable. The exception to this will be for downstream locations near the confluence of Middle Creek and Cow Creek and on Cow Creek. At these locations, depth-width integrated samples will be collected. The process to be employed is described in greater detail in Section 4.9. The purpose of the depth-width integrated sample is to collect a composite sample representative of the flow of the entire stream channel.

Surface water samples from all locations will be analyzed for total and dissolved metals (EPA CLP Inorganics), pH, conductivity, total dissolved solids (TDS), total suspended solids (TSS), alkalinity, acidity, hardness, major anions (sulfate, chloride, fluoride, carbonate, bicarbonate) and cations (calcium, magnesium, sodium, and potassium), nitrate/nitrite, and ammonia. Hardness will be calculated from measured calcium and magnesium concentrations. The dissolved metals samples will be field filtered with a 0.45-μm filter. Details regarding sample collection procedures are presented in Section 4.9, and detailed analytes, sample containers, holding times, and QA/QC requirements are presented in Section 5. Field water quality parameters will also be measured at each sample location (i.e., pH, conductivity, DO, ORP, alkalinity, and temperature).

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Flow rate will be measured and/or estimated at all surface water sampling locations. The major variation in flow ranging from groundwater seeps to mountain streams will require the use of several flow monitoring techniques. The specific technique used at each location will be determined in the field based on site-specific conditions. These methods may include some combination of portable electronic velocity meter, bucket and stopwatch, portable flat plate weir, portable cutthroat flume, sudden injection tracer test, or visual estimates. At some locations, such as seeps or springs, a visual flow estimate may be necessary (e.g. < 1 gallon per minute [gpm]). Photographic documentation and field observations will be collected at all locations.

3.5 Groundwater Sampling

This section describes the sampling rationale, locations, and analysis for groundwater sampling.

3.5.1 Sampling Rationale

Five groundwater monitoring wells have been installed at the Site during previous investigations. Currently, limited data exists regarding the groundwater quality in the vicinity of the Formosa Mine. Additionally, data are limited regarding Site hydrogeology as it relates to contaminant transport. The purpose of groundwater sampling is to supplement the small dataset of groundwater samples from the existing locations, and to begin collecting data regarding seasonal fluctuations in groundwater levels and contaminant concentrations.

3.5.2 Sampling Locations and Analyses

The condition of the existing monitoring wells will first be evaluated and then groundwater samples will be collected. Existing groundwater wells are planned to be sampled initially one time. Further sampling of existing wells may occur on a monthly or quarterly basis based on consultations with and direction from EPA. Figure 3-5 shows the locations of the five existing monitoring wells planned for sampling. Table 3-2 shows the depths and screen intervals of the existing monitoring wells at the Site.

Samples collected from groundwater monitoring wells will be submitted for analysis for dissolved metals, pH, conductivity, TDS, alkalinity, acidity, hardness, major anions/cations, nitrate/nitrite, and ammonia. Analytical methods to be used are discussed in Section 5. During purging of monitoring wells, field parameters (pH, conductivity, DO, ORP, alkalinity, temperature, and ferrous iron) will be measured and recorded. Details regarding sampling methods and parameter measurements are discussed in Section 4.10.

3.6 Flume and Electronic Data Logger Installation

Currently, there is a lack of detailed information regarding seasonal fluctuations in flow rates from the Formosa adit and within ARD-impacted streams in upper Middle Creek and upper South Fork Middle Creek. In order to evaluate ARD treatment options for both adit discharges and impacted stream areas, detailed temporal data regarding fluctuations in flow rate and water quality is a necessity. The seasonal variations in flow and water chemistry, including capturing data at peak flow conditions following precipitation events, are a critical aspect in evaluating treatment technologies, treatment costs, and ARD collection and conveyance system design.

Flumes will be installed at the Formosa adit, sampling location MXR, and at a location in upper South Fork Middle Creek. The location in the upper South Fork will be determined in the field and through discussions with EPA. A location will be selected in order to provide adequate characterization of seasonal fluctuations in flow rate and water quality of ARD-affected water. Flumes (H-flumes or Parshall flumes) are currently planned to be installed rather than weirs, as flumes tend to be somewhat self-cleaning and would allow for more unhindered passage of metal precipitates and sediments through the flume.

In conjunction with flume installation, doppler-style electronic flow meters will be installed at each location. For the upper MXR and upper South Fork Middle Creek locations only, electronic pH, conductivity, and temperature data loggers will also be installed. Instrumentation at the flumes will be maintained on a monthly basis along with surface water sampling, or more frequently as required. Electronic data from the loggers will also be downloaded on a monthly basis.

3.7 Quality Assurance/Quality Control Samples

Quality assurance/quality control (QA/QC) samples for surface water, groundwater, and surface soil sampling will include field duplicate samples, matrix spikes (MSs), matrix spike duplicates (MSDs), and equipment rinsate blanks. The number of QA/QC samples to be collected during the field effort is described in Section 6.5.1.

Internal laboratory QA protocols will be maintained in addition to the field QA/QC controls. These include laboratory blanks (i.e., calibration blanks, preparation blanks), laboratory duplicates, and laboratory control sample/laboratory control sample duplicates (LCS/LCSDs).

Section 4
Field Activities, Methods, and Procedures

The following is a summary of field activities that will be performed by CDM personnel, as well as EPA, BLM, and USGS personnel, for the RI field program:

- Mobilization/Demobilization
- Procurement of equipment and supplies
- Field documentation
- Field instrument calibration and maintenance
- Photographic documentation
- Test and sample location documentation
- Surface material sample collection
- Seep and spring surveys
- Surface water sample collection
- Groundwater sample collection
- Flume and water flow/quality instrumentation installation
- Equipment decontamination
- Investigation-derived waste (IDW) management

The following subsections reference CDM standard operating procedures (SOPs), where applicable, or provide Site-specific procedures if there are not applicable SOPs. The SOPs applicable to this investigation include the following:

- Surface Water Sampling (SOP 1-1)
- Sample Custody (SOP 1-2)
- Surface Soil Sampling (SOP 1-3)
- Groundwater Sampling Using Bailers (SOP 1-5)
- Water Level Measurement (SOP 1-6)
- Packaging and Shipping Environmental Samples (SOP 2-1)
- Guide to Handling Investigation-Derived Waste (SOP 2-2)
- Lithologic Logging (SOP 3-5)
- Field Logbook Content and Control (SOP 4-1)
- Photographic Documentation of Field Activities (SOP 4-2)
- Well Development and Purging (SOP 4-3)
- Field Equipment Decontamination at Nonradioactive Sites (SOP 4-5)
- Control of Measurement and Test Equipment (SOP 5-1)

All of these SOPs are included in Appendix A.

4.1 Mobilization / Demobilization

Prior to the mobilization for field activities, a field-planning meeting will be conducted by the CDM project manager (PM) and attended by the field staff and a member of the CDM QA staff. The agenda will be reviewed and approved by the QA staff prior to the meeting. The meeting will briefly discuss and clarify:

- Objectives and scope of the fieldwork
- Equipment and training needs
- Communication requirements
- Field operating procedures, schedules of events, and individual assignments
- Required QC measures
- Documents governing field work that must be on site
- Any changes in the field plan documents

A written agenda, reviewed by the CDM QA staff, will be distributed and an attendance list signed. Copies of these documents will be maintained in the project files. Additional meetings will be held when the documents governing fieldwork require it or when the scope of the assignment changes significantly.

The field team personnel will perform the following activities before initiating sample collection:

- Review and understand the SAP (comprised of the FSP and QAPP)
- Review and understand the Site health and safety plan (HASP) (Appendix B) to determine health and safety protocols for performing Site work
- Ensure that all sample analyses are scheduled through designated EPA/CDM laboratories
- Obtain required sample containers and other supplies
- Locate overnight shipping service (FedEx or equivalent) and/or laboratories, and note hours-of-operation
- Obtain and check field sampling equipment
- Obtain and check field supplies, including personal protective equipment (PPE)
- Verify procurement of all other necessary equipment, supplies, and subcontractors
- Obtain utility locate information as required for Site activities.

4.2 Equipment and Supplies

A preliminary list of equipment and supplies which will be required for the RI is presented in Table 4-1. For analyses to be performed at subcontract laboratories, the laboratories will provide all sample containers and any preservatives used to collect and contain samples. All sample containers will be pre-cleaned and traceable to the facility that performed the cleaning.

4.3 Field Documentation

Information and notations will be recorded as required in the applicable field logbook in accordance with CDM's SOP 4-1, Field Logbook Content and Control (Appendix A).

4.4 Field Instrument Calibration and Maintenance

Field equipment (pH/conductivity meter, water quality multi-meter, HACH ferrous iron kit) used for measuring, monitoring, or analytical purposes is calibrated and maintained periodically to assure accuracy within specific limits set by the equipment manufacturer or designated rental company. A copy of the calibration information will be provided for all rental equipment and will be maintained in the project files. The field team will be required to calibrate and field check the field equipment per the manufacturer's procedures manual. Information related to the field calibration will be noted on the appropriate field forms or field logbook. This information should include, at a minimum, the instrument identification number, date and time of calibration, calibration standard used, the person performing calibration, adjustments made, any problems noted during calibration, and a record of calibration measurements.

4.5 Photographic Documentation

Photographs will be taken at each sample location and at any place that the field team determines necessary. These photographs will be taken in accordance with CDM's SOP 4-2, Photographic Documentation of Field Activities (Appendix A).

4.6 Test and Sample Location Documentation

Test locations (surface material or surface water sample locations) will be located primarily through the use of a GPS unit. GPS coordinates will also be collected at existing monitoring wells. If GPS cannot successfully be used to determine test locations due to heavy forest cover, locations will be determined using field surveying methods such as compass and measuring tape. Due to the steep terrain present at the Site, clinometers will be required to compute the slope angle and corresponding horizontal distance. If a GPS reading can be collected at the reference locations, the azimuth angle and distance from the unknown location may be entered into the offset function in the GPS instrumentation. The unknown location can then be logged using the offset function. Measurement of elevation may also be required with the use of a pressure altimeter.

Surface water sample locations will be marked in the field using steel T-posts and markings or other adequate means to ensure that sample locations remain consistent throughout the duration of monthly and quarterly sampling events while not presenting a safety hazard. Surface material sample locations will be marked using wood stakes and flagging as necessary to collect all necessary sample location information (e.g. GPS coordinates). Surface water sampling locations will also be documented using digital photographs.

The GPS unit will have wide area augmentation system (WAAS) capability or similar enhancements and post-processing differential correction to improve measured coordinate accuracy. The GPS unit will be set to record sample locations in the North American Datum (NAD) 83, Oregon State Plane coordinate system. If this coordinate system is not available on GPS unit, the coordinate system used should be clearly noted in the field logbook. The manufacturer's instructions for use of the GPS unit and enabling WAAS capability (if available in the region) will be followed. Direct readouts of horizontal and vertical coordinates for test locations will be recorded in the field logbook or appropriate field forms along with test location ID, and electronic data in raw form and reflecting post-processing differential corrected locations will be archived as electronic files.

4.7 Surface Material Sample Collection

Collection of surface soil and waste rock samples will be conducted in accordance with CDM's SOP 1-3, Surface Soil Sampling (Appendix A). Grab surface soil and waste rock samples will be analyzed in the field for paste pH and conductivity measurements and lithologic logging as discussed in Section 4.7.1 below. Based on the results of the paste pH and conductivity tests and lithologic logging, a subset of sample locations (approximately 20 percent) will have samples collected for total metals, ABA parameters, and modified SPLP at off-site laboratories. Electron microprobe (mineralogy) analyses on a subset of approximately 10 percent of samples will also be conducted at an off-site laboratory. Samples will be selected for laboratory analyses in order cover the range of paste pH and conductivity results observed (i.e. high to low pH and high to low conductivity), with the intent of adequately characterizing the geochemical characteristics of the different geologic materials present at the Site.

Figure 3-1 indicates the areas where surface material sample collection is anticipated. Within surface disturbance areas and waste rock piles, a grid pattern will be generally used in the field for the collection of paste pH measurements and soil sample collection. Along roadways indicated in Figure 3-1, sample locations will be spaced at regular intervals along the roadway. Planned grid spacing and sampling intervals along roadways are presented in Table 3-1. Specific locations for paste pH and conductivity measurements will be selected in the field by the project geochemist and/or field team leader (FTL) based on visual evaluation of lithology, sulfide mineralization, and secondary alteration. Specific details on selection of paste pH and conductivity sample locations were provided in Section 3.2. A hand tool, such as a stainless steel trowel or disposable plastic trowel, will be used to collect surface material samples. Samples will be collected between depths of 0 – 6 inches below ground surface. The material collected from each location will be visually logged and then analyzed for paste pH and conductivity as discussed in Section 4.7.1 below. Selected samples for off-site chemical analyses will be placed in labeled sample jars or Whirl-Pak™ bags. Sample custody will be maintained in accordance with CDM's SOP 1-2, Sample Custody (Appendix A). Samples will not be processed in the field (i.e., drying, splitting, sieving); these tasks will occur at a CDM soil preparation laboratory prior to submittal for chemical analysis at an off-site laboratory, as described in Section 4.7.2 below.

After sample collection, wood stakes and/or survey flagging will be placed at the sample location. The sample location number/identification will be placed on the survey flag using a permanent marker. General sample locations and field observations will be recorded in the field logbook. The sample locations will be photographed as discussed in Section 4.5, and the sample location will then be determined using GPS or other methods as discussed in Section 4.6.

4.7.1 Paste pH and Conductivity Field Measurements and Lithologic Logging

The results from paste pH and conductivity measurements and lithologic logging will be used to determine which samples will be sent to an off-site laboratory for chemical analysis. Field paste pH and conductivity measurements and lithologic logging will be completed by following the procedures indicated below:

1. Collect soil/waste rock using a stainless steel or disposable plastic trowel from a depth of 0 – 6 inches below ground surface

2. Visually log sample according to CDM's SOP 3-5, Lithologic Logging (Appendix A), with the following project-specific modifications. The specific lithologic information recorded for each sample will be limited to the following:

   - Identification of soil classification using the Unified Soil Classification System (USCS) abbreviations (use of sieves not required)

   - Description of primary lithology

   - Description of sulfide mineralization including presence of pyrite chalcopyrite, and sphalerite

   - Description of alteration minerals including iron oxide/hydroxide and jarosite group minerals

   - Test for presence of calcite with 10% hydrochloric acid solution. Care will be taken to ensure that hydrochloric acid is kept separate from material to be tested for paste pH or samples for laboratory analysis.

   - Identification of color using a Munsell color chart

3. Remove rocks and gravel from the sample

4. Place approximately 1 inch of finer soil material (i.e., less than approximately 1/16-inch) in the bottom of a disposable plastic cup

5. Add distilled water to sample to make a paste (approximately 2:1 liquid:solid ratio by volume). Mix with disposable plastic stirrer or swirl cup to make paste

6. Measure pH and conductivity with probe and record measurements on appropriate field forms or in field logbook

4.7.2 Offsite Chemical Analyses

Samples collected for offsite chemical analyses will be prepared for shipment in accordance with CDM's SOP 2-1, Packaging and Shipping Environmental Samples, (Appendix A). Samples to be submitted for total metals, ABA, modified SPLP, and electron microprobe analyses will be shipped to a CDM soil preparation laboratory for drying, splitting, and sieving (for total metals analysis only) prior to being shipped to the CLP or subcontract laboratory for analysis. Samples will be dried and four to five sample splits will be created for each sample. One of the splits will be sieved with a 60-mesh (250 μm) screen, and materials smaller than 250 μm will be submitted for total metals analyses. One split will be archived for potential future processing/analyses, and the remaining splits will be submitted for ABA, SPLP, and electron microprobe analyses (all three analyses to be conducted at separate laboratories). Sample custody will be maintained during this time period in accordance with CDM's SOP 1-2, Sample Custody (Appendix A).

EPA CLP laboratories and CDM subcontracted laboratories will be used for off-site chemical analyses. A listing of the sample container, holding times, and preservative requirements are summarized in Table 5-2 in Section 5.

4.8 Seep and Spring Surveys

As discussed in Section 3.3, two seep and spring surveys will be conducted at the Site in order to identify areas of ARD discharge and unaffected groundwater discharge to support Site hydrogeological evaluation. The process of the seep and spring surveys will consist of visual inspections in the upper Middle Creek, upper South Fork Middle Creek, West Fork Canyon Creek, and Russell Creek drainages. If seeps or springs are identified, the water quality will be sampled for field parameters including pH, conductivity, DO, ORP, and temperature. If insufficient flow is present at the seep or spring to completely immerse the multi-meter probe, water will be collected into a dedicated polyethylene bottle to facilitate measurement of field parameters.

Water samples for laboratory analysis will be collected from identified seeps or springs at the discretion of the FTL. Procedures for collecting these samples will follow those of normal surface water samples (Section 4.9). The flow rate of the seeps or springs will be measured or estimated visually, and the location of the seeps will be recorded. Seep or spring locations will be documented using GPS or other methods as discussed in Section 4.6. Based on information gained from spring and seep surveys, new surface water locations may be added to the surface water monitoring program based on EPA direction and consultation.

4.9 Surface Water Sample Collection

Surface water samples will be collected during both monthly and quarterly sampling events as discussed in Section 3.4. Figure 3-2 indicates locations where surface water samples will be collected during monthly sampling events, and Figures 3-3 and 3-4 indicate sampling locations for the quarterly events. In addition to the locations indicated on these figures, additional surface water samples may be collected from seeps, springs, and other surface water features to be identified during the seep and spring surveys.

4.9.1 Water Sample Collection

Collection of surface water samples will be conducted in accordance with CDM's SOP 1-1, Surface Water Sampling (Appendix A). Samples are planned for collection starting at downstream sampling locations and progressing upstream, as indicated in SOP 1-1. Surface water samples will be analyzed in the field for water quality parameters (pH, conductivity, DO, ORP, alkalinity, and temperature). Field alkalinity will be measured during sampling using HACH field test kits or equivalent. Water samples will then be collected for analysis of total and dissolved metals, TDS, TSS, alkalinity, acidity, hardness, major anions/cations, nitrate/nitrite, and ammonia at an off-site laboratory. All samples will be collected in pre-cleaned and pre-preserved sample bottles (for samples requiring preservation). Samples collected for dissolved metals and anions will be filtered in the field using a 0.45-µm filter. Filtration will be completed using a peristaltic pump and dedicated tubing with an in-line 0.45–µm filter cartridge attached to the tubing. Approximately 200 milliliters (mL) of deionized water, followed by a minimum of 50 mL of sample water, will be passed through the filter prior to filling sample containers. Sample filtration will be completed prior to sample preservation, and will be completed as soon as possible following sample collection. Samples that require preservatives will not be collected directly into the pre-preserved sample containers, but will first be collected in a dedicated container and then transferred into the appropriate pre-preserved containers. This process reduces the likelihood of losing preservatives during the sampling process.

The majority of surface water samples will be collected as grab samples from near the middle of the stream at each location. Sample bottles will be immersed directly into the stream if the water depth is of sufficient depth; otherwise, samples will be collected using a peristaltic pump and dedicated tubing. For downstream locations near the confluence of Cow Creek and Middle Creek (sample locations M13.0, C1, C2, C3, and WF1), samples will be collected as depth-width integrated samples. CDM anticipates collecting depth-integrated samples at 10 equal-width verticals (i.e., composite from entire depth of stream) within the streams. Samples from each vertical will be combined within a churn splitter and mixed prior to filling sample containers. The process for depth-width integrated sample collection is described in CDM Federal SOP 1-1, Surface Water Sampling. Due to the size, depth and flow rates at these locations, samples are planned for collection using a small raft secured by ropes tied across the stream channel. If high flow rates at these locations (i.e. flood or spring runoff conditions) make sampling from a raft or boat unsafe, then alternative methods of sample collection will be evaluated.

Sample custody will be maintained in accordance with CDM's SOP 1-2, Sample Custody (Appendix A). Samples will be submitted to the designated laboratory in accordance with CLP Guidance for Field Samplers (Appendix C) and the CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples. EPA CLP laboratories and CDM subcontracted laboratories will be used for off-site chemical analyses. A listing of the sample container, holding times, and preservative requirements are summarized in Table 5-3 in Section 5.

After sample collection, field observations will be recorded in the field logbook. The sample locations will be photographed as discussed in Section 4.5, and the location of the samples will then be determined using GPS as discussed in Section 4.6. During the initial sampling event at the Site, sampling locations will be marked using steel T-posts or other means to ensure that subsequent sampling events do not deviate from the specified locations.

4.9.2 Flow Rate Measurement

During each sampling event, flow will be measured or estimated using some combination of portable electronic velocity meter, bucket and stopwatch, portable flat plate weir, portable cutthroat flume, sudden injection tracer test, or visual estimates. Determination of the appropriate method for flow measurement will be made by field personnel. Locations where the stream width is greater than approximately 3 feet will have velocity and depth measured at equal-width increments in order to calculate a more accurate estimate of the total flow rate. At some surface water sampling locations (e.g. seeps and springs), flow rate may be estimated visually. Flow velocity and/or rate will be recorded in field logbooks or field water sampling forms as appropriate.

4.10 Groundwater Sample Collection

Groundwater samples will be collected from existing Site monitoring wells identified on Figure 3-5.

4.10.1 Well Inspections and Water Level Measurements

During the first sampling event at the Site, each groundwater well will be inspected for any signs of damage to the well casing. If the wells are usable, a synoptic set of static water levels will be measured at all wells at the beginning of the sampling round, in accordance with the CDM Federal SOP 1-6 Water Level Measurement. Based on water levels measured during this synoptic event and reported screen intervals of wells, the depth to set the sampling pump will be determined by the FTL.

4.10.2 Purging

All monitoring wells will be purged in accordance with CDM Federal SOP 4-3, Well Development and Purging, utilizing the volumetric purging method described in

Section 5.2 of the SOP. A minimum of three well casing volumes will be evacuated from each well prior to sampling. If three well volumes cannot be removed from the well due to slow recharge conditions, the volume of water removed will be recorded on the appropriate field forms. All wells will be purged using a 2-inch bladder pump, or equivalent. Disposable bailers will be present on-site in case sampling using pumps is not feasible due to slow groundwater recharge or inability to place pumps inside the wells.

As the wells are purged, water quality parameters (i.e., ORP, pH, temperature, DO, conductivity, and turbidity) will be monitored after each well volume. If possible, in-line monitoring equipment will be used to increase the reading stability. Field ferrous iron (Fe^{2+}) and alkalinity will be measured immediately prior to sampling using HACH field test kits or equivalent. These field analyses will be conducted in accordance with manufacturer's recommendations. The water quality parameters will be recorded on a groundwater purge form or logbook. Purging will be continued until three calculated well volumes have been purged.

4.10.3 Well Sampling

All samples will be collected in accordance with the CDM Federal SOP 4-3, Well Development and Purging. Samples will be collected from the pump discharge tubing after completion of purging as described in Section 4.10.2. If pumping is not feasible due to slow recharge conditions or inability to place a pump in the well, groundwater samples will be collected using bailers in accordance with CDM Federal SOP 1-5, Groundwater Sampling with Bailers. Samples will be collected for analysis of dissolved metals, pH, conductivity, TDS, alkalinity, acidity, hardness, major anions/cations, nitrate/nitrite, and ammonia at an off-site laboratory. Water samples to be collected for dissolved metals will be filtered in the field using a 0.45-µm filter prior to preservation. Filters will be placed in-line with the well sampling tubing.

Sample custody will be maintained in accordance with CDM's SOP 1-2, Sample Custody (Appendix A). Samples will be submitted to the designated laboratory in accordance with CLP Guidance for Field Samplers (Appendix C) and the CDM Federal SOP 2-1, Packaging and Shipping of Environmental Samples. EPA CLP laboratories and CDM subcontracted laboratories will be used for off-site chemical analyses. A listing of the sample container, holding times, and preservative requirements are summarized in Table 5-4 in Section 5.

4.11 Flume and Electronic Data Logger Installation

As discussed in Section 3.6, CDM currently plans to install flumes at Formosa Adit, location MXR, and at a location in upper South Fork. A fiberglass flume is currently in place at the Formosa Adit. This sample location currently generates very large quantities of iron hydroxide sludge, and the flume is currently clogged with iron precipitates. This flume will be cleaned and evaluated for suitability. If necessary this flume will be replaced. A doppler-style electronic flow meter and datalogger will be installed with the flume. This type of instrument has the advantage of requiring no contact whatsoever with the water passing through the flume. This approach is expected to provide accurate flow data, with relatively less maintenance than pressure transducers (which must be submerged within a stilling well). The doppler flow meter would be attached to a data logger, and flow data would be downloaded during routine surface water sampling events.

Fiberglass flumes are also planned to be installed at location MXR and at a location within upper South Fork. These flow monitoring devices are planned to be H-flumes or Parshall flumes. The flumes will be set in concrete and concrete wing walls will be installed at the upgradient side to force water to flow into, rather than around the flumes. The size of the flumes will be selected based on available data and professional judgment. Flumes will be installed during a season with low flow conditions to allow for easier installation in the stream channel. Doppler-style electronic flow monitoring instrumentation and data loggers will also be installed at these locations.

At MXR and in the Upper South Fork flumes, water quality instrumentation will also be installed. CDM plans to install electronic water quality monitoring instrumentation to collect continuous pH, conductivity, and temperature data at these locations. Although precipitates are also present at these sites, the precipitate load is significantly lower than at the Formosa Adit, and the potential to effectively use instruments that are submerged in the water is better at MXR and upper South Fork. Despite lower precipitate loads at these locations, it is still anticipated that maintenance and cleaning of the instrumentation will be required at least monthly. Data loggers at these locations would also be downloaded on a regular basis during routine surface water sampling.

4.12 Equipment Decontamination

Decontamination methods will follow CDM's SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites (Appendix A).

As indicated in Section 4.9.1, sampling at locations that use non-dedicated sampling equipment will proceed from downstream to upstream (least contaminated to most contaminated). Non-dedicated equipment used for surface water sample collection (i.e. churn splitter) used during this sampling procedure will be decontaminated by rinsing with deionized water immediately after sample collection. Prior to collection of the next sample, the equipment will be thoroughly rinsed in the stream at the next sample location. If concentration trends are not known, or if it is necessary to re-use sampling equipment from a high concentration area to a low concentration area, then the equipment will be decontaminated as described in SOP 4-5, Section 5.3, including the dilute nitric acid rinse necessary when sampling for inorganic constituents.

Small non-dedicated soil sampling equipment such as shovels or trowels will be decontaminated by removing adhered soil from the blade or other parts in contact with the subsurface using a brush or similar tool. Rinsate water will be discharged to the ground surface at the Site.

Dedicated one-use (disposable) sampling equipment such as trowels or scoops, aluminum pans, and/or plastic bags or containers will be used to collect soil samples and therefore will not require decontamination.

PPE will be cleaned using a brush and potable water to remove gross contamination and adhered soil before disposal.

Personnel performing sampling tasks will follow the personnel decontamination procedures specified in the HASP (Appendix B).

4.13 IDW Management

IDW will include the PPE worn by the field samplers, dedicated (disposable) sampling equipment and supplies, purge water from groundwater sampling, and decontamination liquids created by cleaning non-dedicated sampling equipment. IDW will be managed in accordance with CDM Federal SOP 2-2, Guide to Handling Investigation-Derived Waste.

PPE and disposable sampling equipment will be handled as general site refuse and be disposed of as municipal solid waste.

Groundwater sampling purge water will be disposed of on the site.

Due to the small volume of decontamination water created for small sampling equipment, this IDW will be disposed of on the ground next to the sample location. Containerization of the decontamination water will not be required.

IDW sampling will not be required for any IDW management tasks under this SAP.

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Section 5
Project Management and Data Quality Objectives

This QAPP (Part II of the SAP) supports the initial RI field program. This QAPP was prepared in accordance with EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, QA/R-5, Interim Final (EPA 2001). This section covers the basic area of project management, including the project organization, background and purpose, project description, quality objectives and criteria, special training, and documentation and records. Appendix A includes a copy of applicable CDM SOPs (CDM 2005a).

5.1 Project Organization

Organization and responsibilities specific to this study are discussed in this section. CDM will provide the necessary technical and field staff to perform sampling and reporting aspects of the project, with assistance from EPA, USGS, and BLM personnel as necessary. When personnel from EPA, USGS, and BLM perform sampling and reporting tasks for this investigation, the procedures outlined in this SAP will be followed by all personnel, and oversight of all personnel will be the responsibility of CDM. Analytical services are provided through the EPA CLP (metals analyses), the EPA Region 10 Manchester Environmental Laboratory, and a CDM subcontracted analytical laboratory to be determined through the procurement process. Table 5-1 includes contact information for key project personnel.

5.1.1 EPA Region 8 and 10 Management

The EPA Project Officer, Ms. Jodi Powell, is responsible for:

- Tracking work assignment budgets
- Reviewing work plans
- Maintaining communication with the Remedial Project Managers (RPMs) and EPA contractor contract personnel

The EPA RPM, Ms. Denise Baker-Kircher, has responsibility for the RI and is CDM's primary contact for coordinating work at the Site. Ms. Baker-Kircher is responsible for:

- Defining sampling scope
- Defining data quality objectives
- Selecting sampling team and contractors
- Reviewing all project deliverables

- Maintaining communications with the sampling team for updates on the status of the activities
- Reviewing monthly status reports
- Providing oversight of the sampling
- Assuring that plans are implemented according to schedule
- Informing personnel of any special considerations associated with the project
- Providing site access
- Reviewing work progress for each task to ensure that budgets and schedules are met
- Reviewing and analyzing overall performance with respect to goals and objectives
- Using sampling data in site remediation decision-making
- Ensure samples are collected consistent with project objectives
- Ensure samples are collected in a manner so that data represent actual investigation conditions

The EPA Region 10 QA Manager, Ms. Gina Grepo-Grove, is responsible for approving quality assurance project plans for projects within Region 10. The Regional Sample Control Coordinator, Ms. Bethany Plewe, is responsible for coordinating laboratory support and tracking samples and analytical results. Ms. Plewe is also the point of contact for communication to the EPA contract laboratories.

5.1.2 CDM Management

CDM is a RAC contractor to EPA Region 8 through the EPA RAC 2 Region 8 contract. EPA management is described in Section 5.1.1.

The following personnel from CDM are assigned to this project:

Project Manager	Dee Warren
Project Geochemist	Mark Nelson
Project Engineer	Nick Anton
Field Team Leader	Nick Anton
Quality Assurance Manager	Doug Updike
Project Quality Assurance Coordinator	Kimberly Zilis

Data Manager | To be determined

5.1.2.1 Project Manager

The CDM PM for the RI is Ms. Dee Warren. Ms. Warren, as PM, is responsible for the overall management and coordination of the following activities:

- Maintaining communications with EPA regarding the status of this project
- Preparing monthly status reports
- Supervising production and review of deliverables
- Reviewing analytical results
- Overseeing operation and maintenance activities
- Tracking planned budgets and schedules
- Incorporating and informing EPA of changes in the work plan, SAP, HASP, and/or other project documents
- Notifying the responsible QA staff immediately of significant problems affecting the quality of data or the ability to meet project objectives
- Scheduling personnel and material resources
- Procuring laboratory and non-laboratory subcontractors, when necessary
- Implementing field aspects of the investigation, including this SAP and other project documents
- Organizing and conducting periodic meetings with field and project personnel
- Implementing the QC measures specified in CDM's RAC 2 Region VIII Quality Management Plan (QMP) (CDM 2005b), this QAPP, and other project documents
- Implementing corrective actions resulting from staff observations, QA/QC surveillances, and/or QA audits
- Providing oversight of data management
- Providing oversight of daily and periodic report preparation

5.1.2.2 Project Geochemist

The CDM Project Geochemist for the RI is Mr. Mark Nelson. Mr. Nelson is responsible for determining the physical and chemical data needed for RI evaluations and ensuring the collected data is acceptable for use in RI evaluations. Mr. Nelson will provide consultation in the field and determine samples to be sent for off-site laboratory analysis in order to meet project requirements. Mr. Nelson will incorporate the validated data into evaluations within the RI report.

5.1.2.3 Project Engineer

The CDM Project Engineer for the RI is Mr. Nick Anton. Mr. Anton is responsible for determining the physical and chemical data needed for RI evaluation and ensuring the collected data is acceptable for use in subsequent RI evaluations. Mr. Anton will incorporate the validated data into evaluations within the detailed RI report.

5.1.2.4 Field Team Leader

The CDM FTL for the RI is Mr. Nick Anton. Mr. Anton will be responsible for all field activities performed under this SAP.

He will also be responsible for ensuring that health and safety protocols specified in the HASP are carried out during these activities. His responsibilities related to health and safety are specified in the HASP (Appendix B).

Mr. Anton is responsible for the following field activities:

- Coordinating work activities including testing, field measurements, logging, and sampling
- Ensuring that the protocols specified in the HASP are carried out during field activities
- Identifying problems, resolving difficulties in consultation with EPA and CDM staff, implementing and documenting corrective action procedures at the facility team level, and providing communication between the sampling team and project management
- Ensuring that sampling is conducted in accordance with the SAP and that the quantity and location of all samples meet the requirements of this SAP
- Maintaining proper chain-of-custody forms and sample labels for proper transfer of the samples to the analytical laboratory
- Scheduling and conducting required sampling activities
- Preparing and shipping samples to the offsite analytical laboratories
- Maintaining sampling and monitoring equipment and ensuring that the required sample bottles and preservatives are at the Site

5.1.2.5 Quality Assurance Manager

CDM's QA manager, Mr. Doug Updike, implements the QA program. The QA manager is independent of the technical staff and reports directly to the president of CDM or equivalent on QA matters. The QA manager, thus, has the authority to objectively review projects and identify problems and the authority to use corporate resources as necessary to resolve any quality-related problems.

5.1.2.6 Project Quality Assurance Coordinator

The QA coordinator for this project, Ms. Kimberly Zilis, reports to Mr. Doug Updike on QA matters. Under the oversight of Mr. Updike, she is responsible for the following:

- Verifying that corrective actions resulting from staff observations, QA/QC surveillances, and/or QA audits are implemented
- Reviewing and approving the project-specific plans
- Directing the overall project QA program
- Maintaining QA oversight of the project
- Reviewing QA sections in project reports, as applicable
- Reviewing QA/QC procedures applicable to this project
- Auditing selected activities of this project performed by CDM and subcontractors, as necessary
- Initiating, reviewing, and following up on response actions, as necessary
- Maintaining awareness of active projects and their QA/QC needs
- Consulting with the CDM QA manager, as needed, on appropriate QA/QC measures and corrective actions
- Conducting internal system audits to check on the use of appropriate QA/QC measures, if applicable
- Arranging performance audits of measurement activities, as necessary
- Providing monthly written reports on QA/QC activity to the CDM QA manager
- Receiving copies of the laboratory data packages from the EPA laboratories and CLP laboratories

5.1.2.7 Data Manager

The CDM data manager for this project will be determined prior to commencement of field activities. The data manager will receive the data directly from the laboratory, and coordinate with Ms. Zilis to ensure a QA/QC review of the data package is performed, including checking that the data with backup instrument calibration and standard information is included.

5.2 QAPP Organization, Background, and Purpose

This QAPP is organized in accordance with requirements for quality assurance for project plans, EPA QA/R-5 March 2001 (EPA 2001). This section (Section 5.0) presents project management and introductory information. Section 6.0 provides guidance for measurement and data acquisition. Section 7.0 describes assessment and oversight aspects of the project, and Section 8.0 details data validation and usability issues. References are provided in Section 9.0.

Project background and information for the Site is provided in Section 2 of this SAP. The objective of the RI investigation is discussed in Section 1.1 of this SAP. The purpose of this QAPP is to provide guidance to ensure that all environmentally related data collection procedures and measurements are scientifically sound and of known, acceptable, and documented quality and conducted in accordance with the requirements of the project.

5.3 Project Description

A description of this project is provided in Section 1 of this SAP. Samples will be analyzed for parameters listed in Tables 5-2 through 5-4. Sampling activities and all associated procedures are described in detail in this SAP.

5.4 Quality Objectives and Criteria for Measurement

This section provides internal means for control and review of the project so that environmentally related measurements and data collected are of known and acceptable quality. The subsections below describe the data quality objectives (DQOs) (Section 5.4.1) and data measurement objectives (Section 5.4.2).

5.4.1 Data Quality Objectives

The DQO process is a series of planning steps based on the scientific method that are designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended purpose. EPA has issued guidelines to help data users develop site-specific DQOs (EPA 2006). The DQO process is intended to:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect the data
- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the design

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps, and the output from each step influences the choices that will be made later in the process. These steps include:

- Step 1: State the problem
- Step 2: Identify the decision
- Step 3: Identify the inputs to the decision
- Step 4: Define the study boundaries
- Step 5: Develop a decision rule
- Step 6: Specify tolerable limits on decision errors
- Step 7: Optimize the design

During the first six steps of the process, the planning team develops decision performance criteria (i.e., DQOs) that will be used to develop the data collection design. The final step of the process involves developing the data collection design based on the DQOs. A brief discussion of these steps and their application to this QAPP is provided below.

5.4.1.1 Step 1: State the Problem

The purpose of this step is to clearly define the problem so that the focus of the study is unambiguous.

Historical operations at the Formosa mine site have resulted in discharge of ARD and metals contamination into surface waters. In addition, mine waste and contaminated soil are present at the ground surface and within backfilled underground mine workings. The mine waste and contaminated soil have the potential to be acid-generating and to leach metals into surface water and groundwater. Additionally, subsurface contamination may be transported to the surface through seeps and springs.

The sampling and analyses detailed in this SAP will support characterization of physical characteristics, source materials, and nature and extent of contamination, as well as refine development of the conceptual site model for Formosa Mine. This investigation is designed to evaluate the geochemical characteristics of source materials at the Site, and assess impacts to surface water and groundwater at the Site. All data collected during this investigation will be utilized to evaluate remedial options during the FS evaluations. Data will also be utilized to support future human health and ecological risk assessments at the Site. Required tests, analyses and methods for each media to be sampled during this investigation are provided in Tables 5-2 through 5-4.

The planning team members include Denise Baker-Kircher, Martha Lentz and Joe Goulet of EPA; Kathleen McCarthy and Annette Sullivan of USGS; Greg Aitken of ODEQ; John Barber of BLM; and Dee Warren, Mark Nelson, and Nick Anton of CDM. The decision maker is Denise Baker-Kircher. All personnel conducting this field investigation will be from CDM or one of its subcontractors, with the potential for assistance by other planning team members (EPA, USGS, ODEQ, or BLM) and/or other government agencies or private organizations. Any field work performed by others will be under supervision and oversight of CDM or EPA personnel.

5.4.1.2 Step 2: Identify the Decision

This step identifies what questions the analyses will attempt to resolve and what actions may result. Specific decision questions for this study include:

Surface Water:

- What is the nature and extent of surface water contamination emanating from the Formosa Mine, and are the concentrations observed in exceedance of water quality screening criteria?

- What is the quantity and water quality of the drainage from the Formosa adit and other ARD sources on the Site, and how does the flow rate and quality vary over time?

- What is the quantity and water quality of flow of ARD-impacted streams at the Site, and how does the flow rate and quality vary over time

Groundwater:

- What is the nature and extent of groundwater contamination present at the Site, and how does groundwater contamination contribute to surface water impacts through springs and seeps?

Surface Soil and Waste Rock

- What is the nature and extent of surface soil and waste rock contamination present at the Site, and are metals concentrations greater than screening criteria for human health?

- What is the potential for mine waste rock and soil in surface disturbance areas on the Site to be ARD-generating, and what is the potential for these materials to leach contaminants (i.e. metals) into surface waters or into the subsurface?

- What is the areal extent and volume of mine waste rock and soil at the Site that is capable of generating ARD and/or leaching contaminants to surface waters?

The alternative actions include either further investigation or no further action. The decision statement is whether or not answers to the decision questions are known. If yes, then no further action is necessary. If no, then further investigations may be necessary

5.4.1.3 Step 3: Identify the Inputs to the Decision

The purpose of this step is to identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement. The information required to resolve the decision statement consists of the following:

- Chemical and geochemical characteristics of surface water, groundwater, and exposed mine waste and soil
- Information regarding temporal and seasonal variations in flow quantity and water quality at the Formosa adit, other ARD sources, and in ARD-impacted surface waters
- Information regarding location, quality, and quantity of ARD discharges from previously unidentified groundwater seeps and springs

The sources for this information are data collected in the field and laboratory analysis of samples collected during this investigation. The sampling locations and procedures are identified in Sections 3 and 4 of the FSP, respectively. The testing and analytical methods to be used are listed in Tables 5-2 through 5-4.

5.4.1.4 Step 4: Define the Boundaries of the Study

This step defines the spatial and temporal boundaries to which this investigation will apply and determines when and where data should be collected.

This investigation will be conducted within the areas shown in Figures 3-1 through 3-5. Boundaries were delineated to characterize the nature and extent of surface water contamination. The boundaries of the soil and waste rock investigation are presented on Figure 3-1, and were selected, generally, to include areas of surface disturbance and suspected contamination in the vicinity of the Formosa Mine and former processing areas. With the exception of sampling of existing groundwater wells, this study is focused on surface water and mine wastes and soils exposed at the surface to a depth of approximately 6 inches.

The temporal boundaries of the study are dependent on the duration of the RI field work, which is tentatively scheduled to begin in the summer/fall of 2009 and continue through the RI/FS process. Monthly and quarterly sampling of surface water and groundwater is planned during this time, and continuous measurement of flow quantity at three locations on the Site are planned. Surface material sampling and spring and seep sampling will also be conducted at this time. Data collected during this time frame will be utilized to evaluate future remedial options at the Site; therefore the temporal variation in water quality and quantity has a degree of variability and uncertainty, and will be subject to evaluation and judgment regarding future RA decisions for the Site.

Groundwater and surface water sample locations correspond to previous sample locations, though additional sampling locations may be added based on observations during site reconnaissance and initial sampling efforts. The data populations needed for decision-making include the chemical concentrations (including both detected and non-detected values) for all the media sampled and analyzed. Constraints that could potentially interfere with data collection are inaccessible sampling locations. Inaccessibility of sampling locations may be due to ground surface conditions (e.g.

topography or surface obstructions) or due to seasonal weather and surface water flow conditions. Alternative locations will be selected if proposed sample locations are inaccessible.

5.4.1.5 Step 5: Develop a Decision Rule

The purpose of this step is to define the parameters of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing among alternative actions.

The parameters of interest are the concentrations of constituents identified in the separate media, as well as the flow rate and volume of ARD discharges and contaminated surface waters. At this time, Site-specific preliminary remediation goals (PRGs) have not been developed for the Site. In the absence of Site-specific PRGs, decisions regarding contaminants in surface water will be based on the comparison of the laboratory analytical results to the screening criteria set forth by the State of Oregon. The analytical methods stated in Section 5.4.4 were chosen to ensure that the reporting limits are below these criteria. Decisions regarding contaminants in surface soil and waste rock will be based on evaluation of field paste pH and conductivity data, comparison of the laboratory total metals results to EPA soil screening levels and ODEQ soil risk based concentration (RBC) values, comparison of SPLP results to the surface water screening criteria, and evaluation of ABA data to determine the potential for the materials sampled to generate ARD. Screening criteria for total metals results will be further refined during the development of the risk assessment for the Site.

If the analytical result for a particular media/constituent is above the screening criteria, then the associated location for that sample is considered contaminated for that constituent. In this instance, the extent of contamination (for a particular constituent or multiple constituents) will be described to include at a minimum the area of the contaminated location. For evaluation of ABA data, materials sampled will be rated on their potential to generate ARD. The degree (i.e., high, moderate, low) of potential for ARD generation will be described to include at a minimum the area of the sample location and/or other locations containing similar geologic materials. For evaluation of field paste pH data, samples with paste pH less than 4.5 may be considered acid generating. Potential for acid generation will then be verified with ABA results. The relative background paste conductivity of surface materials present at the Site is unknown at this time; therefore, the degree of contamination based on paste conductivity will be evaluated in the field and verified with SPLP results.

If the chemical characteristics of the media are identified from this investigation to sufficiently support RI evaluations, then no further investigation will be conducted. If chemical characteristics of the media are not identified from this investigation to sufficiently support RI evaluations, then either further investigation will be conducted or it may be decided that although not completely known, enough information has been collected to continue and no further investigation will be conducted.

5.4.1.6 Step 6: Specify Tolerable Limits on Decision Errors

Decision makers' tolerable limits on decision errors, which are used to establish performance goals for the data collection design, are specified in this step. Decision makers are interested in knowing the true value of the physical and chemical characteristic analyses. Since analytical data can only estimate these values, decisions that are based on measurement data could be in error (decision error). There are two reasons why the decision maker may not know the true value of the constituent concentration. These are:

1. Concentrations may vary over time and space. Limited sampling may miss some features of this natural variation because it is usually impossible or impractical to measure every point of a population. Sampling design error occurs when the sampling design is unable to capture the complete extent of natural variability that exists in the true state of the environment.

2. Analytical methods and instruments are never absolutely perfect; hence a measurement can only estimate the true value of an environmental sample. Measurement error refers to a combination of random and systematic errors that inevitably arise during the various steps to the measurement process.

The combination of sampling design and measurement error is the total study error. Since it is impossible to completely eliminate total study error, basing decisions on sample concentrations may lead to a decision error. The probability of decision error is controlled by adopting a scientific approach to select between one condition (the null hypothesis) and another (the alternative hypothesis). The null hypothesis is presumed to be true (not rejected) in the absence of evidence to the contrary. For this project, the null hypothesis is that the physical and chemical properties of the soil, surface water, and groundwater are suitable for protection of the environment and human health. The alternative hypothesis is that the physical and chemical properties of the soil, surface water, and groundwater are not suitable for the protection of the environment and human health.

A false positive, or "Type I" decision error, refers to the type of error made when the baseline condition is rejected when it is true, and a false negative, or "Type II" decision error, refers to the type of error made when the null hypothesis is not rejected when it is false. For this project, a Type I decision error would result in deciding that the constituent concentrations are above the screening criteria when they are not. A Type II decision error would result in deciding that the constituent concentrations are below the screening criteria when they are not. A Type II decision error may cause harm to the environment and/or human health, whereas a Type I decision error may cause spending money when it is not required. A Type II error is less acceptable than a Type I error.

The closer the reported concentration is to the screening level, the higher the probability that an incorrect decision will be made and, therefore, there is a gray region surrounding the screening level. Because it would be worse to harm life than spend unnecessary money, a gray region, as discussed in the DQO guidance, has been identified as the screening level minus 5 percent where the decision will be made that the null hypothesis is rejected (true value considered above screening level) and, thereby, limiting the possibility of a Type II error near the screening level. Tolerable decision limits are established outside the gray region to allow decision makers to make a decision based on professional judgment. Again, because it would be worse to harm life than to spend unnecessary money, a tolerable limit has been identified as the lower limit of the gray region plus or minus (±) 10 percent. In this area, the decision makers may decide that although the reported concentration is below the screening level or gray region, so as to not make a Type II decision error, the null hypothesis is rejected.

5.4.1.7 Step 7: Optimize the Design for Obtaining Data

The data collection program is based on information provided in this QAPP and is presented in Sections 3 and 4 of the FSP. Sample locations are selected to characterize chemical and physical characteristics of the surface water, groundwater, and surface soil and waste rock. Spatial patterns of contaminants will be determined based on the results of the comprehensive sampling event and subsequent monthly and quarterly sampling events.

5.4.2 Data Measurement Objectives

Every reasonable attempt will be made to obtain a complete set of usable field measurements and analytical data. If a measurement cannot be obtained or is rejected for any reason, the effect of the missing data will be evaluated by CDM. This evaluation will be reported to EPA with a proposed corrective action as described in Section 7.

In addition, the FSP provides guidance to ensure that the samples obtained are representative of the media to be investigated at the Site.

5.4.2.1 Quality Assurance Guidance

The field QA program has been designed in accordance with CDM's RAC 2 Region VIII QMP (CDM 2005b), Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4, (EPA 2006), and EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, QA/R-5 (EPA 2001).

5.4.2.2 Precision, Accuracy, Representativeness, Completeness, and Comparability Criteria

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are indicators of data quality. PARCC goals are established for the site characterization to aid in assessing data quality as discussed in the following paragraphs.

Precision

The precision of a measurement is an expression of mutual agreement among individual measurements of the same property taken under prescribed similar conditions. Precision is quantitative and most often expressed in terms of relative percent difference (RPD). RPD is calculated as follows:

RPD = (S-D)/((S+D)/2) *100

Where: S = Sample result
D = Duplicate result

Precision of reported results is a function of inherent field-related variability plus laboratory analytical variability. Field duplicate samples will be collected to provide a measure of the contribution to overall variability of field-related sources. Contribution of laboratory-related sources to overall variability is measured through analysis of laboratory duplicates or MSD analyses.

The acceptable precision criteria for duplicate analyses are as presented in Table 5-5.

Chemical analytical data will be evaluated for precision using field duplicates, laboratory duplicates, and MSDs in accordance with the laboratory-specific limits, methodology, or EPA CLP, National Functional Guidelines (NFG) for Inorganic Data Review (EPA 2004),

Accuracy

Accuracy is the degree of agreement of a measurement with an accepted reference or true value, and is a measure of the bias in a system. Accuracy is quantitative and usually expressed as the percent recovery (%R) of a sample result. %R is calculated as follows:

%R = SSR - SR / SA x 100

Where: SSR = Spiked sample result
SR = Sample result
SA = Actual spike concentration

Ideally, it is desirable that the reported concentration equals the actual concentration present in the sample. Acceptable QC limits for %R are either defined by NFG or method-defined, whichever is applicable. Chemical analytical data will be reviewed for accuracy using the recoveries for surrogates, MS/MSDs, and LCSs, in accordance with the acceptable QC limits described above, or as applicable.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent (1) the characteristic being measured, (2) parameter variations at a sampling point, and/or (3) an environmental condition. Representativeness is most concerned with the proper design of the sampling plan and the absence of cross-contamination of samples. Acceptable representativeness will be achieved through:

- Careful, informed selection of sampling sites
- Selection of testing parameters and methods that adequately define and characterize the extent of possible contamination and meet the required parameter reporting limits
- Proper gathering and handling of samples to avoid interference and prevent contamination and loss
- Collection of a sufficient number of samples to allow necessary characterization

Representativeness is a consideration that will be employed during all sample locations and collection efforts and will be assessed qualitatively by reviewing field procedures and actual sampling locations versus planned locations. Representativeness will be reviewed quantitatively by evaluating the method, rinsate, and trip blanks as stated in the NFGs.

Completeness

Completeness is a measure of the amount of usable data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Usability will be determined by evaluation of the PARCC parameters, excluding completeness. Those data that are validated or evaluated and are not considered estimated or are qualified as estimated or non-detect are considered usable. Rejected data are not considered usable. Completeness will be calculated following data evaluation. For this work, a completeness goal of 90 percent is projected for all analytical data. If this goal is not met, the EPA contractor project manager and EPA RPM will discuss the effect. Completeness is calculated using the following equation:

Completeness = DO/DP *100

Where: DO = Amount of usable data obtained
DP = Predicted amount of usable data

Comparability

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Standard EPA analytical methods and QC will be used to ensure comparability of results with other analyses performed in a similar manner.

5.4.3 Field Measurements

The field measurements collected during this RI will be groundwater level measurements using a water level indicator; pH, temperature, conductivity, DO, and ORP using a water quality multi-meter for groundwater and surface water samples;

ferrous iron and field alkalinity using HACH kits for adit water, groundwater, and seep and spring samples; paste pH and conductivity for soil and waste rock samples; and measurements of stream velocity, depth, and flow rate using staff gauges and a velocity meter.

5.4.4 Laboratory Analysis

Analytical methods, reporting limits, holding times, and QC analyses are discussed below.

Analytical Methods
The analytical methods that will be used are presented in Tables 5-2 through 5-4.

Laboratories
Samples will be analyzed by the EPA CLP laboratory, the EPA Region 10 Manchester Environmental Laboratory, and a CDM subcontracted laboratory. Prior to shipping samples, sampling personnel will ensure that all laboratories are ready to receive and analyze samples, can provide necessary data packages, and can report required information to CDM. The data report will contain a case narrative that briefly describes the number of samples, the analyses or test performed, and any noteworthy analytical difficulties or QA/QC issues associated with the submitted samples. The data report will also include signed chain-of-custody forms, cooler receipt forms, analytical data, and a QC package. An electronic copy of the data will also be provided by the laboratories to CDM.

Reporting Limits
The reporting limits for the parameters to be monitored as a part of this RI are presented in Tables 5-2 through 5-4. Reporting limits are the minimum levels to which the laboratory will report analytical results without a qualifier when an analyte is detected. The laboratory can sometimes detect analytes at concentrations of up to an order of magnitude lower than the reporting limits. In this case, when a positive detection is less than the reporting limit, the value may be reported and qualified as an estimated concentration.

Holding Times and Preservation
Holding times are storage times allowed between sample collection and sample extraction or analysis (depending on whether the holding time is an extraction or analytical holding time) when the designated preservation and storage techniques are employed. The holding times are presented in Tables 5-2 through 5-4. All water samples will be cooled and stored at 4 degrees Celsius (°C) ± 2°C until analysis is performed. Soil samples will be preserved as necessary for analyses.

Quality Control Analyses
Quality control samples will be collected during the RI. These samples include duplicate samples, MS/MSDs, and rinsate blanks. The field QC duplicate samples to be collected are discussed in Section 6.5.1 of this document.

In addition to the field QA/QC controls internal laboratory QA procedures are maintained by the designated laboratories. These will include method blanks, surrogates, MS/MSDs, and/or LCSs, or others as designated in the applicable method(s).

Duplicate Samples
Field duplicate samples are collected and analyzed to assess the overall precision of the field sample collection. These duplicates will be submitted "blind" to the chemical laboratory by using sample numbers and times that are different than their associated environmental sample. The criteria for field sampling precision for soil/waste rock samples and water samples is an RPD less than or equal to 35 and 20, respectively. Field duplicate samples for all media will be collected at a frequency of 10 percent, one per every 10 regular samples collected.

Equipment Rinsate Blanks
Equipment rinsate blank samples are collected and analyzed to assess the effectiveness of equipment decontamination procedures. These duplicates will be submitted "blind" to the chemical laboratory by using sample numbers and times that are different than their associated environmental sample. Rinsate blanks will be collected at a frequency of once per day if equipment is decontaminated between sampling locations. Rinsate blanks will be prepared and submitted for total metals analysis only. Results of the rinsate blank samples will be evaluated as part of the data validation and usability as described in Section 8.

5.5 Special Training Requirements

Special training required for this RI field program include the following:

- Health and safety training, as described in the HASP
- Field equipment operation/calibration training
- EPA CLP training
- FORMS II Lite training

Specialized technical services, such as concrete construction for flume installation, will be obtained via procured subcontractors.

5.6 Documentation and Records

The laboratories will submit analytical data reports to CDM, both as hardcopy and electronic copy. Each data report will contain a case narrative that briefly describes the number of samples, the analyses, and any analytical difficulties or QA/QC issues associated with the submitted samples. The data report will also include signed chain-of-custody forms, cooler receipt forms, analytical data, a QC package, and raw data. The laboratories will also provide an electronic copy of the data to CDM in accordance with each laboratory subcontract.

CDM's local administrative staff in Denver has the responsibility for maintenance of the document control system. This system includes a document inventory procedure and a filing system. Project personnel are responsible for project documents in their possession while working on a particular task. Field logbook(s) will be filed as part of the document control procedure. Documentation describing changes to approved plans, if they occur, will be included in the document control system.

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Section 6
Measurement and Data Acquisition

This section covers sample process design, sampling methods requirements, handling and custody, analytical methods, QC, equipment maintenance, instrument calibration, supply acceptance, nondirect measurements, and data management. The field procedures are designed so that the following occurs:

- Samples collected are consistent with project objectives
- Samples are collected in a manner so that data represent actual investigation conditions

6.1 Sample Process Design

The overall goal of the RI field program is to provide physical and chemical data necessary to support critical evaluations and decisions for the RI and FS. The sample process design is discussed in Sections 3 and 4 of the FSP in this SAP.

6.2 Sampling Methods Requirements

Sampling methods, sample containers, and overall field management are described below.

6.2.1 Sampling Equipment and Preparation

Equipment required for the field investigation (including measurement, sampling, documentation, and decontamination equipment) is presented in Section 4 of the FSP.

Field preparatory activities include review of SOPs (Appendix A), procurement of field equipment, laboratory coordination, confirmation of site access, as well as a field planning meeting that includes field personnel and QA staff. Mobilization and site setup is described in Section 4 of the FSP.

6.2.2 Sample Containers

Sample containers required for this field investigation are presented in Tables 5-2 through 5-4. The cleaned sample containers with lot number will be either pre-preserved or preserved in the field, when required.

6.2.3 Sample Collection, Handling, and Shipment

Samples collected during the investigation consist of soil/waste rock and water samples collected for chemical analyses and QC samples. All sample collection procedures are outlined in Section 4 of the FSP and the relevant SOPs (Appendix A). QC samples will also be collected, handled, and shipped in accordance with these procedures.

6.3 Sample Handling and Custody Requirements

Custody and documentation for field and laboratory work are described below, followed by a discussion of corrections to documentation.

6.3.1 Field Sample Custody and Documentation

The information contained on the sample label and the chain-of-custody record will match. The purpose and description of the sample label and the chain-of-custody record are discussed in the following sections.

6.3.1.1 Sample Labeling and Identification

A unique alphanumeric code will identify each sample collected during sampling events (as specified in SOP 1-2, Sample Custody [Appendix A]). The coding system will provide a tracking record to allow retrieval of information about a particular sample and to ensure that each sample is uniquely identified. Sample numbers will correlate with locations to be sampled. The sample locations and numbers will be identified in the field logbooks.

Sample numbers will begin with the month, year and site abbreviation (i.e., 0609F indicates that the sample was collected in June 2009 at the Formosa Mine Site).

The second character set will identify the station location where the sample was collected (i.e. MXR, SFA5, etc). Station locations for surface water and groundwater samples are indicated on Figures 3-2 through 3-5. Station locations for soil and waste rock sample locations will be identified in the field and will correlate with a grid location where paste pH measurements were collected.

The third character set represents the type of media sampled (i.e., SW for surface water, GW for groundwater, SO for soil/waste rock).

The fourth character set will consist of a four-digit number. The first digit represents the type of sample collected according to the following:

0 – Regular field sample
3 – Duplicate sample
5 – Rinsate sample

The last three digits in the character set represent the sample depth in feet below ground surface (bgs). All surface water and surface soil samples (less than 6 inches bgs) will have a depth of 0 ft bgs listed in the sample ID. Depth information is required for groundwater samples (based on pump depth).

The following are examples of sample numbers to be used on the project:

0609F-SFA5-SW-3000

0609F = June 2009, Formosa Mine Site

SFA5	**=**	**Sample collected from station SFA5**
SW	**=**	**Surface water sample**
3000	**=**	**Duplicate sample, collected from a depth of 0 ft bgs**

0909F-MW2-GW-0130

0909F	**=**	**September 2009, Formosa Mine Site**
MW2	**=**	**Sample collected from well MW-2**
GW	**=**	**Groundwater sample**
0130	**=**	**Regular field sample collected from a depth of 130 ft bgs**

0909F-P045-SO-5000

0909F	**=**	**September 2009, Formosa Mine Site**
P045	**=**	**Sample collected from surface soil/waste rock sample station P045**
SO	**=**	**Soil/Waste rock sample**
5000	**=**	**Equipment rinsate sample collected following surface sample collection (less than 6 inches bgs)**

Labels will be used in accordance with SOP 1-2, Sample Custody (Appendix A). Sample labels will be completed and affixed to the appropriate sample containers. Preprinted labels may be used. These labels will be secured with waterproof tape and will include, at least, the sample identification number, the parameter(s) to be analyzed, the sampler's initials, and the preservative used. At the time of sample collection, a member of the field team will add the date and time of sample collection.

6.3.1.2 Chain-of-Custody Requirements

Chain-of-custody (COC) procedures and sample shipment will follow the requirements stated in CDM's SOP 1-2, Sample Custody and SOP 2-1, Packaging and Shipping of Environmental Samples (Appendix A) for samples sent to the laboratories. The COC record is employed as physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. A COC record is employed as physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. A completed COC record is required to accompany each shipment of samples.

6.3.1.3 Sample Packaging and Shipping

Water samples for chemical analysis will be packaged and shipped in accordance with SOP 2-1, Packaging and Shipping of Environmental Samples (Appendix A). These samples will be placed in a plastic bag and then in a cooler with ice and held at

4°C plus or minus (±) 2°C. Custody seals will be placed over at least two sides of the cooler, and then secured by tape if custody is released to a non-sampler.

All samples will be picked up by a courier, delivered to the laboratory, or shipped by an overnight delivery service to the designated laboratory, as necessary.

For all samples submitted to the CLP laboratory for analysis, the FTL will be responsible for communicating sample shipping and chain-of-custody information to the RSCC on the day of shipping.

6.3.1.4 Field Logbook and Records

Field logbooks will be maintained in accordance with SOP 4-1, Field Logbook Content and Control (Appendix A). The log is an accounting of activities at the Site and will duly note problems or deviations from the governing plans and observations relating to the sampling and analysis program. The FTL will maintain the logbook(s) and will send copies of the field logbook on a monthly basis to the CDM PM in Denver for review and filing in the project files. Additional field forms to be utilized during field data collection are included in Appendix D.

6.3.2 Laboratory Custody Procedures and Documentation

Laboratory custody procedures are provided in the laboratories' QA management plan for all laboratories. Upon receipt at the offsite laboratories, each sample shipment will be inspected to assess the condition of the shipping cooler and the individual samples. This inspection will include measuring the temperature of the cooler to document that the temperature of the samples is within the acceptable criteria (4°C ± 2°C, if samples require chilling) and verifying sample integrity. The enclosed COC records will be cross-referenced with all of the samples in the shipment. These records will be signed by the laboratory sample custodian and copies provided to CDM will be placed in the project files. The sample custodian will continue the COC record process by using the COC number on each sample on receipt. It is the laboratory's responsibility to maintain internal logbooks and records throughout sample preparation, analysis, data reporting, and disposal.

6.3.3 Corrections to and Deviations from Documentation

Documentation modification requirements for field logbook entries are described in SOP 4-1, Field Logbook Content and Control (Appendix A). For the logbooks, a single strikeout, initialed and dated, is required for documentation changes. The correct information should be entered in close proximity to the erroneous entry.

All deviations from the guiding documents will be recorded in the field logbook(s). Any major deviations will be documented according to CDM's RAC 2 Region VIII QMP (CDM 2005b). Any modifications to COC forms will be made on all copies. The EPA RPM will be notified of any major changes or deviations.

6.4 Analytical Methods Requirements

The laboratory QA program and analytical methods are addressed below.

6.4.1 Laboratory Quality Assurance Program

Samples collected during this project will be analyzed in accordance with standard EPA and/or nationally recognized analytical procedures. The purpose of using standard procedures is to provide analytical data of known quality and consistency. Analytical laboratories will adhere to QC requirements as established by EPA methods for chemical analyses.

6.4.2 Methods

The methods to be used for chemical analyses are presented in Section 5.4.4 and Tables 5-2 through 5-4. The holding time requirements and preservatives for each analytical parameter are also provided in Section 5.4.4 and Tables 5-2 through 5-4.

6.5 Quality Control Requirements

Field, laboratory, and internal office QC are discussed below.

6.5.1 Field Quality Control Samples

Field replicates (duplicates) and equipment rinsate samples will be collected in the field for chemical analyses as indicated in Table 6-1.

Field duplicates will be collected from the same sampling location as the original sample, collected identically and consecutively over a minimum period of time. This type of field duplicate measures the total system variability (field and laboratory variance), including the variability component resulting from the inherent heterogeneity. Field duplicates will be collected at a minimum frequency of 1 per 10 samples per media per sampling event (10 percent). Duplicate sample locations will vary between sampling events.

An equipment rinsate blank will be prepared and submitted for analysis at a minimum frequency of 1 per day per media if equipment is decontaminated between sampling locations. These blanks will consist of American Society for Testing and Material (ASTM) Type II water collected by containing the ASTM water used as a final rinse after equipment decontamination. Specifically, the field rinsate for surface soil will be collected by pouring ASTM Type II water over decontaminated sampling supplies (i.e. hand trowels) and collecting the resulting water for total metals analysis, only. The field rinsate for groundwater will be collected by pouring ASTM Type II water over the decontaminated sampling pump and collecting the resulting water for total metals analysis only. Field rinsates for surface water will only be required if supplies (i.e. churn splitter) are re-used at more than one sampling location.

6.5.2 Laboratory Quality Control

6.5.2.1 Laboratory Quality Control Checks

Each laboratory will perform the QC checks required by the analytical or ASTM methods to be used.

6.5.2.2 Chemical Laboratory Internal Quality Control Samples

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination. For laboratories performing chemical analyses, QC data may be derived from laboratory duplicates, MS/MSDs, LCSs, and/or laboratory blanks (i.e., preparation blanks). Each type of laboratory-based QC sample will be analyzed at a rate of 5 percent, or one per batch (a batch is a group of up to 20 samples analyzed together), whichever is more frequent. Results of the QC analysis will be included in the QC package and QC samples may consist of laboratory duplicates, laboratory blanks, MS/MSDs, and LCSs, whichever is applicable, and any other method-required QC samples.

Laboratory blank samples will be analyzed to assess possible contamination so that corrective measures may be taken, if necessary. Laboratory duplicate samples are aliquots of a single sample that are split on arrival at the laboratory or upon analysis. Results obtained for two replicates that are split in a controlled laboratory environment are used to assess laboratory precision of the analysis. MS/MSDs and LCS analyses may be used to determine accuracy.

6.5.3 Internal Quality Control Checks

Internal QC checks will be conducted throughout the project to evaluate the performance of the project team during data generation. All internal QC will be conducted in accordance with the applicable procedures listed below:

- All project deliverables will receive technical and QA reviews prior to being issued to EPA in any form.
- Completed review forms will be maintained in the project files.
- Corrective-action of any deficiencies is the responsibility of the PM, with assistance from the QA staff, if necessary.

6.6 Equipment Maintenance Procedures

All field and laboratory equipment will be maintained in accordance with the manufacturers' maintenance and operating procedures as well as the laboratory's SOPs.

6.7 Instrument Calibration Procedures and Frequency

Calibration of field and laboratory instruments is addressed in the following subsections.

6.7.1 Field Instruments

Field instruments to measure velocity, pH, conductivity, temperature, DO, ORP, ferrous iron, and alkalinity will be used during this investigation. These field instruments will be calibrated prior to use each day and as often as needed to achieve accuracy within the equipment's specified limits. Daily calibration will be documented on the Equipment Maintenance and Calibration Record form presented in Appendix D.

All equipment will be maintained, calibrated, and operated in accordance with the manufacturer's instructions. If the sampling personnel perceive a potential problem or malfunction with a field instrument, they will recalibrate it. Replacement of the instrument will be implemented if recalibration does not remedy the problem in accordance with SOP 5-1, Control of Measurement and Test Equipment (Appendix A).

6.7.2 Laboratory Instruments

Calibration of laboratory instruments will be based on written procedures approved by laboratory management and included in the laboratory's QA manual. Instruments and equipment will be initially calibrated and continuously calibrated at required intervals as specified by either the manufacturer or more updated requirements (e.g., methodology requirements). Calibration standards used as reference standards will be traceable to EPA, National Institute of Standards and Technology, or another nationally recognized reference standard source.

Records of initial calibration, continuing calibration, repair, and/or replacement of laboratory equipment will be filed and maintained by the laboratory. Calibration records will be filed and maintained at the laboratory location where the work is performed and may be required to be included in data reporting packages.

6.8 Acceptance Requirements for Supplies

Prior to acceptance, all supplies and consumables will be inspected by the FTL to ensure that they are in satisfactory condition and free of defects. Defective equipment will be appropriately labeled in order to avoid its inadvertent use.

6.9 Nondirect Measurement Data Acquisition Requirements

Nondirect measurement data include information from previous sampling events. The acceptance criteria for such data include a review by someone other than the author. Any measurement data included in information from the above sources (i.e., previous sampling events) will determine further action at the Site only to the extent that those data can be verified by project staff.

6.10 Data Management

Sample results data will be delivered to CDM's Denver office both in hard copy form and as an electronic data deliverable (EDD). Electronic copies of all project deliverables, including graphics, will be filed by project number. Electronic files will be routinely backed up and archived. Reports will be submitted to EPA on electronic media such as compact disk – read-only memory (CD-ROM) in Microsoft-compatible format (Word for text-only files, or Excel for certain tables), if requested.

CDM's Denver administrative staff has the responsibility for maintaining the document control system. This system includes a document inventory procedure and a filing system. Project personnel are responsible for project documents in their possession while working on a particular task. Data management protocol and procedure are discussed in Section 8.

Section 7
Assessment and Oversight

Assessments and oversight are necessary to ensure that procedures are followed as required and that deviations from procedures are documented. These reports also serve to keep management current on field and project activities. Assessment and oversight reports are discussed below.

7.1 Assessments and Response Actions

Assessments and corresponding response actions are discussed below.

7.1.1 Assessments

Performance assessments are quantitative checks on the quality of a measurement system and are appropriate to analytical work. Performance assessments for the laboratory may be accomplished by submitting reference material as blind reference (or performance evaluation) samples. These assessment samples are samples with known concentrations that are submitted to the laboratory without informing the laboratory of the known concentration. Samples will be provided to the laboratory for performance assessment upon request from the EPA RPM.

System assessments are qualitative reviews of different aspects of project work to check on the use of appropriate QC measures and the functioning of the QA system. Any determination of or changes to project assessments will be performed under the direction of the QA manager, who reports directly to the CDM president. Quality Procedure 6.1, as defined in the CDM RAC 2 Region VIII QMP (CDM 2005b), defines CDM's corporate assessments, procedures, and requirements.

Due to the amount of sampling and the duration of the project, both a field audit and an office audit are scheduled for the Site annually. Audits are conducted in accordance with Quality Procedure 6.2 of the CDM RAC 2 Region VIII QMP (CDM 2005b).

7.1.2 Response Actions

Response actions will be implemented on a case-by-case basis to correct quality problems. Minor response actions taken in the field to immediately correct a quality problem will be documented in the applicable field logbook, and a verbal report will be provided to the CDM PM. For verbal reports, the CDM PM will complete a communication log to document that response actions were relayed to him/her. Major response actions are those that may affect the quality or objective of the investigation. Major response actions taken in the field will be approved by the CDM PM and the EPA RPM prior to implementation of the change. Quality problems that cannot be corrected quickly through routine procedures require implementation of a Corrective Action Request (CAR) Form.

All formal response actions will be submitted to CDM's RAC Region VIII QA manager or RAC regional QA coordinator for review and issuance. CDM's PM or project QA coordinator will notify the QA manager when quality problems arise that may require a formal response action. CAR forms will be completed according to Quality Procedure 8.1 of the CDM RAC 2 Region VIII QMP (CDM 2005b).

7.2 Reports to Management

Regular QA reports will be provided to management. Additional reports to management will be provided if significant quality problems are encountered. Field staff will note any quality problems in a logbook and/or other form of documentation such as field data sheets. CDM's PM will inform the project QA coordinator upon encountering quality issues that cannot be immediately corrected.

Topics to be summarized regularly may include but not be limited to:

- Technical and QA reviews that have been conducted
- Activities and general program status
- Project meetings
- Calibration data
- Corrective action activities
- Any unresolved problem
- Assessment of data deficiencies
- Any significant QA/QC problems not included above
- Good performance by field and project personnel

Section 8
Data Validation and Usability

Laboratory results will be reviewed for compliance with project objectives. Data validation and evaluation are discussed in Sections 8.1 and 8.2, respectively.

8.1 Data Review, Validation, and Verification Requirements

CDM and/or EPA will validate data submitted by analytical laboratories. Data qualification will be based on the EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (NFG) (EPA 2004), with method-specific requirements superseding the NFG. Data validation consists of examining the sample data package(s) against pre-determined standardized requirements. The validator may examine, as appropriate, the reported results, QC summaries, case narratives, chain-of-custody information, raw data, LCS/LCSDs, MS/MSDs, initial and continuing instrument calibration, and other reported information to determine the accuracy and completeness of the data package. During this process, the validator will verify that the analytical methodology was followed and QC requirements were met. The validator may recalculate selected analytical results to verify the accuracy of the reported information. Analytical results will then be qualified as necessary.

Data verification includes checking that results have been transferred correctly from laboratory data printouts to the laboratory report and to the EDD.

8.2 Data Quality Determination

The following sections describe activities for assessing the effectiveness of the implementation of the project and associated QA/QC. The purpose of the appraisal is to ensure that the SAP is implemented as prescribed.

8.2.1 Reconciliation with Data Quality Objectives

Once data have been generated, CDM will evaluate the analytical data for the PARCC parameters as stated in Section 5.4.2.2 of this SAP. Sample data will be maintained in a Microsoft Access database or equivalent. Laboratory QC sample data will be stored in hard copy (in the project files) and in a separate database.

8.2.2 Data Quality Assessment

Formally conducted data quality assessments will be performed as part of the data review and evaluation process; this may be performed in conjunction with the reconciliation with DQOs step (Section 8.2.1). Processes and protocols for conducting data quality assessments are described in the following sections.

8.2.2.1 Informal Data Quality Assessments

Informal data quality assessments may be conducted at any time during the sampling and analysis activities to ensure that project requirements are met and to document any changes made to the SAP as a result of unexpected field or sample conditions. Informal data quality assessments can be performed by any project team member from the FTL to the sampling technician. The purpose of the informal project data quality assessment is to document changes, additions, or deletions in the field or analytical procedures as it relates to the SAP, to provide rapid feedback to the project staff, and to facilitate corrective action and continuous improvement. The informal data quality assessment is documented on a field or laboratory modification form. The modification form indicates the proposed change and the rationale for the change and requires CDM and EPA approval before it may be implemented.

Other possible informal data quality assessments may be carried out over the course of the project, including review and verification of procedures, followed as part of real-time control charting of QC samples analyzed via field and contract laboratory procedures.

8.2.2.2 Formal Data Quality Assessments

Formally conducted data quality assessments will be performed as part of the data review and evaluation process; this may be performed in conjunction with the reconciliation with DQOs (Section 8.2.1). Formal data quality assessments will be performed by project team member(s), such as the FTL or another who is familiar with the project DQOs and is capable of assessing whether all aspects of the project goals were met. The purpose of the formal project data quality is to document changes, additions, or deletions in the field or analytical procedures as it relates to the SAP and to independently evaluate the effect the modifications may have on the project DQOs. Another major role of the data quality assessment is to determine and discuss data gaps, trends, and usability.

Other possible formal data quality assessments that may be carried out over the course of the project include:

- Review and verification of procedures followed as part of real-time control charting of QC samples analyzed via field and contract laboratory procedures
- Evaluation of the flow of electronic data

Reporting the result of the formal data quality assessment should be incorporated in the section of the Data Presentation/Evaluation Report that outlines whether or not DQOs were met. Data quality assessments will be performed by the project chemist or project QA coordinator in conjunction with the FTL or staff familiar with the project DQOs.

Section 9
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Tables

Table 3-1 - Paste pH and Conductivity Sample Quantites by Location
Formosa Mine Superfund Site

Site Location Designation	Grid or Linear Sampling	Grid or Sample Spacing (ft) (Approximate)	Estimated Number of Field Paste pH Samples
Surface Disturbance Areas			
Formosa 1 Adit Waste Rock Dump	Grid	100	14
Silver Butte 1 Adit Waste Rock Dump	Grid	100	27
Encapsulation Mound and Waste Rock Dumps	Grid	100	65
Ore Storage Area and Waste Rock Dumps	Grid	100	35
Formosa 2, Formosa 3, and 1090 Adit Waste Rock Dumps	Grid	100	9
404 Adit Waste Rock Dump	Grid	100	4
Road Areas			
Road 30-6-35.1 - north of Formosa Adit	Linear	200	4
Road 30-6-35.1 - between Silver Butte 1 Adit and encapsulation mound	Linear	100	9
Road 30-6-35.1 - southwest of encapsulation mound towards 404 Adit	Linear	200	6
Road 31-6-26.1 - northeast of encapsulation mound towards Silver Butte Peak	Linear	200	22
Road [illegible] east of encapsulation mound	Linear	200	4
South Fork Road - south of encapsulation mound	Linear	200	21
		Total	220

Notes:

Number of samples indicated is an estimate based on the grid spacing or linear spacing indicated. Additional paste pH and conductivity samples will be collected at the discretion of field personnel to delineate areas of potential ARD-generating rock and soils

Actual grid locations and spacing will be determined in the field and will be adjusted due to field constraints (e.g. topography and surface features)

ft - feet

Table 3-2 - Monitoring Well Construction Information
Formosa Mine Superfund Site

Well ID	Installation Date	Approximate Ground Surface Elevation (ft amsl)*	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)
MW-1	10/22/1999	3353	67	87
MW-2	10/23/1999	3287	113	148
MW-3	10/23/1999	3240	57	77
MW-4	2/20/2002	3270	255	270
MW-5	2/21/2002	3340	85	100

* Elevations have been estimated based on topographic maps of the Site

ft - feet

amsl - above mean sea level

bgs - below ground surface

Table 4-1 Field Equipment and Supplies
Formosa Mine Superfund Site

GENERAL SUPPLIES	
SAP	120V, 300W AC inverter
Site maps and aerial photos	Printer
Pens, Sharpies, extra fine point markers	Printer paper
Field logbooks (Rite in the Rain Environmental)	Tools (e.g. wrenches, screwdrivers, wire cutters, utility knives etc.)
Field notebooks with appropriate forms (photo log, groundwater sampling log, surface water sampling log for flows, etc)	Chisel-point rock hammer
Digital camera	Shovel
Laptop computer (with Forms-2-Lite)	
SAMPLE COLLECTION SUPPLIES	
1-L poly bottles (unpreserved) - wide-mouth	Disposable bailers (1.5-inch diameter)
500 mL poly bottles (HNO_3 preserved)	
250-mL poly bottles (H_2SO_4 preserved)	Whirl-Pak® plastic bags - 36oz
Peristaltic pump (for sample collection and filtering)	Disposable soil sampling trowels
Silicone tubing for peristaltic pump (1/4-inch ID)	Disposable mixing cups and plastic mixers (for paste pH tests)
1/4-inch poly tubing	Hand trowel/shovel – stainless steel
0.45 µm Filters - Disposable with 1/4" hose barbs	Munsell soil color chart
DH-81 Depth-Integrated Sampler (non-metallic) with 3-foot Extension Rod(s)	Buckets with marked increments (measuring flow rates)
Churn splitter	Stopwatch
Distilled Deionized Water (ASTM Type II) (for rinsate blanks)	Portable flume
Bladder pump (2-inch)	Steel rake (for portable flume installation)
Teflon-lined tubing - 3/8-inch	Level (for portable flume installation)
Air compressor for bladder pump	Staff gauge (Minumum 12 feet?)
Measuring cup (flow rate measurement)	Paper towels
10% hydrochloric acid solution and eyedropper	Visqueen plastic sheeting
Hand lens	
SAMPLE PROCESSING AND SHIPPING SUPPLIES	
Ice	Custody seals
FedEx shipping labels	Sample container labels
Ice chests	Garbage bags
Absorbent (kitty litter)	Bubble wrap
Tape - clear, duct, and strapping	Scissors
Ziploc bags (quart and gallon size)	

Table 4-1 (Continued) Field Equipment and Supplies
Formosa Mine Superfund Site

SAMPLE LOCATION SURVEYING AND DOCUMENTATION	
Compass	Orange spray paint (for T-posts)
Measuring tape	Kimwipes
Hip-chain	Pressure altimeter
Clinometer	Survey flagging
Steel T-posts (for marking surface water sampling locations)	Wood lath (for marking paste pH locations)
Hammer (sledge)	
DECONTAMINATION/IDW SUPPLIES	
Decon buckets (5-gallon)	Brushes
Sprayers	Distilled Water
Liquinox	Large brushes, plastic scrapers, (for cleaning flumes)
Nitric acid solution (10%)	Drums (for purge water/precipitate sludge/decon water)
HEALTH AND SAFETY SUPPLIES	
First aid kit (should include benadryl, rubbing alcohol, and calamine for poison ivy/oak exposure, tick and insect bite kits)	Rubber overboots
Waterproof boots	Hip or Chest waders
Cellular telephone	Rain Gear (jackets, pants, ponchos)
Fire extinguisher	Orange hunter vests and hats
Cotton undergloves	Ear plugs (for work near heavy equipment)
Nitrile gloves (regular and elbow-length)	Inflatable Raft and Oars (include air pump)
Large Tyvek coveralls (see HASP)	Personal Floatation Devices
Safety glasses	Ring buoys (2) with 90 ft of rope
Portable eyewash	Heavy-duty rope and D-rings (secure boat to shore anchor)
Herbicide (poison ivy/oak control)	Rope, harnesses, belay device for rappelling (if needed on steep slopes)
EQUIPMENT FOR ONSITE FIELD MEASUREMENTS	
pH/Conductivity meters (3)	Water level indicator
Water quality multi-meter (pH, DO, ORP, Conductivity, Turbidity, Temperature) (2)	Electromagnetic velocity meter (Marsh-McBirney)
HACH ferrous iron kit and reagent packets	Transducers/data loggers
HACH alkalinity kit	Handheld GPS unit

V - volt
W - watt
L - liter
mL - milliliter
HNO_3 - nitric acid
H_2SO_4 - sulfuric acid
ID - inner diameter
oz - ounce
ASTM - American Society of Testing and Materials
% - percent
HASP - health and safety plan
GPS - global positioning system
ft - feet

Table 5-1 - Project Personnel Contact Information
Formosa Mine Superfund Site

Project Personnel	Title	Organization	Telephone Number	Mailing Address	Email Address
Jodi Powell	Project Officer	EPA	(303) 312-6715	1595 Wynkoop Street Denver, CO 80202	powell.jodi@epa.gov
Denise Baker-Kircher	Remedial Project Manager	EPA	(206) 553-4303	1200 Sixth Avenue Ste 900 Seattle, WA 98101	baker.denise@epa.gov
Gina Grepo-Grove	Quality Assurance Manager	EPA	(206) 553-1632	1201 Sixth Avenue Ste 900 Seattle, WA 98101	grepo-grove.gina@epa.gov
Bethany Plewe	Regional Sample Control Coordinator	EPA	(206) 553-1603	1202 Sixth Avenue Ste 900 Seattle, WA 98101	plewe.bethany@epa.gov
Dee Warren	Project Manager	CDM	(720) 264-1121	555 17th Street Ste 1100 Denver, CO 80202	warrendee@cdm.com
Mark Nelson	Project Geochemist	CDM	(605) 578-9726	11898 Gilt Edge Road Deadwood, SD 57732	nelsonmr@cdm.com
Nick Anton	Project Engineer/Field Team Leader	CDM	(720) 264-1147	555 17th Street Ste 1100 Denver, CO 80202	antonnr@cdm.com
Doug Updike	Quality Assurance Manager	CDM	(816) 412-3149	9200 Ward Parkway Ste 500 Kansas City, MO 64114	updikedj@cdm.com
Kim Zilis	Project Quality Assurance Coordinator	CDM	(720) 264-1155	555 17th Street Ste 1100 Denver, CO 80202	ziliskj@cdm.com

Table 5-2 Analytical Parameters, Methods, Containers, Preservation, Holding Times, and Reporting Limits for Soil and Waste Rock Samples
Formosa Mine Superfund Site

Analyte/Parameter	Method	Matrix	Sample Container	Preservation	Maximum Holding Times	Reporting Limits (mg/kg)
Acid-Base Accounting	Sobek, 1978 (Modified)	Soil	One 18-oz. Whirl-Pak® Plastic Bag	NA	6 months	NA
Total Sulfur						
Water - Extractable Sulfur						
HCl - Extractable Sulfur						
HNO_3 - Extractable Sulfur						
Residual Sulfur						
Acid Generating Potential						
Acid - Neutralization Potential						
Total Metals	EPA CLP Inorganics - ILM05.4	Soil	One 8-oz. Wide Mouth Glass Jar	Sieve with 60-mesh (250 μm) Cool to 4°C (± 2°C)	6 months	
Aluminum						20*
Antimony						6*
Arsenic						1*
Barium						20*
Beryllium						0.5*
Boron[2]						TBD
Cadmium						0.5*
Chromium						1*
Cobalt						5*
Copper						2.5*
Iron						10*
Lead						1*
Lithium[2]						TBD
Manganese						1.5*
Mercury						0.1*
Molybdenum[2]						TBD
Nickel						4*
Selenium						3.5*
Silver						1*
Thallium						2.5*
Thorium[2]						TBD
Uranium[2]						TBD
Vanadium						5*
Zinc						6*
pH	Paste pH - Field Method	Soil	NA	NA	ASAP[3]	NA
Synthetic Precipitation Leaching Procedure (SPLP) - Metals	EPA 1312 (Modified for 3:1 Liquid:Solid Ratio)	Soil	One 16-oz. Wide Mouth Glass Jar	Cool to 4°C (± 2°C)	6 months	
Aluminum						200 μg/L*
Antimony						2 μg/L*
Arsenic						1 μg/L*
Barium						10 μg/L*
Beryllium						1 μg/L*
Boron[2]						100 μg/L
Cadmium						0.5 μg/L**
Chromium						2 μg/L*
Cobalt						1 μg/L*
Copper						2 μg/L*
Iron						100 μg/L*
Lead						1 μg/L*
Lithium[2]						100 μg/L
Manganese						1 μg/L*
Mercury						0 2 μg/L*
Molybdenum[2]						1 μg/L*
Nickel						1 μg/L*
Selenium						5 μg/L*
Silver						0.1 μg/L**
Thallium						1 μg/L*
Thorium[2]						1 μg/L*
Uranium[2]						1 μg/L*
Vanadium						5 μg/L*
Zinc						2 μg/L*
Electron Microprobe (Mineralogy)	NA	Soil		NA	NA	NA

[1] Units in mg/kg, unless otherwise noted.
[2] Indicates metals not included in standard EPA Contract Laboratory Program (CLP) Target Analyte List (TAL). Will be necessary to request modified analysis from EPA CLP laboratory.
[3] Sample analysis for paste pH should be conducted as soon as possible (ASAP), immediately after sample collection
* Indicates contract-required quantitation limits for EPA CLP inorganics analyses

mg/kg - milligrams per kilogram
μg/L - micrograms per liter
NA - not applicable
TBD - to be determined

Table 5-3 Analytical Parameters, Methods, Containers, Preservation, Holding Times, and Reporting Limits for Surface Water Samples
Formosa Mine Superfund Site

Analyte/Parameter	Method	Matrix	Sample Container	Preservation	Maximum Holding Times	Reporting Limits (μg/L)[1]
Total Dissolved Solids	SM 2540C	Water	One 500-mL polyethylene bottle	Cool to 4°C (± 2°C)	7 days	20,000
Total Suspended Solids	USGS I3765	Water			7 days	4,000
Alkalinity, Carbonate, Bicarbonate	SM 2320B	Water			14 days	NA
Acidity	EPA 305.1	Water	One 250-mL polyethylene bottle	Cool to 4°C (± 2°C)	14 days	10 mg/L $CaCO_3$
Chloride	EPA 300.0	Water	One 125-mL polyethylene bottle	Cool to 4°C (± 2°C), 0.45-μm filter in the field	28 days	60
Flouride	EPA 300.0	Water			28 days	40
Sulfate	EPA 300.0	Water			28 days	300
Dissolved Metals	EPA CLP Inorganics - ILM05.4	Water	One 500 mL polyethylene bottle	Cool to 4°C (± 2°C), HNO_3 to pH<2, 0.45-μm filter in the field	6 months except for Mercury (28 days)	
Aluminum						200*
Antimony						2*
Arsenic						1*
Barium						10*
Beryllium						1*
Boron[2]						100
Cadmium						0.5**
Calcium						500
Chromium						2*
Cobalt						1*
Copper						2*
Iron						100*
Lead						1*
Lithium[2]						100
Magnesium						500
Manganese						1*
Mercury						0.2*
Molybdenum[2]						1
Nickel						1*
Potassium						500
Selenium						5*
Silver						0.1**
Sodium						500
Thallium						1*
Thorium[2]						1
Uranium[2]						1
Vanadium						5*
Zinc						2*
Total Metals (See Dissolved Metals List for Individual Metals and Reporting Limits)	EPA CLP Inorganics - ILM05.4	Water	One 500 mL polyethylene bottle	Cool to 4°C (± 2°C), HNO_3 to pH<2	6 months except for Mercury (28 days)	See Dissolved Metals reporting limits
Nitrogen, Nitrate/Nitrite	EPA 353.2	Water	One 250 mL polyethylene bottle	Cool to 4°C (± 2°C), H_2SO_4 to pH <2	28 days	50
Nitrogen, Ammonia	EPA 350.1	Water	One 250 mL polyethylene bottle	Cool to 4°C (± 2°C), H_2SO_4 to pH <2	28 days	100

[1] Units in micrograms per liter (μg/L), unless otherwise noted.
[2] Indicates metals not included in standard EPA Contract Laboratory Program (CLP) Target Analyte List (TAL). Will be necessary to request modified analysis from EPA CLP laboratory.

* Indicates contract-required quantitation limits for EPA CLP inorganics analyses

** Indicates reporting limit lower than contract-required reporting limit for EPA CLP inorganics analyses

ASAP - as soon as possible
N/A - not applicable
$CaCO_3$ - calcium carbonate
mg/L - milligrams per liter
HNO_3 - nitric acid
H_2SO_4 - sulfuric acid
C - degrees Celsius
mL - milliliters

Table 5-4 Analytical Parameters, Methods, Containers, Preservation, Holding Times, and Reporting Limits for Groundwater Samples Formosa Mine Superfund Site

Analyte/Parameter	Method	Matrix	Sample Container	Preservation	Maximum Holding Times	Reporting Limits (μg/L)[1]
Total Dissolved Solids	SM 2540C	Water	One 500-mL polyethylene bottle	Cool to 4°C (± 2°C)	7 days	20,000
Total Suspended Solids	USGS I3765	Water			7 days	4,000
Alkalinity, Carbonate, Bicarbonate	SM 2320B	Water			14 days	NA
Acidity	EPA 305.1	Water	One 250-mL polyethylene bottle	Cool to 4°C (± 2°C)	14 days	10 mg/L $CaCO_3$
Chloride	EPA 300.0	Water	One 125-mL polyethylene bottle	Cool to 4°C (± 2°C), 0.45-μm filter in the field	28 days	60
Flouride	EPA 300.0	Water			28 days	40
Sulfate	EPA 300.0	Water			28 days	300
Dissolved Metals	EPA CLP Inorganics - ILM05.4	Water	One 500 mL polyethylene bottle	Cool to 4°C (± 2°C), HNO_3 to pH<2, 0.45-μm filter in the field	6 months except for Mercury (28 days)	
Aluminum						200*
Antimony						2*
Arsenic						1*
Barium						10*
Beryllium						1*
Boron[2]						100
Cadmium						0.5**
Calcium						500
Chromium						2*
Cobalt						1*
Copper						2*
Iron						100*
Lead						1*
Lithium[2]						100
Magnesium						500
Manganese						1*
Mercury						0.2*
Molybdenum[2]						1
Nickel						1*
Potassium						500
Selenium						5*
Silver						0.1**
Sodium						500
Thallium						1*
Thorium[2]						1
Uranium[2]						1
Vanadium						5*
Zinc						2*
Nitrogen, Nitrate/Nitrite	EPA 353.2	Water	One 250 mL polyethylene bottle	Cool to 4°C (± 2°C), H_2SO_4 to pH <2	28 days	50
Nitrogen, Ammonia	EPA 350.1	Water	One 250 mL polyethylene bottle	Cool to 4°C (± 2°C), H_2SO_4 to pH <2	28 days	100

[1] Units in μg/L, unless otherwise noted.

[2] Indicates metals not included in standard EPA Contract Laboratory Program (CLP) Target Analyte List. Will be necessary to request modified analysis from EPA CLP laboratory.

* Indicates contract-required quantitation limits for EPA CLP inorganics analyses

** Indicates reporting limit lower than contract-required reporting limit for EPA CLP inorganics analyses

ASAP - as soon as possible
N/A - not applicable
$CaCO_3$ - calcium carbonate
mg/L - milligrams per liter
HNO_3 - nitric acid
H_2SO_4 - sulfuric acid
C - degrees Celsius
mL - milliliters

Table 5-5 Precision Criteria fo Duplicate Analyses
Formosa Mine Superfund Site

Media	Field or Laboratory Duplicate		Matrix Spike Duplicate
	Either Result is less than or equal to 5 times the reporting limit	**Both Results are greater than or equal to 5 times the reporting limit**	
Soil/waste rock	Difference is less than or equal to 2 times the reporting limit	RPD less than or equal to 35	Collected on request by EPA RPM
Water	Difference is less than or equal to 2 times the reporting limit	RPD less than or equal to 20	Collected on request by EPA RPM

Table 6-1 Field Quality Control Sample Quantities
Formosa Mine Superfund Site

Sample Media	Field Duplicate	Field Rinsate	MS/MSD
Surface Soil	1 per 10 samples	1 per day if sampling equipment is decontaminated between uses	1 per 20 samples for metals analysis only
Surface Water	1 per 10 samples, minimum of one per sample event	1 per day if sampling equipment is decontaminated between uses	1 per 20 samples for metals analysis only
Groundwater	1 per 10 samples, minimum of one per sample event	1 per day if sampling equipment is decontaminated between uses	1 per 20 samples for metals analysis only

Figures

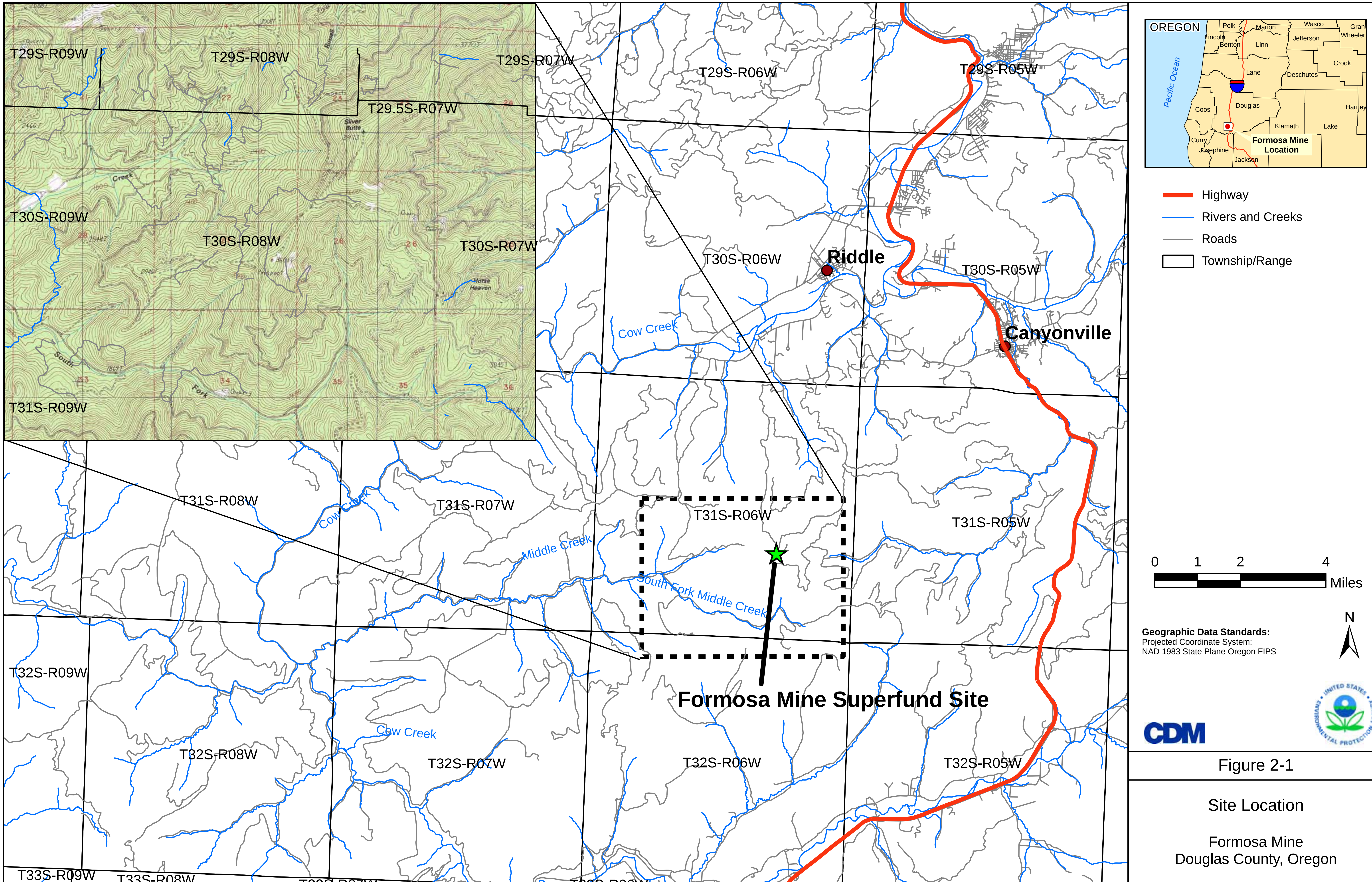
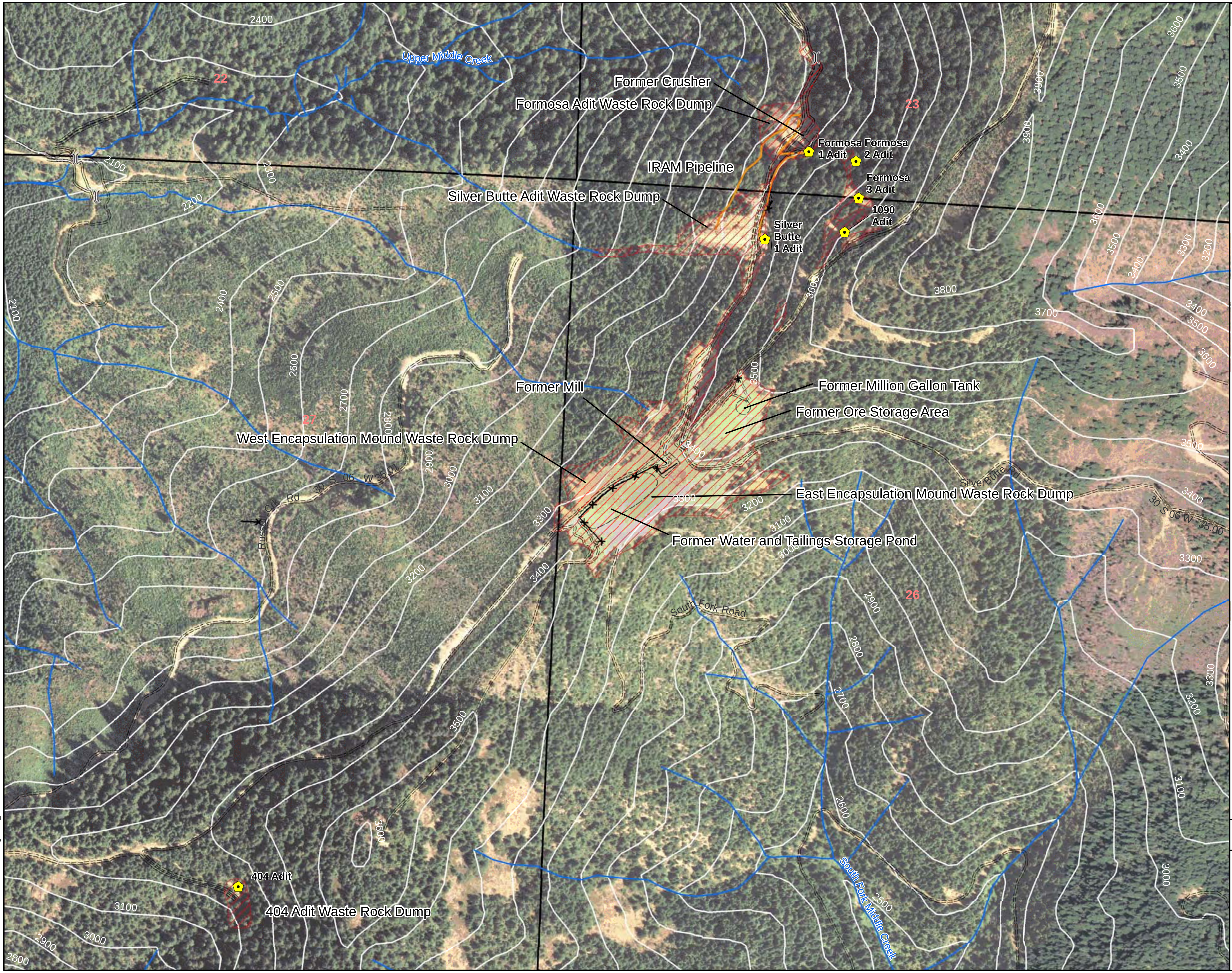


Figure 2-1

Site Location

Formosa Mine
Douglas County, Oregon



Legend

- Adit
- Culverts
- Fence
- IRAM Adit Water Diversion Pipeline
- Roads
- Hydrology
- Contours (100 ft)
- Surface Disturbance Areas
- Sections

0 250 500 1,000 Feet

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS

Data Sources:
Bureau of Land Management

CDM

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Figure 2-2

Site Features

Formosa Mine
Douglas County, Oregon

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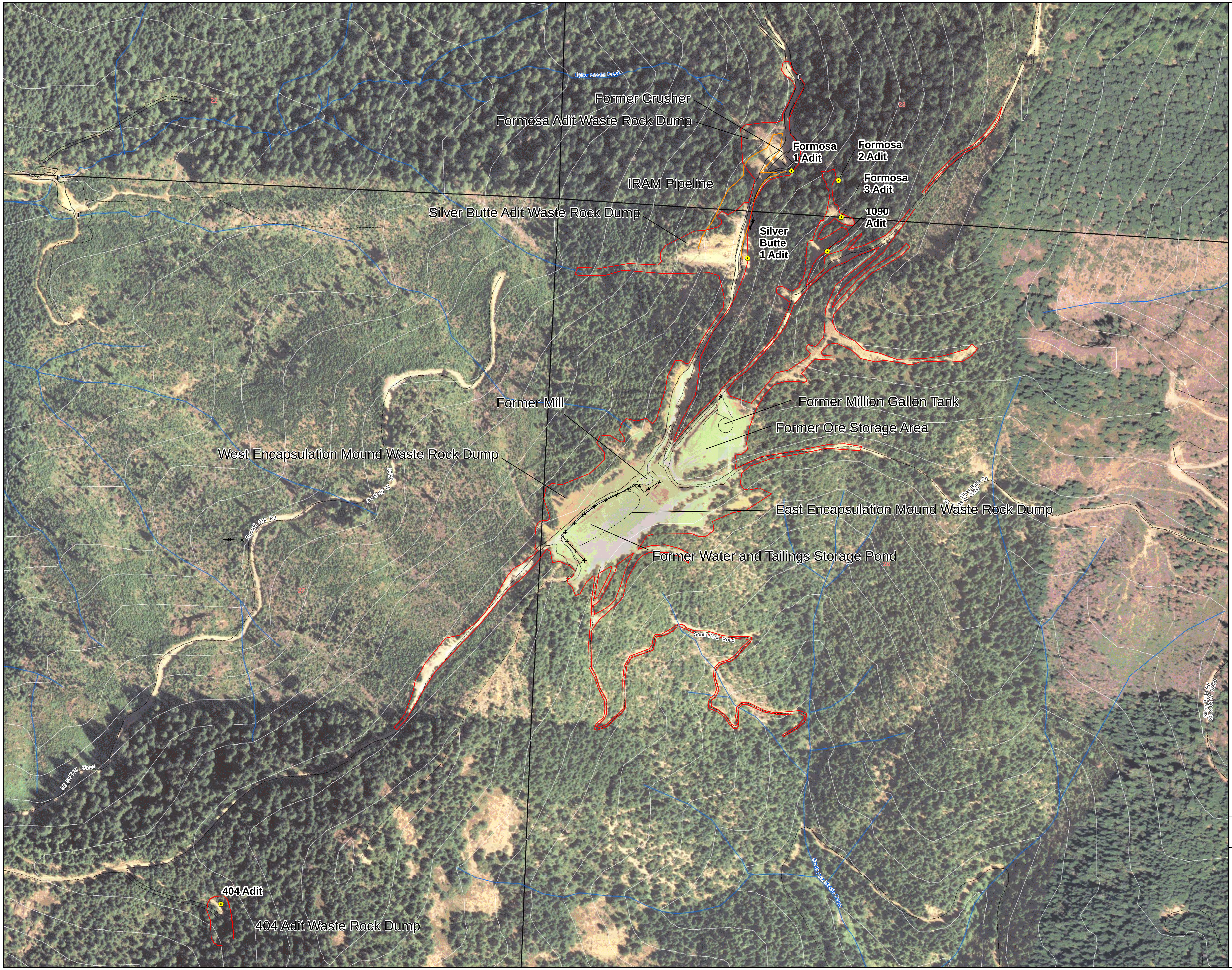


Legend

- Adit
- Culverts
- Fence
- IRAM Adit Water Diversion Pipeline
- Roads
- Hydrology
- Contours (100 ft)
- Paste pH and Conductivity Survey
- Historic Site Features
- Sections

0 250 500 1,000 Feet

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS

CDM

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Figure 3-1

Paste pH
and Conductivity Survey

Formosa Mine
Douglas County, Oregon

Figure 3-2

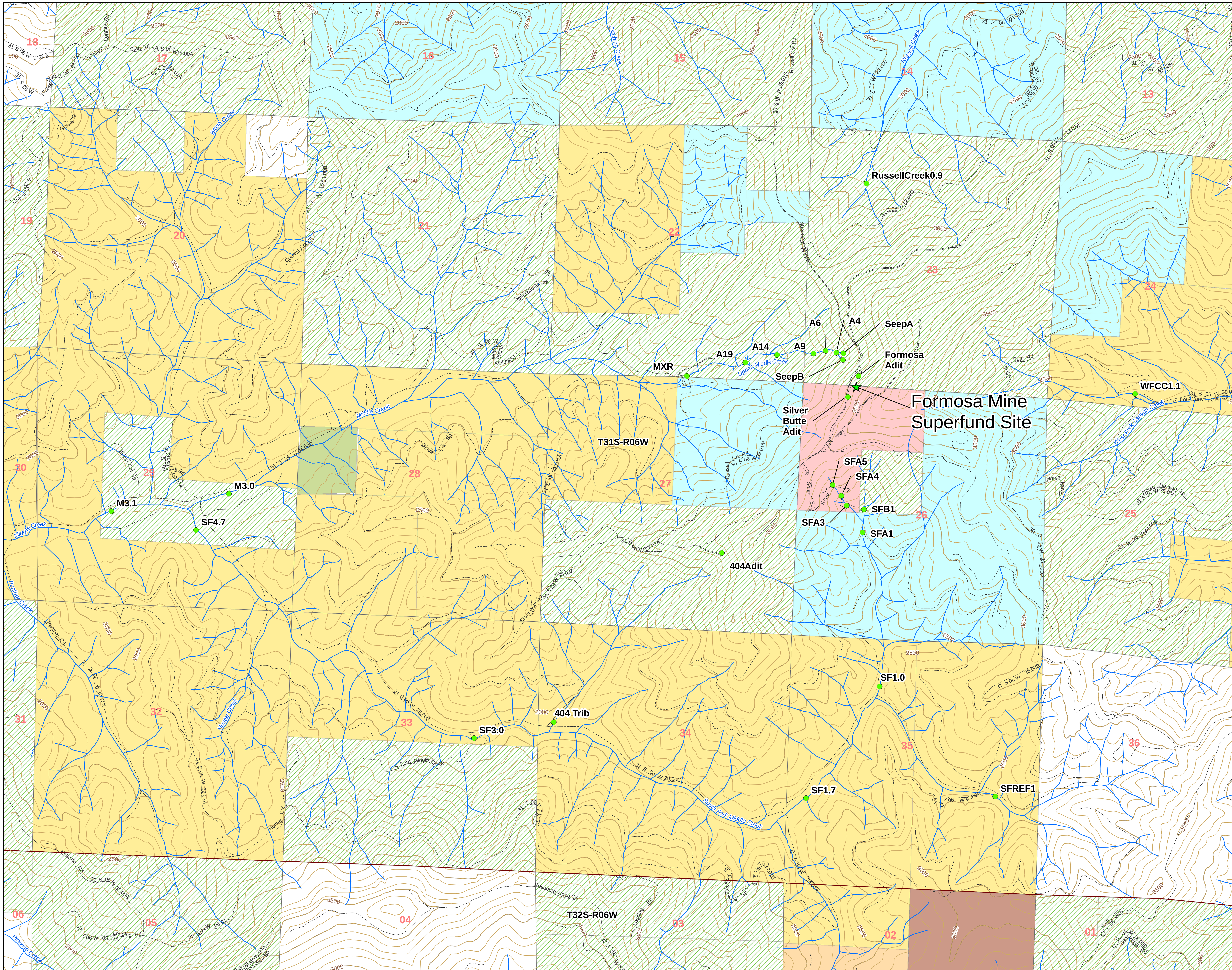
Monthly Surface Water Sampling Locations

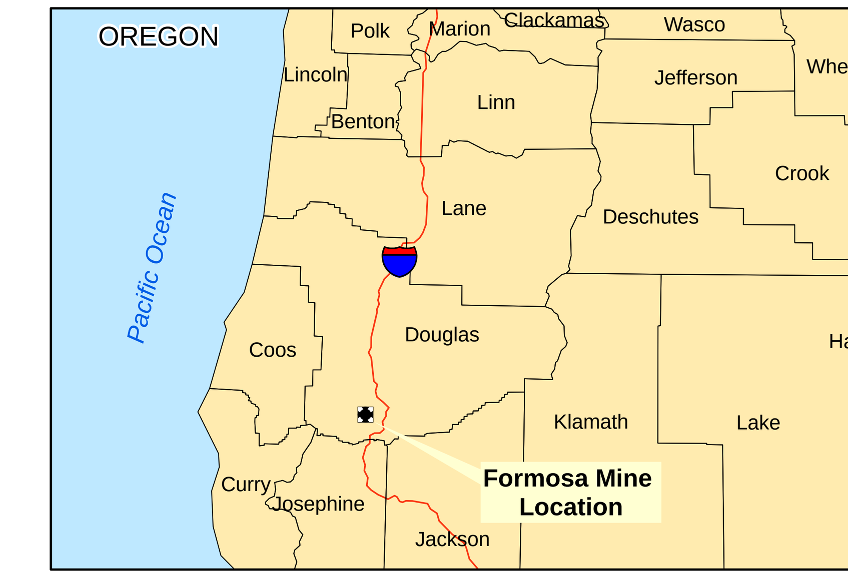
Formosa Mine
Douglas County, Oregon

Figure 3-3

Quarterly Surface Water Sampling Locations Outer Zoom

Formosa Mine
Douglas County, Oregon





Legend

- Surface Water Sampling Locations
- Roads
- Hydrology
- Contours (100 ft)
- Contours (500 ft)
- Township/Range
- Sections

Land Ownership

- Coast Range Resources
- Ford, Allyn
- Formosa Exploration Co.
- Lone Rock Timber Land Co.
- Plum Creek Timber Land
- Roseburg Resources Co.
- Silver Butte Timber Co.
- State of Oregon
- Bureau of Land Management
- Other

1 inch = 1,000 feet

N

Geographic Data Standards:
Projected Coordinate System:
NAD 1983 State Plane Oregon FIPS

CDM

Figure 3-4

Quarterly Surface Water Sampling Locations Middle Zoom

Formosa Mine
Douglas County, Oregon

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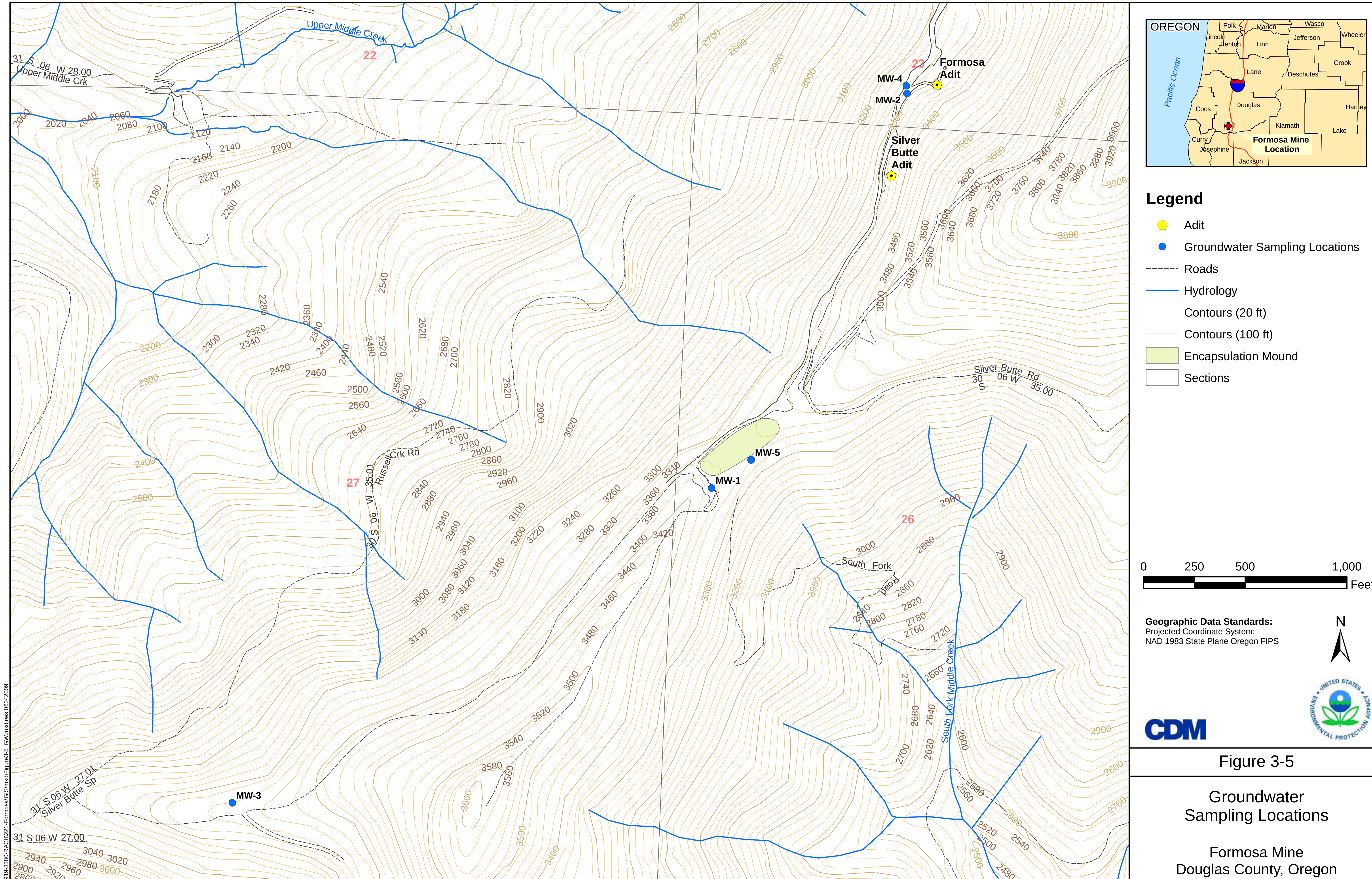


Figure 3-5

Groundwater Sampling Locations

Formosa Mine
Douglas County, Oregon

Appendix A

CDM Federal Standard Operating Procedures

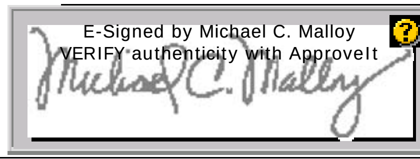
Surface Water Sampling	SOP 1-1 Revision: 7 Date: March 2007

Prepared: Del Baird

Technical Review: Curt Coover

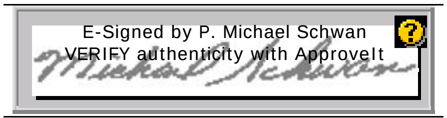
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective
The purpose of this standard operating procedure (SOP) is to define requirements for collection and containment of surface water samples.

2.0 Background
Surface water samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition.

2.1 Definitions
Surface Water - Water that flows over or rests on the land and is open to the atmosphere. This includes ditches, streams, rivers, lakes, pools, ponds, and basins.

Shallow Surface Water - Water within 1 to 3.3 feet (0.3 to 1 meter) of the surface of a body of water.

Deep Surface Water - Water deeper than 3.3 feet (1 meter) of the surface of a body of water.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Simple Composite - Two or more subsamples taken from a specific media and site at a specific point in time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Temporal Composite - Two or more subsamples taken from a specific media and site over a period of time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Churn Splitter - Large vessel for compositing subsamples. Includes a mechanism to agitate the water to keep solids suspended.

2.2 Associated Procedures
- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-2, *Photographic Documentation of Field Activities*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities
Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this SOP, related SOPs, and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL also must ensure that the quantity and location of surface water samples collected meet the requirements of the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

All or part of the equipment listed under the “as needed” category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or “blue ice”
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- Life jacket
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies

As needed:

- Pond sampler with 1-liter (L) beaker (preferably Teflon®), clamp, and heavy-duty telescoping pole
- Weighted bottle sampler, 1-L capacity (preferably Teflon) and handle; see USGS Open File Report 2005-1087 for selection of sampler; a Kemmerer or Van Dorn sampler may be used if Teflon is not required
- Churn splitter
- Peristaltic pump or suitable replacement
- Temperature, pH, and conductivity meter(s), dissolved oxygen meter, redox potential meter (as required by project plan)
- Boat with depth finder for deep water or inaccessible shorelines
- Global positioning system (GPS) unit
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

5.0 Procedures

5.1 Preparation

The following steps should be taken when preparing for sampling surface water:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

3. Select wadeable stream/river sampling locations that exhibit cross-sectional homogeneity and are well-mixed. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lake samples, the investigator should consider the lake stratification caused by seasonal temperature differences. If possible, select a location that can be described precisely, such as xx feet upstream of xx bridge. Use caution when wading streams more than 1 to 2 feet deep. Flowing water can be a safety hazard.

4. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.

5. Make field measurements as required by the project plans in physical, chemical, and biological characteristics of the water (e.g., discharge, gage height, temperature, dissolved oxygen, conductivity, pH).

6. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.

7. The sampler should be facing upstream when sampling, both for proper sample collection and for safety (ability to observe floating objects).

8. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.

9. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.

10. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.

11. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4 5.

12. Processes for verifying depth of samples must be included in site-specific project plans.

13. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control sample requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Shallow Surface Water Sample Collection for Wadeable Streams

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis

All volatile organic compound (VOC) samples should be discrete samples. The following steps must be taken when collecting shallow surface water VOC samples:

If the volatile organic analysis (VOA) vials do not require a preservative:

1. Approach the sample location from downstream; do not enter the sample area. Slowly submerge VOA vials completely into an area of gently flowing water and fill. Do not disturb bottom sediments. The open end of the vials should be pointed upstream

Note: When collecting samples for VOC analysis, avoid collecting from a surface water point where water is cascading and aerating.

2. Cap the VOA vial while it is underwater. Be sure to dislodge all air bubbles from the cap before sealing the vial.

3. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.

4. Proceed to Step 5 below.

If the VOA vials require a preservative:

1. Collect a sufficient sample in a clean glass jar as in Steps 1 and 2 above for unpreserved vials. Specific sampling devices to be used must be specified in site-specific plans.

2. Decant the sample immediately into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Tip vials slightly while filling to reduce turbulence until nearly filled. Then straighten vial to vertical for final filling. Ensure that a meniscus is raised above the lip of the vial before capping.

3. Cap each vial once the meniscus has formed.

4. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.

5. Wipe the outside of sample vials with a Kimwipe or clean paper towel. Affix a completed sample label.

6. Place sample vial(s) in a zip-top plastic bag and seal the bag.

7. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Discrete Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

The following steps must be followed when collecting discrete shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Directly dip the sample container, with the opening facing upstream, into the surface water and fill. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. Do not disturb underlying sediments.

2. Filter samples if required by the site-specific plan.

3. Add appropriate preservatives to the sample containers if required and check pH.

Note: Use a separate container when field testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

4. Cap the sample containers and wipe the outer surfaces of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

5. Place sample container(s) in individual zip-top plastic bags, if possible, and seal the bags.

6. Immediately pack all samples into a chilled cooler.

5.2.3 Method for Collecting Simple Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of simple composite samples, then a sampler capable of collecting composite samples is required. For width and depth integrated (WDI) composite samples, a DH-48 or DH-81 are recommended, but the QAPP may specify an alternative. The following steps must be followed when collecting simple composite shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Record the gage height, if any, before and after sampling.

2. Select the number of width increments based on the requirements of the QAPP. Generally, small well mixed streams require few increments while large or poorly mixed streams require more increments.

3. For fewer than six width increments, subsample locations can be visually estimated. For more than five width increments, string a tape measure across the stream above the water surface to be able to accurately identify the subsample locations. Increments should be evenly spaced across the stream for equal width-integrated (EWI) sampling.

4. If depth-integrated sampling is required, collect a subsample at each width increment by submerging the sampler, orifice facing upstream, from the surface to near the bottom and back up to the surface again in an even steady motion. Do not disturb the sediment at the bottom. The sampler should be retrieved less than full. If the sampler is full, empty it and repeat the subsample collection.

5. If depth-integrated sampling is not required, submerge the sampler with the orifice facing upstream into the surface water and fill.

6. Empty the sampler into a churn splitter or temporary container for later splitting.

7. Repeat Steps 4 to 6 for each width increment.

8. If temporary containers were used, empty into churn splitter. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.

9. Follow Steps 2 though 6 in Section 5.2.2.

5.2.4 Method for Collecting Temporal Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of temporal composite samples, this can be accomplished using a series of discrete samples collected by hand or an automated sampler, or using a series of simple composite samples. Refer to the preceding sections for collecting the subsamples. The compositing scheme can be time-based (e.g., once per hour for 4 hours) or time-discharge (or time gage height) based (e.g., once per hour until the gage height exceeds xx feet, then change to once per 15 minutes).

Because of the project-specific nature of temporal composite sampling, the specific requirements should be identified in the QAPP. The following are general steps to be followed to collect temporal composite samples:

1. Provide for a method of measuring discharge or gage height before, during, and after sample collection as required in the QAPP.

2. Select the number of time increments based on the requirements of the QAPP. If the time increments change based on a change in flow or water quality, specify the trigger, the new time increment, and any additional trigger to return to the previous increment.

3. Calculate the storage volume for the subsamples and provide a churn splitter of adequate size to contain the entire sample to be composited.

4. Collect the samples according to a method described in this SOP or alternate specified in the QAPP.

5. Provide for cold storage of subsamples, if possible. Do not process any subsamples by filtering or preserving unless specified in the QAPP.

6. Following collection of all subsamples, empty the containers into a churn splitter. If discrete data are required including laboratory or field analysis, retain a portion of the subsample.

7. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.

8. Follow Steps 2 though 6 in Section 5.2.2.

9. Field parameters should be measured in the surface water at the time of collection. Some field parameters can be measured on the subsamples at the time of compositing, but the temperature and temperature-dependant parameters will not be representative.

5.3 Deep Surface Water Sample Collection

5.3.1 Method for Collecting Samples at Specified Depth Using a Weighted Bottle Sampler

The following steps must be followed when collecting surface water samples at specific depths using a weighted bottle sampler:

1. Lower the weighted bottle sampler to the depth specified in the site-specific plan.

2. Remove the stopper by pulling on the sampler line; allow the sampler to fill with water.

3. Release the sampler line to reseat the stopper and retrieve the sampler to the surface.

4. Wipe the weighted bottle sampler dry with a Kimwipe or clean paper towel.

5. Remove the stopper slowly. Fill the specified number of sample containers by slightly tipping the sampler against each sample bottle. Samples to be used for VOC analysis should be decanted directly from the sampler first into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Add appropriate preservatives to the other sample containers and check pH. Samples may be pooled in stainless steel, glass, or Teflon containers to obtain the necessary volumes. Filter samples if required. Collect sample in separate container for pH, conductivity, temperature, and other measurements if necessary.

6. Close each sample container with the Teflon-lined cap once it is filled. Check for air bubbles in the VOC sample containers. If bubbles are present, discard and resample.

7. Wipe the outside of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

8. Place sample container(s), if possible, in individual zip-top plastic bags, and seal the bags.

9. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Deep Surface Water Sample Collection Using a Peristaltic Pump

The following steps must be followed when collecting deep surface water samples using a peristaltic pump:

1. Install clean medical-grade silicon or Teflon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.

2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling depth. Attach the intake sampling tube to the intake pump tube.

3. Lower the intake tube into the surface water at the specified sampling location to the specified depth; make sure the end of the intake tube does not touch underlying sediments.

4. Start the pump and allow at least three tubing volumes of liquid to flow through and rinse the system before collecting any samples. Do not immediately dispense the purged liquid back to the surface water body. Instead, collect the purged liquid and return it to the source after sample collection is complete.

5. Fill the specified number of sample containers directly from the discharge line. Filter samples if required by the site-specific plan. While filling, allow the liquid to flow gently down the inside of the sample bottle to minimize turbulence.

For VOC samples, fill prepreserved VOA vials and allow a meniscus to form above the top of the container before capping. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Check VOA vials to ensure that there are no air bubbles. Add appropriate preservatives to the other samples and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

6. Cap the sample container(s). Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.

7. Place sample container(s) in individual zip-top plastic bags and seal the bags.

8. Immediately pack all samples into a chilled cooler.

9. Drain the pump system, rinse it with deionized water, and wipe it dry. Replace all tubing with new tubing before sampling at another sampling location. Place all used tubing in plastic bags to be discarded or decontaminated according to the site-specific plans.

6.0 Restrictions/Limitations

Peristaltic pumps are generally not capable of lifting water distances greater than 20 to 25 feet (6 to 7.5 meters) above the normal hydrostatic level.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point and has been disturbed.

7.0 References

U. S. Department of Energy. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods,* DOE/HWP-69/R1. July 1990 or current revision.

__________. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R2. September 1996 or current revision.

U. S. Environmental Protection Agency, Region 2. *CERCLA Quality Assurance Manual*. March 1988 or current revision.

__________, Region 4. *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual*. May 1996 or current revision.

U. S. Geological Survey. *National Field Manual for the Collection of Water-Quality Data*, *Chapter A4*. September 1999.

__________. A guide to the Proper Selection and Use of Federally Approved Sediment and Water Quality Samplers. Open-File Report 2005-1087. 2005.

Sample Custody	SOP 1-2 Revision: 5 Date: March 2007

Prepared: David O. Johnson

Technical Review: S. Budney

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt

QA Review: Jo Nell Mullins

Approved: *Signature/Date*

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VERIFY authenticity with ApproveIt

Issued: *Signature/Date*

1.0 Objective

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements shall be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

2.0 Background

2.1 Definitions

Sample - A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

Chain-of-Custody Record - A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 General Responsibilities

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

Field Team Leader - The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork.

Field Sample Custodian - The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM forms)
- Sample labels and/or tags
- EPA Field Operations Records Management System II Lite™ (FORMS II Lite™) software (if required)
- Printer paper
- Custody seals
- Clear tape
- Computer
- Printer

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations before the actual fieldwork. As few people as possible shall handle samples.

2. Complete sample labels or tags for each sample using waterproof ink.

3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.

   - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.

   - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

Note: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, a chain-of-custody record shall be filled out for each cooler documenting only samples contained in that particular cooler.

3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record and field logbook in accordance with TSOP 4-1, *Field Logbook Content and Control*.

Procedure for Completing CDM Example Chain-of-Custody Record
The following procedure is to be used to fill out the CDM chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA Contract Laboratory Program (CLP) or a subcontract laboratory or generated by FORMS II Lite™) is used to track the custody of samples, the custody record shall be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the “Remarks” box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier’s airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time.
13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter appropriate designation for laboratory quality control (e.g., matrix spike/matrix spike duplicate [MS/MSD], matrix spike/duplicate [MS/D]), or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the “Remarks” column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left “Relinquished by” box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under “Remarks” on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent “Received by” box and keeps the copy. The white copy is returned to CDM.

5.2 Sample Labels and Tags
Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM projects.

1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):

   - Record the project code (i.e., project or task number).
   - Enter the station number (sample number or EPA CLP identification number) if applicable.
   - Record the date to indicate the month, day, and year of sample collection.
   - Enter the time (military) of sample collection.

- Place a check to indicate composite or grab sample.
- Record the station (sample) location.
- Sign in the space provided.
- Place a check next to “yes” or “no” to indicate if a preservative was added.
- Place a check under “Analyses” next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for “laboratory sample number.”
- Place or write additional relevant information under “Remarks.”

2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

3. Securely attach sample tags to the sample bottle. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring-style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted, and relooped around the neck until the slack in the string is removed.

4. Double-check that the information recorded on the sample tag is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals
Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) before shipment. The seals shall be signed and dated by the shipper.

Custody seals may also be required to be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping
CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples* defines the requirements for packaging and shipping environmental samples.

6.0 Restrictions/Limitations
Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure shall be followed.

For EPA CLP sampling events, combined chain-of-custody/traffic report forms generated with EPA FORMS II Lite™ or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM project manager.

7.0 References
U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. Revised March 1992. *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p.85.

__________. Region IV. 1996. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Section 3.3. May.

__________. 2002. *FORMS II Lite™ User’s Guide, Version 5.1*.

__________. 2002. *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/240/R-02/009. Section 2.2.3. December.

__________. 2004. *Contract Laboratory Program (CLP), Guidance for Field Samplers,* EPA-540-R-00-003. Final. Section 3.2. August.

Figure 1
Example CDM Chain-of-Custody Record

CDM

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

CHAIN OF CUSTODY RECORD

PROJECT ID.	FIELD TEAM LEADER	LABORATORY AND ADDRESS	DATE SHIPPED
PROJECT NAME/LOCATION		LAB CONTRACT:	AIRBILL NO.

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other ______________

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other ________________

SAMPLE TYPE
G = Grab
C = Composite

ANALYSES (List no. of containers submitted)

SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESER-VATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	20__ DATE	TIME SAMPLED									REMARKS (Note if MS/MSD)
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

SAMPLER SIGNATURES:

RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME
RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME	RELINQUISHED BY: (PRINT) (SIGN)	DATE/TIME	RECEIVED BY: (PRINT) (SIGN)	DATE/TIME

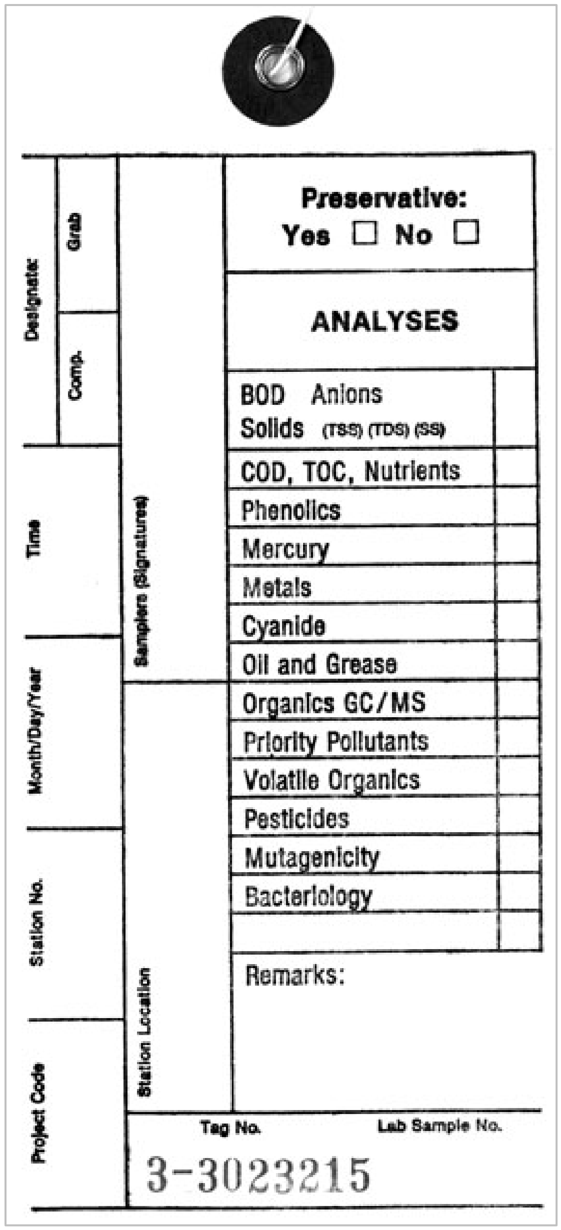
COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers.

1/98

Note: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

Figure 2
Example Sample Tag



Note: Equivalent sample labels or tags may be used.

Surface Soil Sampling

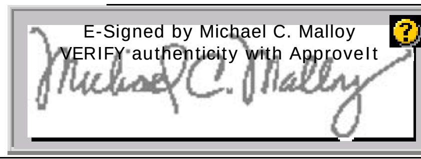
SOP 1-3
Revision: 6
Date: March 2007

Prepared: Del R. Baird

Technical Review: Mark Caldwell

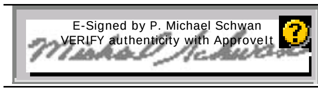
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the techniques and requirements for the collection of surface soil samples.

2.0 Background

The techniques and protocols described herein may be used to collect other surface media, including sediment and sludge.

2.1 Definitions

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Spoon/Scoop - A small stainless steel or Teflon® utensil approximately 15 cm (6 inches) in length with a stem-like handle.

Surface Soil - Soils generally defined as the soils extending from ground surface to approximately 30 centimeters (cm) (1 foot) below ground surface (bgs). Surface soil samples are frequently collected from 0 to 15 cm (0 to 6 inches) bgs. Depending on application, the soil interval to be sampled will vary.

Trowel - A small stainless steel or Teflon shovel approximately 15 to 20 cm (6 to 8 inches) in length with a slight (approximately 140°) curve across the length. The trowel has a stem-like handle (for hand operation). Samples are collected with a spooning action.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Surface soil samples are collected to determine the type(s) and level(s) of contamination and are often important to risk assessment. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling.

Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically the top 1 to 2 cm of material are carefully removed before collection of the sample. If a thick, matted root zone is encountered at or near the surface, it shall be removed before collecting the sample.

Surface soil, exposed sediment, or sludge is collected using stainless steel and/or Teflon-lined trowels or scoops.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of surface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect surface soil samples in accordance with this procedure and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

- Insulated cooler and clear waterproof sealing tape
- Ice bags or “blue ice”
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, or bowls
- Stainless steel and/or Teflon-lined trowels or spoons (or equipment as specified in the site-specific plans)
- Plastic sheeting
- Project plans (work plan/health and safety plan)
- Appropriate sample containers
- Field logbook
- Indelible black ink pen and/or marker
- Sample chain-of-custody forms
- Custody seals
- Decontamination supplies

Additional equipment is discussed in Section 5.2.2, VOC Field Sampling/Preservation Methods.

5.0 Procedures

5.1 Preparation

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

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

3. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

4. Processes for verifying depth of sampling must be specified in the site-specific plans.

5. Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place equipment to be used on the plastic; place the insulated cooler(s) on separate plastic sheeting.

6. A clean, decontaminated trowel, scoop, or spoon will be used for each sample collected. Other equipment may be used (e.g., shovels) if constructed of stainless steel.

5.2 Collection

The following general steps must be followed when collecting surface soil samples:

1. Wear clean gloves during handling of all sample containers and sampling devices.

2. Surface soil samples are normally collected from the least contaminated to the most contaminated areas, if known.

3. Document the sampling events, recording the information in the designated field logbook. Document any and all deviations from SOPs in the field logbook and include rationale for changes. See CDM Federal SOP 4-1.

4. Carefully remove stones, vegetation, snow, etc. from the ground surface in the immediate vicinity of the sampling location.

5. First collect required sample aliquot for volatile analyses, as well as any other samples that would be degraded by aeration. Follow with collection of samples for other analyses.

6. Decontaminate sampling equipment between sample locations. See CDM Federal SOP 4-5.

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis
The requirements for collecting grab samples of surface soil for volatile organic compounds (VOCs) or other samples degraded by aeration are as follows:

1. VOC samples shall be collected with the least disturbance possible.

2. VOC samples shall be collected as grab samples; however, the method of collection will vary from site to site, based on data quality objectives and the degree of known or suspected contamination.

3. Complete sample label by filling in the appropriate information and securing the label to the container. Cover the sample label with a piece of clear tape.

4. Use a clean stainless steel or Teflon-lined trowel or spoon (or tube) to collect sufficient material in one grab to fill the sample containers.

5. With the aid of a clean stainless steel spatula, quickly fill the sample containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Fill the containers as full and compact as possible to minimize headspace.

6. Immediately secure the Teflon-lined cap(s) on the sample container(s).

7. Wipe the containers with a clean Kimwipe or paper towel to remove any residual soil from the exterior of the container.

8. Place the containers in individual zip-top plastic bag(s) and seal the bag(s).

9. Pack all samples as required. Include properly completed documentation and affix signed and dated custody seals to the cooler lid. See CDM Federal SOPs 1-2 and 2-1.

Note: A trip blank shall be included with sample coolers containing VOC samples. QC sample requirements vary from project to project. Consult the project-specific work plan for requirements.

5.2.2 VOC Field Sampling/Preservation Methods
The following four sections contain SW-846 test methods for sampling and field preservation. These methods include EnCore™ Sampler Method for low-level analyses, EnCore Sampler Method for high-level analyses, acid preservation for low-level analyses, and methanol preservation for high-level analyses. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements.

Note: Some variations from these methods (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.2.2.1 EnCore Sampling Equipment and Collection for Low Level Analyses (<200 µg/kg)
The following equipment is required for low-level analysis:

- Three 5-gram (g) samplers

Note: The sample volume requirements are general requirements. Actual sample volumes, sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce) wide-mouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting low level analysis (<200 µg/kg) by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.

2. Remove sampler and cap from package and attach T-handle to sampler body.

3. Quickly push the sampler into a freshly exposed surface of soil until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

4. Extract the sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.

5. Push cap on with a twisting motion to secure to the sampler body.

6. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.

7. Fill out sample label and attach to sampler.

8. Repeat procedure for the remaining two samplers.

9. Collect moisture sample in 110-mL (4-ounce) wide-mouth jar using a clean stainless steel spoon or trowel.

10. Store samples at 4° Celsius (C), (±2°C). Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.2 Acid Preservation Equipment and Sampling Requirements for Low Level Analyses (<200 µg/kg)
Note: Determine specific field acid preservation procedure based on the requirements specified in the analytical method to be employed. Variations between analytical methods exist with respect to field acid preservation.

The following equipment and supplies are required if field acid preservation is required:

- One 40-mL VOA vial with acid preservation (for field testing of soil pH)
- Two preweighed 40-mL VOA vials with acid preservative and stir bar (for lab analysis)
- Two preweighed 40-mL VOA vials with water and stir bar (in case samples cannot be pre-preserved)
- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (for screening sample and/or high level analysis)
- One 110-mL (4-oz) wide-mouth glass jar or applicable container for moisture analysis
- One 55-mL (2-oz) jar with acid preservative (if additional acid is needed because of high soil pH)
- One appropriately sized scoop capable of delivering 1 g of solid sodium bisulfate
- pH paper
- Weighing scale capable of reading to 0.01 g

- Set of balance weights used in daily balance calibration
- Gloves for working with preweighed sample vials
- Paper towels
- Sodium bisulfate acid solution ($NaHS0_4$)
- A cutoff plastic syringe or other coring device capable of collecting sufficient sample volume (5 g)

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a high pressure in a sealed vial that could result in the explosion of the sample container. The following steps provide information on the effervescing capacity of the soil.

1. Wear clean gloves during handling of all sample containers and sampling devices.

2. Place approximately 5 g of soil into a vial that contains acid preservative and no stir bar.

3. Do not cap this vial as it may EXPLODE upon interaction with the soil.

4. Observe the sample for gas formation (due to carbonates in the soil).

5. If vigorous or sustained gas emissions are observed, then acid preservation is not acceptable to preserve the sample.
   - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

6. If a small amount or no gas formation occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.
   - In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to achieve a pH reading of ≤2 standard units (SUs). The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used to test the effervescing capacity of the soils can be used to test the buffering capacity.

2. Wear clean gloves during handling of all sample containers and sampling devices.

3. Cap the vial that contains 5 g of soil, acid preservative, and no stir bar from Step 1 in the effervescing test.

4. Shake the vial gently to homogenize the contents.

5. Open the vial and check the pH of the acid solution with pH paper.
   - If the pH paper reads below 2, then the sampling can be done in the two preweighed 40-mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.
   - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

6. Use the jar with the solid sodium bisulfate acid and add another 1 g of acid to the sample.

7. Cap the vial and shake thoroughly again.

8. Repeat Step 4.
   - If the pH paper reads below 2, then the sampling can be done in the two preweighed 40-mL VOA vials with the acid preservative and stir bar and 1 g extra of acid.

- Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.
- If the pH paper reads above 2, repeat Steps 5 through 7 until the sample pH ≤2 SUs.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear clean gloves during all handling of preweighed vials.
2. Add more acid if necessary (based on the buffering capacity testing discussed in the previous section).
3. Quickly collect a 5-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g of soil from a freshly exposed surface of soil.
4. Carefully wipe exterior of sample collection device with a clean paper towel.
5. Quickly transfer the sample to the appropriate VOA vial, using caution when extruding the sample to prevent splashing of the acid within the vial.
6. Remove any soil from the threads of the sample vial using a clean paper towel.
7. Cap vial and weigh the jar to the nearest 0.01 g.
8. Record exact weight on sample label.
9. Repeat sampling procedure for the duplicate VOA vial.
10. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.
11. Take the empty jar or the jar that contains the methanol preservative and quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size is dependent on who is doing the sampling and requirements specified by the client or analytical laboratory.
12. Carefully wipe the exterior of the collection device with a clean paper towel.
13. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial.
14. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
15. Remove any soil from the threads of the sample vial using a clean paper towel and cap the jar.
16. Weigh the jar with sample to the nearest 0.01 g and record the weight on the sample label.
17. Collect dry weight sample using a clean stainless steel spoon or trowel.
18. Store samples at 4°C, ±2°C.
19. Ship sample containers to the analytical laboratory with plenty of ice and in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.2.3 EnCore Sampling Equipment and Sampling Requirements for High Level Analysis (≥200 µg/kg)
The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler

Note: The volume requirements specified are general requirements. Actual sample volumes, container sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-mL (4-oz) wide-mouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting high level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sample and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into freshly exposed surface of soil until the O-ring is visible within the hole/window on the side of the T-handle. If the O-ring is not visible within the window/hole, then the sampler is not full.
4. Use a clean paper towel to quickly wipe the sampler head so that the cap can be tightly attached.
5. Push cap on with a twisting motion to secure to the sampler body.
6. Fill out sample label and attach to sampler.
7. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
8. Collect moisture sample in 110-mL (4-oz) wide-mouth glass jar or designated container using a clean stainless steel spoon or trowel.
9. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.4 Methanol Preservation Equipment and Sampling Requirements for High Level Analyses (≥200 µg/kg)
The following equipment is required for high-level analysis:

- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

The requirements for sampling and preservation are as follows:

1. Wear clean gloves during all handling of preweighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil.
4. Carefully wipe the exterior of the collection device with a clean paper towel.
5. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.
6. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
7. Remove any soil from the exterior of the vial using a clean paper towel and cap the sample jar.
8. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.
9. Collect a dry weight sample using a clean stainless steel spoon or trowel.
10. Store samples at 4°C, ±2°C.
11. Ship sample containers with plenty of ice to the analytical laboratory in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis
The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.
3. Use a decontaminated stainless steel or Teflon-lined trowel or spoon to obtain sufficient sample from the required interval and subsampling points, if necessary, to fill the specified sample containers.
4. Empty the contents of the sampling device directly into a clean stainless steel or Teflon-lined tray or bowl.
5. Homogenize the sample by mixing with a spoon, spatula, or trowel.
6. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.
7. Secure the appropriate cap on each container immediately after filling it.
8. Wipe the sample containers with a clean Kimwipe or paper towel to remove any residual soil.
9. Place sample containers in individual zip-top plastic bags and seal the bags.
10. Pack all samples as required. Include properly completed documentation and affix custody seals to the cooler lid.
11. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

6.0 Restrictions/Limitations

When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

U. S. Department of Energy. 1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

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Groundwater Sampling Using Bailers

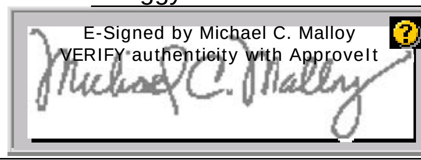
SOP 1-5
Revision: 6
Date: March 2007

Prepared: Del Baird

Technical Review: Peggy Bloisa

QA Review: Jo Nell Mullins

Approved:



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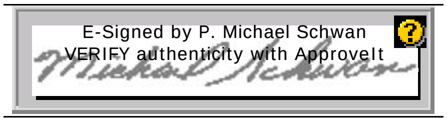

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1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for the collection of groundwater samples with bailers.

2.0 Background

Collection of groundwater samples from monitoring wells on or near a hazardous waste site may be required to characterize the nature and extent of contamination.

Methods used for the collection of groundwater samples include bailing and a variety of pumping techniques. Bailers are hollow cylinders with unidirectional (open up) check valves at the bottom end. Some bailers may also be closed or valved at the upper end. Bailers used in environmental applications are typically constructed of polyvinyl chloride (PVC), polyethylene, stainless steel, or Teflon®. Disposable polyethylene, PVC, and Teflon bailers are becoming more commonly used and eliminate the possibility of cross contamination as a result of poor decontamination. The bailer cable typically consists of disposable nylon cord, disposable polypropylene cord, or Teflon-coated stainless steel wire. The bailer is lowered into the well on an acceptable line until submerged. The bailer is then retrieved to the surface for sample collection. For the best results, the sequence of sampling is from least to most contaminated wells. It is preferable to have bailers dedicated to each monitoring well.

2.1 Associated Procedures

- CDM Federal (CDM) SOP 1-2, *Sample Custody*
- CDM SOP 1-6, *Water Level Measurement*
- CDM SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-3, *Well Development and Purging*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that groundwater samples are collected in accordance with this procedure.

Field Team Leader - The field team leader is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any associated SOPs.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers

- Labels and appropriate forms/documentation for sample shipment
- Sample chain-of-custody forms
- Insulated cooler and waterproof sealing tape (strapping tape)
- Plastic zip-top bags
- Ice double-bagged in plastic zip-top bags
- Bailer of the appropriate design and construction for the sampling application
- Clean cord or wire of sufficient length for conditions
- Water level meter and/or other water level measuring device
- Clean beaker(s) or other container for measurement of water quality parameters
- Plastic sheeting (4-mil thickness)
- Latex or appropriate gloves
- Filtering apparatus, if required
- Appropriate sample containers with labels and preservatives, as required
- Temperature, conductivity, pH, dissolved oxygen, turbidity, and other meters as required by the site-specific field sampling plan
- Photoionization detector (PID) or equivalent and other instruments as required by the site-specific health and safety plan
- Decontamination supplies, as required by CDM SOP 4-5
- Personal protective clothing and equipment as required by the site-specific health and safety plan

5.0 Procedures

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan. All field equipment will be calibrated, tested, or checked for proper functioning before use per the manufacturer's instructions.

3. Prepare the site for sample acquisition. If required, cover the ground surface around the wellhead with plastic sheeting. Arrange the required decontaminated sampling and monitoring equipment for convenient use. If onsite decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the wellhead (i.e., in an exclusion zone).

4. Open the well and note the condition of the casing and cap. Immediately check for organic vapors using a PID or flame ionization detector as appropriate. Refer to the site health and safety plan for the required monitoring and frequencies.

5. Determine the static water level and depth to well bottom in accordance with CDM SOP 1-6. Record this information in the field logbook or on the appropriate form.

6. Purge the well according to CDM SOP 4-3. Allow the water level in the well to recover to 75 percent of its static level so that a representative sample of the screened portion of the aquifer can be obtained. The bailer shall be completely submerged so that it does not contact the bottom of the well. Samples shall be collected within 3 hours of purging if recharge is sufficient. Wells with a low recharge rate must be collected within 24 hours of purging.

7. Securely attach the bailer to the line. The opposite end of the line shall be secured to prevent loss of the bailer into the well.

8. Arrange the sample containers in the order of use. Samples to be analyzed for volatile organic compounds (VOCs), if required, shall be obtained first, followed in order by other organic samples, then inorganic samples and other parameters. For example:

   a) VOCs
   b) Purgeable organic carbon (POC)
   c) Purgeable organic halogens (POX)
   d) Total organic halogens (TOX)
   e) Total organic carbon (TOC)
   f) Extractable organics*
   g) Total metals
   h) Dissolved metals
   i) Cyanide
   j) Sulfate and chloride
   k) Nitrate and ammonia
   l) Radionuclides

   *Extractable organics include semivolatile organic compounds, pesticides, and PCBs.

9. Don clean sampling gloves; lower the decontaminated or disposable bailer into the well. The bailer shall enter the water slowly to prevent aeration, particularly when VOC samples are being collected. Care shall be taken to avoid having the bailer come in contact with the well bottom.

10. Retrieve the filled bailer to the surface. To prevent contamination of the bailer line, do not allow line to contact the ground, rather keep line on the plastic sheeting. Hang the bailer from a bailer stand or other support, if available, or have an assistant hold it off the ground. Immediately obtain any required volatile samples (VOC, POC, POX, TOX, or TOC) by gently transferring water from the bailer to the sample bottle through a VOC sampling device inserted into the bottom of the bailer. Care shall be taken to adjust the flow of the water into the vial so that it is not too fast. The vial shall also be tilted so that the stream of water is directed down the side of the vial to reduce nonlaminar flow into the vial and to prevent aeration. Check the filled VOC vials for bubbles. If bubbles are present in a vial, discard it and fill another vial from the bailer. After collecting volatile samples, lower the bailer to collect additional water for the remaining parameters. If sample filtration is required for metals, it shall be performed immediately following sample retrieval, and before sample preservation. Organic samples generally do not require filtration; VOC samples shall never be filtered. Preservation of samples shall be performed according to the applicable field plan. Check the pH on samples (other than VOCs) that require preservation. Collect additional quality assurance/quality control samples (i.e., duplicate samples) as required by the applicable field plan.

11. Wipe the outer surfaces of the sample containers clean with a Kim-wipe or clean paper towel. Additional sample bottle decontamination may be appropriate in some cases.

12. Properly label all containers according to CDM SOP 2-1.

13. Place sample containers in individual zip-top plastic bags and seal the bags (if required by site-specific plans).

14. Immediately pack all sample containers that require a 4ºC preservation on ice in coolers (refer to the site-specific field sampling plan).

15. Record analytes and volumes collected, and time and date of collection in the field logbook. Prepare chain-of-custody forms according to site-specific plans and CDM SOP 1-2.

16. Decontaminate sampling equipment as needed, according to CDM SOP 4-5.

17. Close and lock the well cover. Clean up the area and place disposable materials (plastic sheeting, gloves, Tyvek®) in the designated waste receptacle.

18. If required by the site-specific field sampling plan, obtain required field measurements such as temperature, conductivity, pH, oxidation potential (Eh), turbidity, salinity, or dissolved oxygen measurements immediately after samples have been collected and record them in the field logbook.

6.0 Restrictions/Limitations

Careful sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

Use of nondisposable bailers may contribute to cross contamination if proper and thorough decontamination procedures are not followed.

7.0 References

Office of Solid Waste and Emergency Response. 1992. *RCRA Ground-water Monitoring: Draft Technical Guidance*, EPA/530/R-93/001. November.

Office of Solid Waste and Emergency Response. 1986. *RCRA Groundwater Monitoring Technical Guidance Enforcement Document*, OSWER-9950.1. September.

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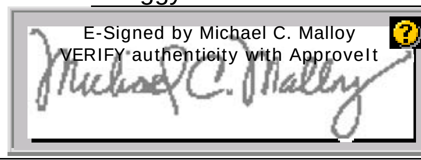
# Water Level Measurement	SOP 1-6 Revision: 6 Date: March 2007

Prepared: Del Baird

Technical Review: Peggy Bloisa



QA Review: Jo Nell Mullins

Approved:

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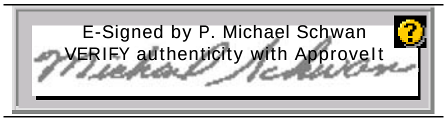

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1.0 Objective

Water level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate the amount of groundwater to be purged from the well. This standard operating procedure (SOP) defines the techniques and requirements for obtaining groundwater level measurements.

2.0 Background

2.1 Definitions

Water Level Indicator - A portable device for measuring the depth from a fixed point (which could be below, at, or above the ground surface) to the groundwater inside a well, borehole, or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well from which all water level measurements from that particular well are made. The measurement point shall be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (as a result of circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole, or other underground opening that is not influenced by discharge or recharge.

Well Riser - A steel, stainless steel, or polyvinyl chloride pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The upper portion (approximately 3 to 5 feet) of the well riser is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well riser. In flush-mounted wells, the protective casing will extend only high enough so that the well and protective casing can be enclosed by a Christy box or equivalent vault. In above-grade wells, the protective casing will extend above the ground surface approximately 2 to 3 feet. The protective casing protects the well riser.

2.2 Associated Procedures

- CDM Federal (CDM) SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion
The most common uses of static water level data are to determine the elevation of groundwater, the direction of groundwater flow, to identify areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relationships. Specific uses for water level data may include:

- Determine the change in water level due to distribution or rate of regional groundwater withdrawal
- Show the relationship of groundwater to surface water
- Estimate the amount, source, and area of recharge and discharge
- Determine rate and direction of groundwater movement

Static water level measurements shall be obtained from each well before purging, sampling, or other disturbance of the water table.

3.0 General Responsibilities
Project Manager - The project manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The field team leader is responsible for ensuring that field personnel obtain water level measurements in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment
4.1 General
- Site-specific plans
- Field logbook
- Indelible black ink pens
- Permanent felt-tip marker (e.g., Sharpie)
- Personal protective equipment
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Tap water and large beaker or bucket
- Water level meter

4.2 Measuring Devices
The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

Electrical tapes are preferred over other devices such as steel tape because of the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.® and Solinst® electronic water level indicators. These instruments are powered by batteries that shall be checked before mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains the batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution shall be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level before activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option. In groundwater with high conductivity the sensitivity control may need to be turned down, and in groundwater with low conductivity the sensitivity control may need to be turned up to get a proper depth to groundwater measurement.

5.0 Procedures

5.1 Preparation

The following steps must be taken when preparing to obtain a water level measurement:

- Assign a designated field logbook to record all field events and measurements according to CDM SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the logbook and include rationale for the changes.
- Always exercise caution to prevent inappropriate or contaminated materials from entering an environmental well.
- Standing upwind from the well, open the groundwater well. Monitor the well with a photoionization detector, flame ionization detector, or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements shall always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. The elevations calculated from the measurement of static water levels shall be referenced to mean sea level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe shall be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials shall not be used.

5.2 Water Level Measurement Using Electrical Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

- Before lowering the probe into the well, the circuitry shall be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe shall then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second and third check reading to verify the measurement before completely withdrawing the tape from the well.
- Independent electrical tape measurements of static water levels using the tape shall agree within 0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape shall be within 0.1 foot.
- Decontaminate the electrical tape according to CDM SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to becoming permanently stretched.

5.3 Other Water Level Measurement Methods

Although the method cited above (electrical water level indicator) for measuring water levels predominates in the environmental sector, there are a number of other methods available that may be well suited for a particular purpose.

5.3.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual readings.

5.3.2 Pressure Gauge Method

This method, also called the air-line submergence method, uses a pressure gauge and is the preferred method for obtaining water level measurements in pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end at the surface is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.3.3 Acoustic Probe Method

The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is lowered into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.3.4 Continuous Recording Method

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital analog computerized continuous recording system and shall be performed according to specifications given by the manufacturer of each unit. In general, when using the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring shall be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers' specifications.

6.0 Restrictions/Limitations

6.1 Groundwater and Miscible Fluids

Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device, resulting in a false water level measurement. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but shall be used with the awareness of possible false measurements. To minimize the effects of "splashing," a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well into which the water level indicator would be inserted. This will minimize the effect of "splashing" until the probe contacts the groundwater and protect the probe from becoming tangled in pump wiring or well spacers associated with downhole equipment such as submersible pumps.

6.2 Immiscible Fluids

For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. A conventional electrical tape often will not respond to nonconducting immiscible fluids.

Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. A special paste or gel applied to the end of the steel tape and submerged in the well will show the top of the oil as a wet line and the top of the water as a distinct color change, or an interface probe can be used that will detect the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. These methods are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than it shall. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable for determining hydraulic gradients without further interpretation. To use such data for determining hydraulic gradients, the difference in density between the light immiscible phase and water has to be considered.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 References

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Packaging and Shipping Environmental Samples

SOP 2-1
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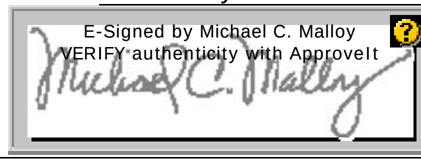
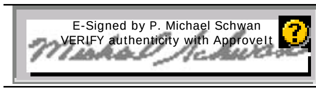


QA Review: Jo Nell Mullins

Approved:

Signature/Date



Issued:

Signature/Date

1.0 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.1 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

Section 2.0 - Packaging and Shipping Samples Preserved with Methanol
Section 3.0 - Packaging and Shipping Samples Preserved with Sodium Hydroxide
Section 4.0 - Packaging and Shipping Samples Preserved with Hydrochloric Acid
Section 5.0 - Packaging and Shipping Samples Preserved with Nitric Acid
Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

1.2 Background

1.2.1 Definitions

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity - Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing - Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*

1.2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. ***Note***: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler shall reflect only those samples within the cooler.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

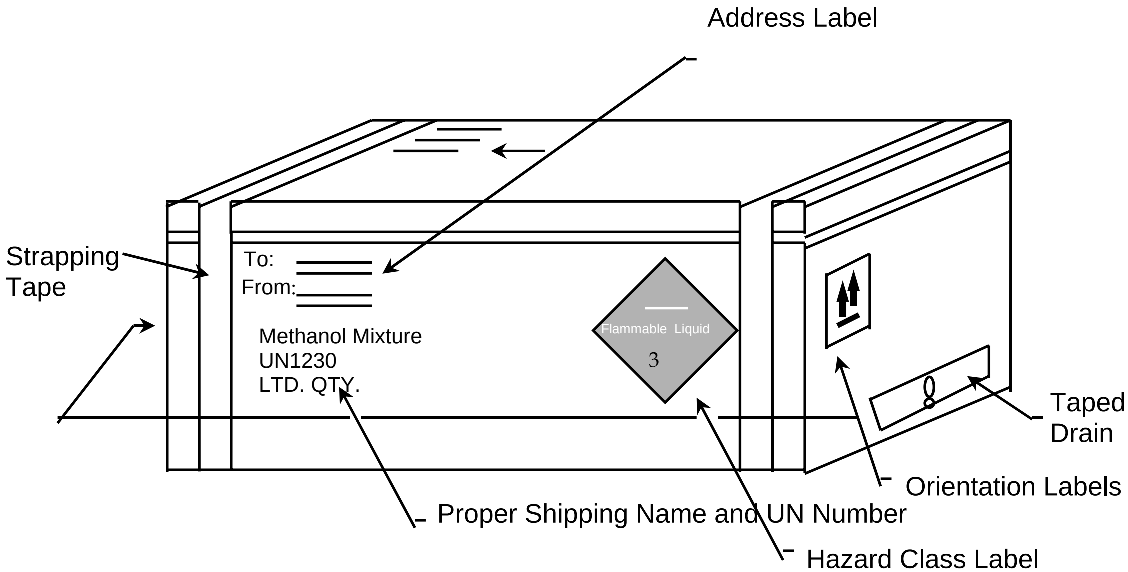
Methanol Mixture
UN1230
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.
Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1
Example of Cooler Label/Marking Locations



3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

Preservative		***Desired in Final Sample***		***Quantity of Preservative (ml) for Specified Container***				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sodium Hydroxide Solution
UN1824
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

Preservative		*Desired in Final Sample*		*Quantity of Preservative (ml) for Specified Container*		
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Hydrochloric Acid Solution
UN1789
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

Preservative		***Desired in Final Sample***		***Quantity of Preservative (ml) for Specified Container***				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
HNO_3	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 mg/L

5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

5.4 Packaging Samples Preserved with Nitric Acid

Samples containing HNO_3 as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Nitric Acid Solution (with less than 20 percent)
UN2031
Ltd. Qty.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.15 percent HNO_3 by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		***Desired in Final Sample***		***Quantity of Preservative (ml) for Specified Container***				
		pH	**Conc.**	**40 ml**	**125 ml**	**250 ml**	**500 ml**	**1 L**
H_2SO_4	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing H_2SO_4 as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

    Sulfuric Acid Solution
    UN2796
    LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as nonregulated or nonhazardous in accordance with the procedure described in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring before shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma). It shall be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments:

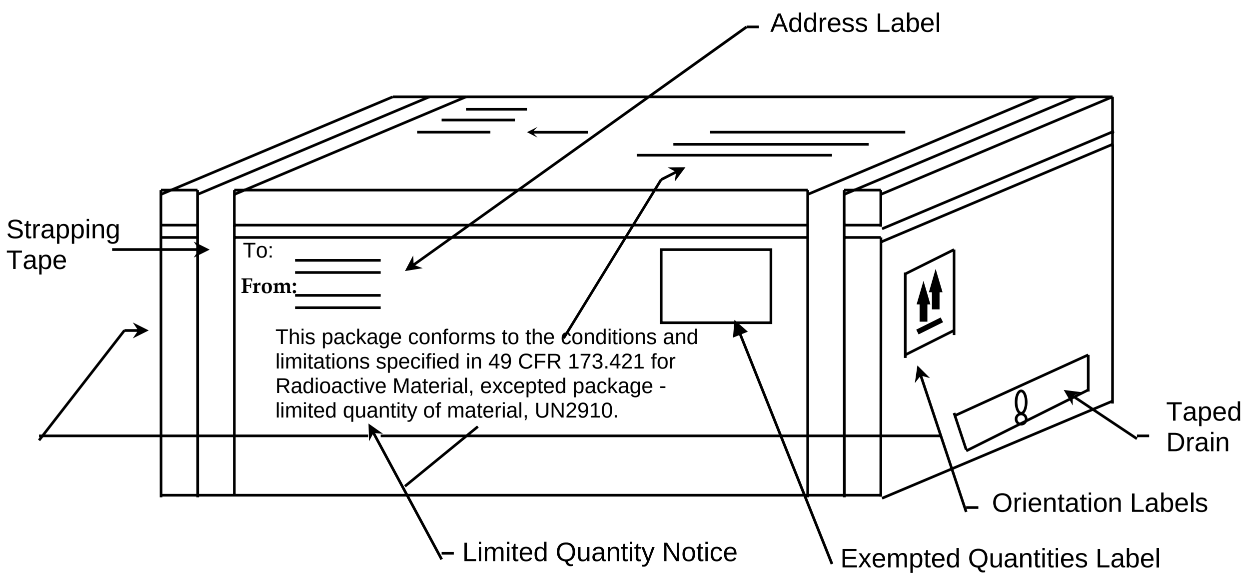
- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: ***"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."***
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

Note: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U.
Note: A declaration of dangerous goods is not required.

Figure 2
Radioactive Material – Limited-Quantity Cooler Marking Example



8.0 References

U. S. Environmental Protection Agency. Region IV. February 1991 or current. *Standard Operating Procedures and Quality Assurance Manual*.

__________. 1996 or current. *Sampler's Guide to the Contract Laboratory Program*, EPA/540/R-96/032.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Shippers General Requirements for Shipments and Packagings*, 49 CFR 173.

Appendix A

Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

Sample Packaging

Yes	No	N/A	
❏	❏	❏	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
❏	❏	❏	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
❏	❏	❏	The drain plug is taped inside and outside to ensure control of interior contents.
❏	❏	❏	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
❏	❏	❏	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
❏	❏	❏	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
❏	❏	❏	The chain-of-custody has been secured to the interior of the cooler lid.
❏	❏	❏	The cooler lid and sides have been taped to ensure a seal.
❏	❏	❏	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
❏	❏	❏	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
❏	❏	❏	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
❏	❏	❏	Section 3 has the **Bill Sender** box checked.
❏	❏	❏	Section 4 has the **Standard Overnight** box checked.
❏	❏	❏	Section 5 has the **Deliver Weekday** box checked.
❏	❏	❏	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
❏	❏	❏	Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box.
❏	❏	❏	Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box.
❏	❏	❏	Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization** have been filled out for the type of chemical being sent.
❏	❏	❏	The **Name, Place and Date, Signature, and Emergency Telephone Number** appears at the bottom of the FedEx Airbill.
❏	❏	❏	The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box.
❏	❏	❏	The E**mergency Contact Information** at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Sub Risk	Quantity	Packing Instruction	Authorization
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes	No	N/A	
❑	❑	❑	The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container.
❑	❑	❑	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
❑	❑	❑	The name and address of the shipper and receiver appear on the top and side of the shipping container.
❑	❑	❑	The air waybill is attached to the top of the shipping container.
❑	❑	❑	**Up Arrows** have been attached to opposite sides of the shipping container.
❑	❑	❑	Packaging tape does not obscure markings or labeling.

Appendix B
Shipment Quality Assurance Checklist

Date: ______________ Shipper: ______________________________ Destination: ___________________________

Item(s) Description: ____

Radionuclide(s): ____

Radiological Survey Results: surface _________________mrem/hr 1 meter _________________________

Instrument Used: Mfgr: _____________________________________ Model: _______________________________

S/N: ____ Cal Date: ____________________________

Limited-Quantity or Instrument and Article

Yes	No	
___	___	1. Strong tight package (package that will not leak material during conditions normally incidental to transportation).
___	___	2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr.
___	___	3. Removable surface contamination less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma).
___	___	4. Outside inner package bears the marking "Radioactive."
___	___	5. Package contains less than 15 grams of ^{235}U (check yes if ^{235}U not present).
___	___	6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**
___	___	7. Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity:
___	___	8. On all air shipments, the statement **Radioactive Material, excepted package-limited quantity of material** shall be noted on the air waybill.

Qualified Shipper: ___________________________ Signature: ____

Guide to Handling Investigation-Derived Waste

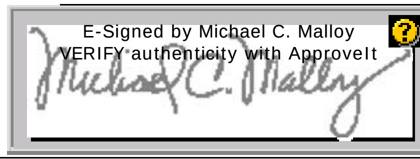
SOP 2-2
Revision: 5
Date: March 2007

Prepared: Tim Eggert

Technical Review: Matt Brookshire

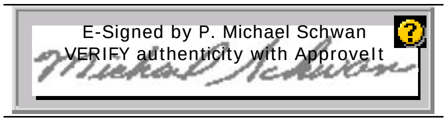
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective

This standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed before field activities
- Removing wastes that pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require offsite disposal or extended aboveground containerization
- Complying with federal, state, local, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste - Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavations, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, sludge, liquid, gaseous, or multiphase materials that may be classified as hazardous or nonhazardous.

Mixed Waste - Any material that has been classified as hazardous and radioactive.

Radioactive Wastes - Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U. S. Environmental Protection Agency (EPA) and appropriate state and local agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive waste. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate nondisposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

Note: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with applicable regulatory requirements.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required shall consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 millimeters
- Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

Containment of IDW shall be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device shall be site-specific.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are:

- Labels and markings that contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are 5 gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the drum color.
- Labels will be secured in a manner to ensure the label remains affixed to the container.

Labeling or marking requirements for IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers shall be predetermined and in accordance with site-specific and/or client requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation offsite onto a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW shall be staged pending chemical analysis or further onsite treatment. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage.

5.0 Procedures

The three general options for managing IDW are (1) collection and onsite disposal, (2) collection for offsite disposal, and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client shall approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Collection and Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are as follows:

1. Return to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate “clean” areas).

2. Spread around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).

3. Consolidate in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate “clean” areas).

4. Send to onsite TSDF - may require analytical analysis before treatment/disposal.

Note: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are as follows:

1. Discharge to surface water, only when IDW is not contaminated.

2. Discharge to ground surface close to the well, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background upgradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.

3. Discharge to sanitary sewer, only when IDW is not contaminated.

4. Send to onsite TSDF - may require analysis before treatment/disposal.

Note: These options may require analytical results to obtain client and/or regulatory approval.

5.1.3 Disposable PPE
The options for handling disposable PPE are as follows:

1. Double-bag contents in nontransparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.

2. Containerize, label, and send to onsite TSDF - may require analysis before treatment/disposal.

5.2 Collection for Offsite Disposal
Before sending to an offsite TSDF, analysis may be required. Manifests are required. In some instances, a bill of lading can be used for nonhazardous solid IDW (i.e., wooden pallets, large quantities of plastic sheeting). Arrangements must be made with the client responsible for the site to sign as generator on any waste profile and all manifests or bill of ladings; it is CDM's policy not to sign manifests. The TSDF and transporter must be permitted for the respective wastes. Nonbulk containers (e.g., drums) must have a DOT-approved label adhered to the container and all required associated placard stickers before leaving for a TSDF off site. These labels must include information as required in 49 CFR 172. Bulk containers (i.e., rolloffs, tanks) do not require container specific labels for transporting off site, but must include appropriate placards as required in 49 CFR 172.

5.2.1 Soil/Sludge/Sediment
When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids
When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums with appropriate secondary containment) until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE
When the final site remedy requires offsite treatment disposal, the IDW may be containerized and stored. The management option selected shall take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.3 Collection and Interim Management
All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW onsite until the final action may be practical in the following situations:
   - Returning wastes (especially sludges and soils) to their onsite source area would require reexcavation for disposal in the final remediation alternative.
   - Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
   - Offsite disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
   - Interim storage may be necessary to provide time for sampling and analysis.

2. Segregate and containerize all waste for future treatment and/or disposal.
   - Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.
   - Containment options for aqueous liquids may include mobile tanks or drums.
   - Containment options for PPE may include drums or roll-off boxes.

6.0 Restrictions/Limitations

Site Managers Shall Determine the Most Appropriate Disposal Option for Aqueous Liquids on a Site-Specific Basis. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the groundwater, the presence of contaminants in the soil at the site, whether the groundwater or surface water is a drinking water supply, and whether the groundwater plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. **Under No Circumstances Shall These Types of Materials Be Brought Back to the Office or Warehouse**.

7.0 References

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Attachment 1
IDW Management Options

Type of IDW	Generation Processes	Management Options
Soil	■ Well/Test pit installations ■ Borehole drilling ■ Soil sampling	**Onsite Disposal** ■ Return to boring, pit, or source immediately after generation ■ Spread around boring, pit, or source within the AOC ■ Consolidate in a pit (within the AOC) ■ Send to onsite TSDF **Offsite Disposal** ■ Client to send to offsite TSDF **Interim Management** ■ Store for future treatment and/or disposal
Sludge/Sediment	■ Sludge pit/sediment sampling	**Onsite Disposal** ■ Return to boring, pit, or source immediately after generation ■ Send to onsite TSDF **Offsite Disposal** ■ Client to send to offsite TSDF **Interim Management** ■ Store for future treatment and/or disposal
Aqueous Liquids (groundwater, surface water, drilling fluids, wastewaters)	■ Well installation/development ■ Well purging during sampling ■ Groundwater discharge during pump tests ■ Surface water sampling ■ Wastewater sampling	**Onsite Disposal** ■ Pour onto ground close to well (nonhazardous waste) ■ Discharge to sewer ■ Send to onsite TSDF **Offsite Disposal** ■ Client to send to offsite commercial treatment unit ■ Client to send to publicly owned treatment works (POTW) **Interim Management** ■ Store for future treatment and/or disposal
Decontamination Fluids	■ Decontamination of PPE and equipment	**Onsite Disposal** ■ Send to onsite TSDF ■ Evaporate (for small amounts of low contamination organic fluids) ■ Discharge to ground surface **Offsite Disposal** ■ Client to send to offsite TSDF ■ Discharge to sewer **Interim Management** ■ Store for future treatment and/or disposal
Disposable PPE and Sampling Equipment	■ Sampling procedures or other onsite activities	**Onsite Disposal** ■ Place in onsite industrial dumpster ■ Send to onsite TSDF **Offsite Disposal** ■ Client to send to offsite TSDF **Interim Management** ■ Store for future treatment and/or disposal

Adapted from U. S. Environmental Protection Agency, *Guide to Management of Investigation-Derived Wastes*, 9345-03FS, January 1992.

Lithologic Logging

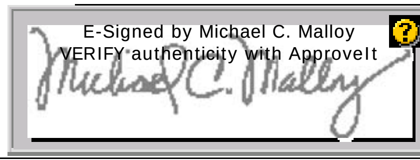
SOP 3-5
Revision: 7
Date: March 2007

Prepared: Del R. Baird

Technical Review: John Hofer

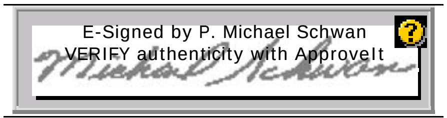
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 Background

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the geologist in what to look for when following the sequences. Example lithologic logs are given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger shall use field equipment and reference charts to help identify the grain-size distribution and shall name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger shall examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger shall provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles shall be examined for angularity by comparing with Attachment B and the sorting shall be determined by percentage estimation. The logger shall note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliated structure (slaty, phyllitic, schistose, or gneissic) or nonfoliated structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color shall be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names shall be listed, and an overall best color name shall be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures shall only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and shall be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and shall be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials shall be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) shall be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it shall be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and shall be described as dry, moist, wet (not flowing), or saturated (flowing water). Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks shall be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they shall be noted and a description as to the density of fractures shall be given. Cavities or vugs may be present, and the density of voids, as well as size estimation, shall be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill shall be added.

Evidence of Contamination - The logger shall examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations shall be noted in the field book as shall any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits shall be recorded on the Lithologic Log Form also.

Description of Contacts - The logger shall note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts shall be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface shall be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock shall be stated and an estimation of their percentage shall be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist under a geologist's supervision, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. To make lithologic descriptions produced by CDM staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

3.0 General Responsibilities

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

Note**:** Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts
- Engineers tape measure or folding stick

5.0 Procedures

5.1 Office

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it shall be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an “NA” shall be entered. Note that the Lithologic Log may be modified based on the type of drilling (i.e., changing the blow count column to rock quality designation (RQD) for rock coring).

The Lithologic Log Form shall be filled out according to the following instructions:

The front page of the form contains general information:

- The project name, location, and description
- Borehole number
- Date that the drilling activity was started and completed
- Name of the person logging the well shall be recorded along with the total depth drilled
- Borehole diameter(s) and drilling methods shall be recorded
- Name and company of the driller and the type of drill rig and bits used

A map showing the drilling location may be attached.

The continuation page(s) shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and shall be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column shall contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes shall be recorded as to why the section was not recovered. The X shall be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits shall be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs shall ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging shall determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger shall record the appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This shall be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference.

General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions shall be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

Description detail will also be dependent on the drilling and sampling methods used. Descriptions of drill cuttings will generally be very basic verses detailed descriptions of soil split-spoon or rock core samples.

This SOP includes protocols for describing igneous, metamorphic, bedrock, sedimentary rocks, and unconsolidated materials. Common abbreviations used for lithologic logging purposes are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology and American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.
- The Munsell soil color chart may be used for descriptions of color.
- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions shall include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category shall be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All interpretive comments shall be segregated from lithologic descriptions by recording them in the remarks column.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation shall be described if observed. Exact measurement of apparent bed thicknesses shall be made when logging core and shall supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they shall do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning shall be recorded on the lithologic log the first time it is used and shall be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description of Discrete Soil or Rock Cores

This section describes the protocols for completing a lithologic description based on discrete soil or rock core samples. The logger shall use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the “big” picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in “seeing” the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and shall use the same description format. The scientist shall use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions shall only be made in addition to descriptions outlined below.

Descriptions of unconsolidated sediments shall follow the following sequence:

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt, and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt, and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage shall be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Bedrock Material

Descriptions of rock core can vary in detail depending on the experience of the geologist and the scope of the project. However, features that shall be noted while logging rock core include depth of major fractures, mineralization in fractures and cavities, degree of weathering, hardness, and RQD. The RQD is a ratio of the total length of intact rock 4 inches in length or longer to the length of the core run. The RQD provides a numeric indication of the degree of fracturing and weathering, and thereby, and indication of conductive zones and preferential contaminant migration pathways.

Description of Sedimentary Rocks
Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

Descriptions for sedimentary rocks shall be given in the lithologic log in the following sequence:
- Name of rock
- Texture
- Color
- Bedding
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks
Igneous and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions shall follow the general format:
- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Foliation

5.2.2 Protocols for Lithologic Description from Drill Cuttings
The majority of boreholes drilled in bedrock are drilled without sampling or coring. This section describes the protocols that may be used for completing lithologic logs when discrete soil samples or rock cores are not collected. Lithologic logging of boreholes drilled without sampling generally requires a higher level of experience from the geologist as interpretations need to be made based on a number of factors that are usually not taken into account when logging from discrete samples. Certain details recorded on lithologic logs based on discrete sampling will not be seen (such as sedimentary structures) and therefore cannot be recorded from drill cuttings. Below are general guidelines that shall be used while filling out boring logs based on drill cuttings:

Auger Drilling
The following are general guidelines that can be used to describe cuttings from auger drilling:

- Collect cuttings for descriptions at least every 5 feet or if a change in the cuttings is noticed.
- Keep in mind travel time for cuttings to reach the surface when estimating the depth from which the cuttings originated.
- Pay attention to the reaction of the drill rig as different lithologies are encountered such as chattering versus smooth drilling, rapid easy auger advancement versus slow hard drilling, and auger refusal.
- Watch for the occurrence of water.

Bedrock Rotary Drilling (including air hammer, air rotary, and mud rotary)
The following are general guidelines that shall be used during rotary drilling:

- Use a strainer to collect cuttings at intervals of at least 10 feet or changes in lithology.
- Wash the cuttings in the strainer with potable water and examine for lithology.
- Note size of rock chips.
- Note changes in drill rig responses such as increasing or slowing drilling rate, sudden drop of the drill stem, increase in chatter and record in the remarks column of the lithologic log. These are usually good indicators of changes in lithology and/or fractures.
- If drilling with air, look for changes in color and reduction or disappearance of dust as an indicator of a lithology change and/or presence of water.
- If drilling with mud/fluid rotary, watch for gain or loss of water as an indicator of conductive zones.
- Record drilling rates as feet/minute, or as start and end times of each drill rod, in the remarks column of the boring log.

6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

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Woodward, L.A. 1988. *Laboratory Manual Physical Geology*, University of New Mexico Printing. Albuquerque, New Mexico.

8.0 Attachments

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Logs
Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts
Attachment C - Comparison Chart for Estimating Percentage Composition
Attachment D - Classification of Igneous Rocks
Attachment E - Classification of Sedimentary Rocks
Attachment F - Classification of Metamorphic Rocks
Attachment G - Lithologic Symbol Chart
Attachment H - Common Abbreviations for Lithologic Logging
Attachment I - Naming of Unconsolidated Materials
Attachment J - Sorting Chart
Attachment K - Example of Unified Soil Classification System (USCS)

Attachment A

CDM Federal Programs Lithologic Logs

Attachment B

Grain-Size Scale; Graph determining size of particles, particle degree of roundness charts

AGI DATA SHEET 29.1

Grain-size Scales

By Roy L. Ingram, University of North Carolina

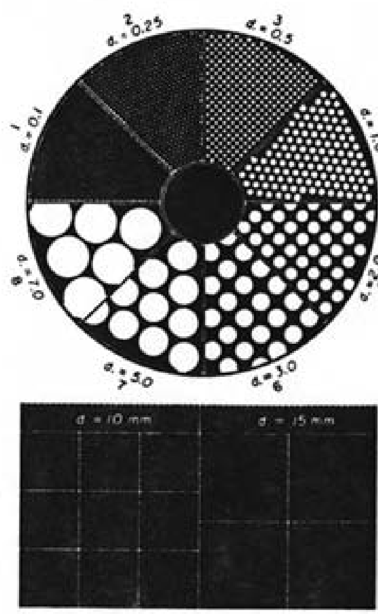
GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS

Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

phi	GRADE LIMITS mm	mm	inches	U.S. Standard Sieve Series	GRADE NAME		
−12	4096		161.3				
					very large	Boulders	GRAVEL
−11	2048		80.6				
					large		
−10	1024		40.3				
					medium		
−9	512		20.2				
					small		
−8	256		10.1				
					large	Cobbles	
−7	128		5.0				
					small		
−6	64		2.52	63 mm			
					very coarse	Pebbles	
−5	32		1.26	31.5 mm			
					coarse		
−4	16		0.63	16 mm			
					medium		
−3	8		0.32	8 mm			
					fine		
−2	4		0.16	No. 5			
					very fine		
−1	2		0.08	No. 10			
					very coarse	Sand	SAND
0	1		0.04	No. 18			
					coarse		
+1	1/2	0.500		No. 35			
					medium		
+2	1/4	0.250		No. 60			
					fine		
+3	1/8	0.125		No. 120			
					very fine		
+4	1/16	0.062		No. 230			
					coarse	Silt	MUD
+5	1/32	0.031					
					medium		
+6	1/64	0.016					
					fine		
+7	1/128	0.008					
					very fine		
+8	1/256	0.004					
					coarse	Clay size	
+9	1/512	0.002					
					medium		
+10	1/1024	0.001					
					fine		
+11	1/2048	0.0005					
					very fine		
+12	1/4096	0.00025					

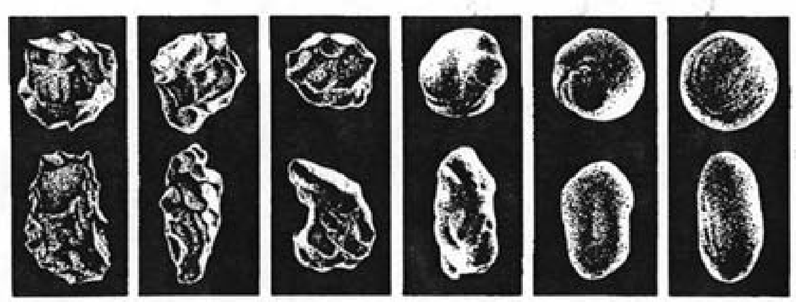
AGI DATA SHEET 29.2

LIGHT PARTICLES



References: (1) George V. Chilingar, 1956, Soviet classification of sedimentary particles and Vasil'evskiy graph: AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1948, Petrography of sedimentary rocks, 2nd ed., 387 p. Gosgeolizdat, Moscow-Leningrad

American Geological Institute, Data Sheets, Third Edition, 1989.

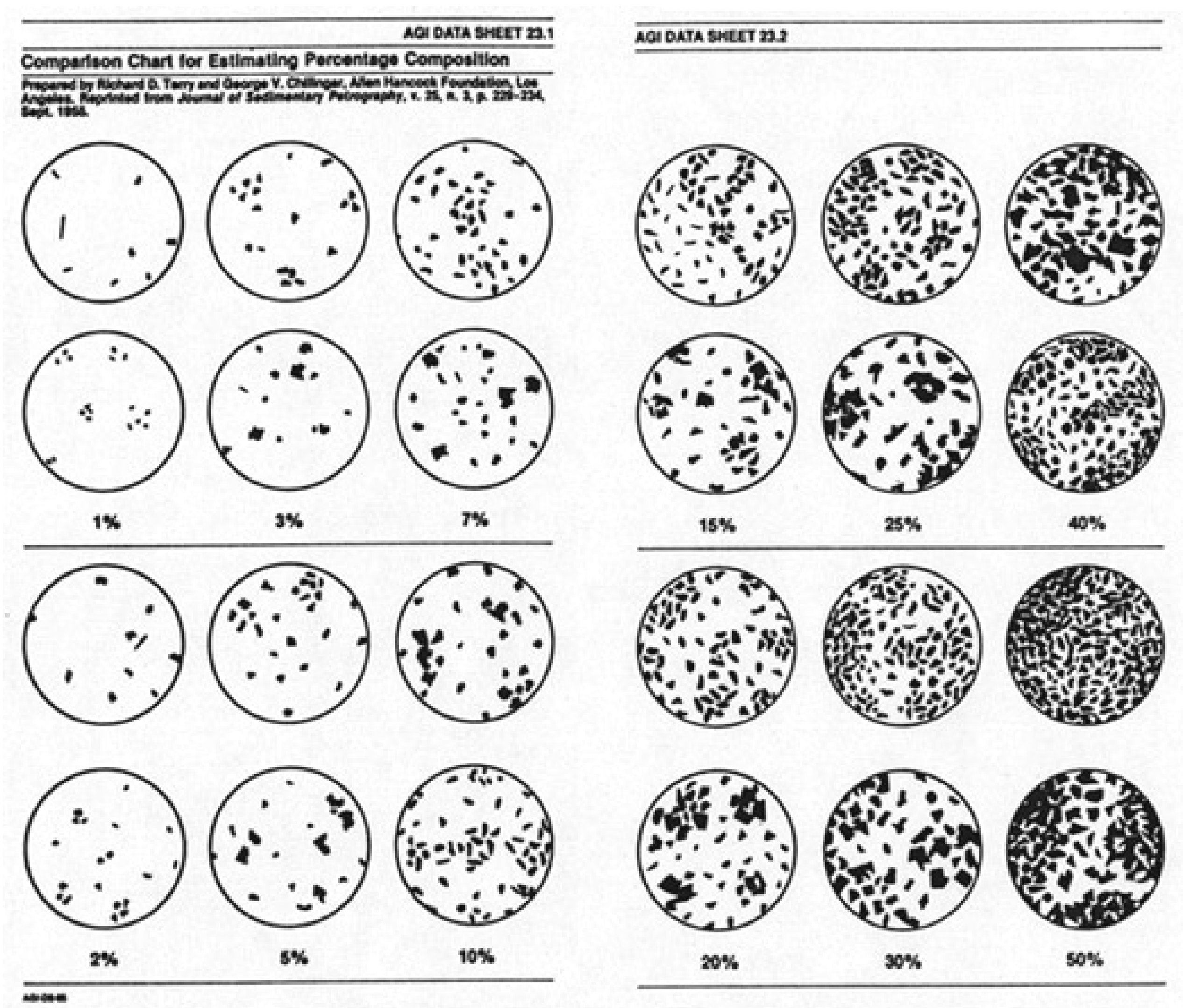


Very angular | Angular | Sub-angular | Sub-rounded | Rounded | Well rounded

Compton, R.R., Manual of Field Geology, 1962.

Attachment C

Comparison Chart for Estimating Percentage Composition



American Geological Institute, Data Sheets, Third Edition, 1989.

Attachment D

Classification of Igneous Rocks

Classification of Igneous Rocks					
Mineral Composition					
		Quartz >10% Abundant feldspar Mafic minerals minor	Quartz <10% Abundant feldspar Mafic minerals moderate	Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent	Mafic minerals >70%
Color Index		Light Color	Intermediate color	Dark	Dark
Chemistry		SiO_2 70%	SiO_2 60%	SiO_2 50%	SiO_2 40%
	Phaneritic (visible with naked eye)	Granite (Gr)	Diorite (Dr)	Gabbro (Gb)	Peridotite (Pr) (mostly olivine)
TEXTURE	Aphanitic (microscopic)	Rhyolite (Ry) (quartz phenocrysts)	Andesite (An) (feldspar or mafic phenocrysts; no quartz)	Basalt (Ba)	Komatiite (Km) (very rare)
		Felsite (Fl) (no phenocrysts)			
	Glassy	Obsidian (ob) Pumice (Pu)		Rare	
	Glassy-Fragmental (Pyroclastic)	Tuff <4mm (Tf) Breccia >4mm (Br)		Rare	

Attachment E

Classification of Sedimentary Rocks

Classification of Sedimentary Rocks				
Detrital	***Detrital Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Rudaceous (clast diameter > 2 mm)	Gravel	Rounded Clasts	Conglomerate (Cg)
			Angular Clasts	Breccia (Br)
	Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm)	Sand	Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary.	Sandstone (Sa)
	Argillaceous (clast diameter <0.0625 mm)	Mud	Non-fissile along bedding planes, silt predominant over clay	Siltstone (Sls)
			Non-fissile along bedding planes, clay predominant over silt	Claystone
			Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown	Mudstone (Ms)
			Fissile along bedding planes	Shale (Shl)
Chemical	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Calcite (Calcium Carbonate)	Effervesces on contact with dilute HCl	Limestone (La)
		Dolomite (Calcium Magnesium Carbonate)	Pulverized sample effervesces on contact with dilute HCL	Dolomite (Dl), Dolostone
	Siliceous	Quartz (Silicon Dioxide)	Hard, dense, fractures conchoidally	Chert (Ch)
	Evaporites	Hydrated Calcium Sulfate	Earthy and crumbly	Gypsum (Gy)
		Calcium Sulfate	Usually exhibits indistinct stratification	Anhydrite
		Halite (Sodium Chloride)	Cubic cleavage	Rock Salt (Na)
Organic (Organogenetic or Biochemical)	***Chemical Classification***	***Principal Composition***	***Additional Identifying Characteristics***	***Name of Rock***
	Calcareous	Fossil shells and fragments	Loosely cemented fragmental limestone	Coquina (Cq)
		Foraminiferal shells	Soft, micritic limestone	Cha k (Chk)
		Calcite or aragonite	Derived from evaporation of spring water	Travertine (Tvr)
	Siliceous	Diatom shells (saltwater or freshwater organisms)	Light-colored, soft, friable, and porous siliceous deposit	Diatomite (Dm)
	Carbonaceous	Plant Remains	Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary.	Coal (Cl)

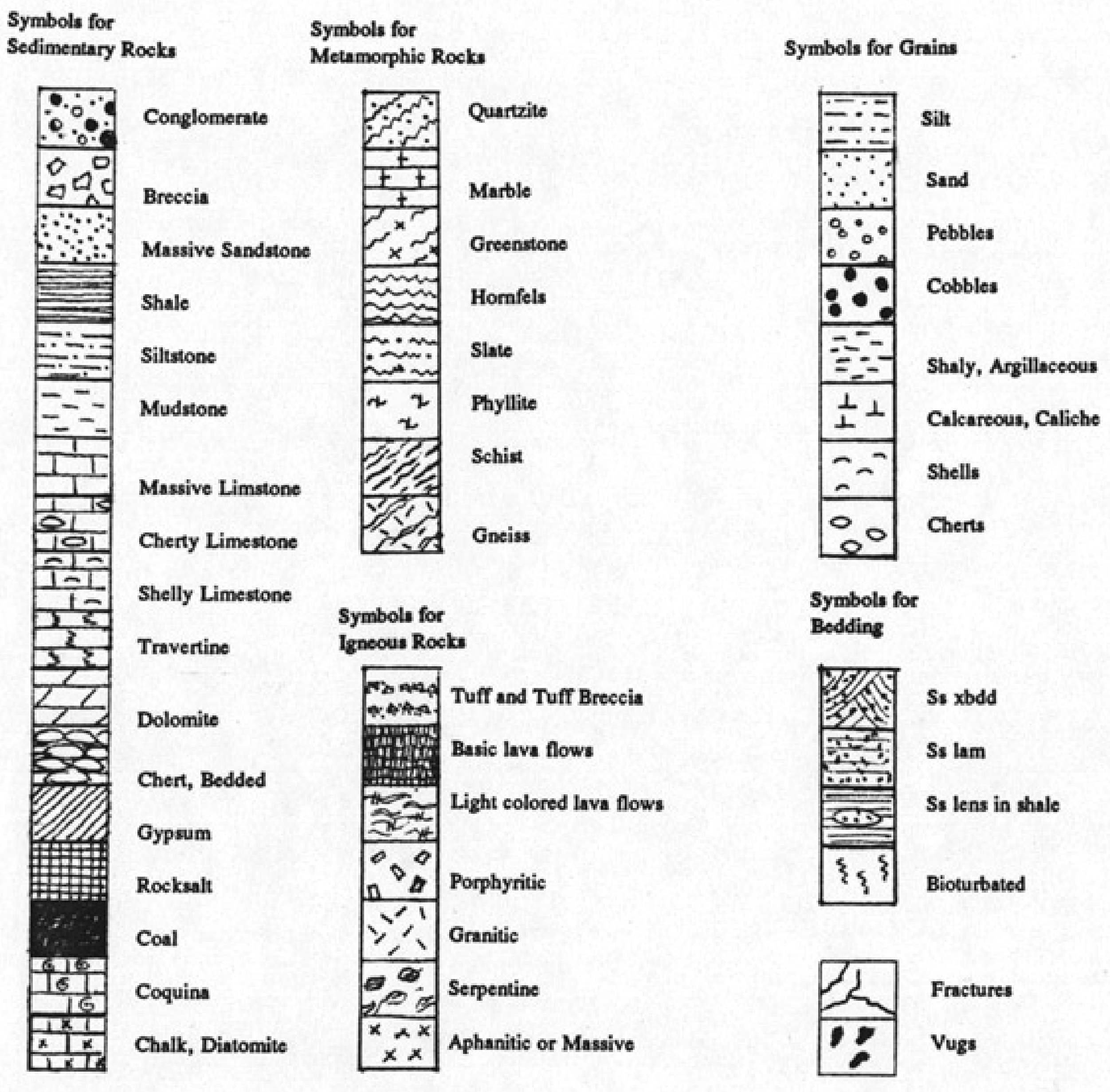
Attachment F

Classification of Metamorphic Rocks

<table>
<tr><th colspan="4">Classification of Metamorphic Rocks</th></tr>
<tr><th>Structure</th><th>Texture</th><th>Chief Minerals</th><th>Name</th></tr>
<tr><td rowspan="4">Non foliate</td><td>granular; breaks across grains</td><td>quartz</td><td>Quartzite (Qzt)</td></tr>
<tr><td>granular; grains clearly visible</td><td>calcite</td><td>Marble (Mbl)</td></tr>
<tr><td>granular; grains altered and indistinct</td><td>plagioclase, chlorite, epidote hornblende</td><td>Greenstone (Grs)</td></tr>
<tr><td>very fine-grained</td><td>indistinguishable; mostly submicroscopic micas and clays</td><td>Hornfels (Hnf)</td></tr>
<tr><td rowspan="12">Foliate</td><td>slaty</td><td>submicroscopic mica, quartz</td><td>Slate (Slt)</td></tr>
<tr><td>phyllitic</td><td>microscopic mica, quartz</td><td>Phyllite (Pyl)</td></tr>
<tr><td rowspan="7">schistose</td><td>microscopic mica, quartz, amphibole</td><td>Blueschist</td></tr>
<tr><td>chlorite, mica plagioclase</td><td>chlorite schist (CL-Sch)</td></tr>
<tr><td>muscovite, quartz</td><td>Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>garnet, muscovite</td><td>Garnet (G) Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>hornblende, plagioclase</td><td>Amphibolite (Amp)</td></tr>
<tr><td>staurolite, garnet, muscovite</td><td>Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>plagioclase, hornblende</td><td>Amphibolite (Amp) Gneiss (Gns)</td></tr>
<tr><td rowspan="3">gneissose</td><td>plagioclase, hornblende</td><td>Amphibolite (Amp) Gneiss (Gns)</td></tr>
<tr><td>feldspar, quartz</td><td>Granitie (Gr) Gneiss (Gns)</td></tr>
<tr><td>eye-shaped feldspar, mica</td><td>Augen (Au) Gneiss (Gns)</td></tr>
</table>

Attachment G

Lithologic Symbol Chart



Compton, R.R., Manual of Field Geology, 1962.

Attachment H

Common Abbreviations for Lithologic Logging

Common Abbreviations		
Abundant – abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	**Contacts**	**Sorting**
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	**Fabric**	
large – lg	grain supported – gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate – im	

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

Attachment I

Naming of Unconsolidated Materials

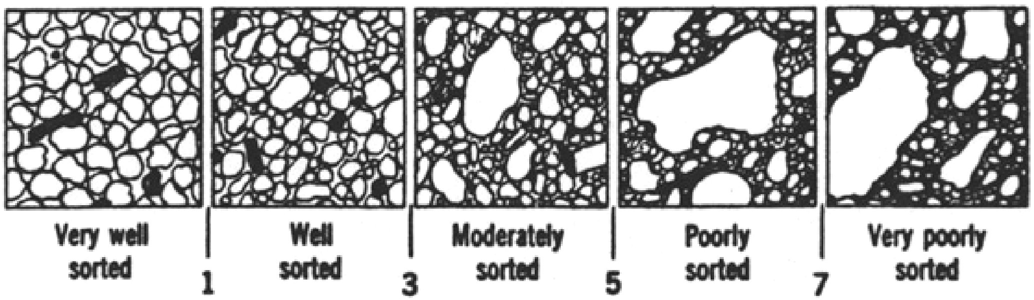
Main Particle	Gravel	Sand	Silt	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay

Note: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.

Compton, R.R., *Manual of Field Geology*, 1962.

Attachment J

Sorting Chart

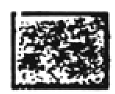


Compton, R.R., Manual of Field Geology, 1962.

Attachment K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)

	MILLIMETERS	INCHES	SIEVE SIZES	
BOULDERS	> 300	> 11.8	-	
COBBLES	75 - 300	2.9 - 11.8	-	
GRAVEL: COARSE	75 - 19	2.9 - .75	-	
FINE	19 - 4.8	.75 - .19	3/4" - No. 4	
SAND: COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10	
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40	
FINE	.43 - .08	.02 - .003	No. 40 - No. 200	
FINES: SILTS	< .08	< .003	< No. 200	
CLAYS	< .08	< .003	< No. 200	

Attachment K

Example of Unified Soil Classification System (USCS) (Continued)

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength q_u Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4 " by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

SAND

SOILTYPE	SPT, N Blows/ft.	Relative Density,%	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcu.g rod driven with 5-lb hammer.

Example of Unified Soil Classification System (USCS) (Continued)

Summary of USCS Field Identification Tests

Coarse-Grained Soils **More than half the material (by weight) is individual grains visible to the naked eye**	**Gravelly Soils** More than half of coarse fraction is larger than 4.75 mm	**Clean Gravels** Will not leave a stain on a wet palm	Substantial amounts of all grain particle sizes	GW
			Predominantly one size or range of sizes with some intermediate sizes missing	GP
		Dirty Gravels Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)	GM
			Plastic fines (to identify, see CL below)	GC
	Sandy Soils More than half of coarse fraction is smaller than 4.75 mm	**Clean Sands** Will not leave a stain on a wet palm	Wide range in grain size and substantial amounts of all grain particle sizes.	SW
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP
		Dirty Sands Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)	SM
			Plastic fines (to identify, see CL below)	SC

	Ribbon	**Liquid Limit**	**Dry Crushing Strength**	**Dilatancy Reaction**	**Toughness**	**Stickiness**	
Fine-Grained Soils **More than half the material (by weight) is individual grains not visible to the naked eye (<0.074 mm)**	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH
Highly Organic Soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture						OL OH Pt

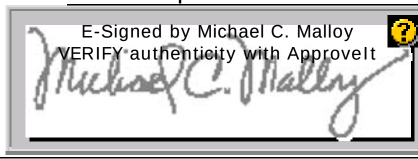
Field Logbook Content and Control	SOP 4-1 Revision: 6 Date: March 2007

Prepared: Del Baird

Technical Review: Laura Splichal

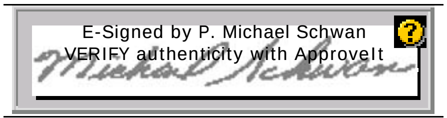
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to set CDM Federal (CDM) criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 Background

2.1 Definitions

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names; observations; data; calculations; date/time; weather; and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 General Responsibilities

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM employees who make entries in field logbooks during onsite activities are required to read this procedure before engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities should be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 Procedures

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office or vehicle for easy reference.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered before initial use of the logbook. Before use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number (if applicable).
- Activity (if the logbook is to be activity-specific), site name, and location.
- Name of CDM contact and phone number(s) (typically the project manager).
- Start date of entries.
- End date of entries.
- In specific cases, special logbooks may be required (e.g., waterproof paper for stormwater monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

Table of Contents

Date/Description	Pages
(Start Date)/Reserved for TOC	1-5

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page. The table of contents should be completed as activities are completed and before placing the logbook in the records file.

5.2 Operation

Requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:
  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)
- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
  - Date and time
  - Name of individual making entry
  - Names of field team and other persons onsite
  - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
  - Level of personal protection used
  - Serial numbers of instruments
  - Equipment calibration information
  - Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.
- Visitors to the site.

5.3 Post-Operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and nonsubjective. Field logbooks, and entries within, are not to be used for personal use.

7.0 References

Sandia National Laboratories. 1991. *Procedure for Preparing Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures,* QA-02-03. Albuquerque Environmental Program, Department 3220, Albuquerque, New Mexico.

Sandia National Laboratories. 1992. *Field Operation Procedure for Field Logbook Content and Control*. Environmental Restoration Department, Division 7723, Albuquerque, New Mexico.

Photographic Documentation of Field Activities

SOP 4-2
Revision: 7
Date: March 2007

Prepared: David O. Johnson

Technical Review: Sharon Budney

QA Review: Jo Nell Mullins

Approved: E-Signed by Michael C. Malloy VERIFY authenticity with ApproveIt

Signature/Date

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1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape or DVD recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 Background

2.1 Definitions

Photographer - A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape or digital versatile discs (DVD) recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component - Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker - A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates - Slates are blank white index cards or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

Arrows and Pointers - Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds - Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back - A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

Photographs and videotape or DVD recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the “visual media” that, for the purpose of this document, shall encompass still photographs, digital photographs, videotape recordings (or video footage), and recordings on DVDs. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer - The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP. Responsibilities will be defined in the project sampling plan.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

A general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Extra batteries for 35mm camera
- Video camera and appropriate storage media (e.g., video tapes, DVDs)
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35mm negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

5.0 Procedures

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review CDM Federal SOP 4-1, *Field Logbook Content and Control* and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

Field Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation before commencing field activities. The site health and safety plan must be read before entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format, especially close-up site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand “Ektapress Gold Deluxe” film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape or DVD brand along with digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Slate Information

It is recommended that each new roll of film or digital storage medium shall contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

Caption Information

All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number (if required) and photograph sequence number
- Date and time
- Photographer
- Description of activity/item shown (e.g., name of facility/site, specific project name, project number)
- Direction (if applicable)

When directed by the sampling plan, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day to a personal computer; the files should be in either “JPEG” or “TIFF” format. Files should be renamed at the time of download to correspond to the logbook. It is recommended the electronic files be copied to a compact disc for backup.

Close-Up and Feature Photography

When directed by the sampling plan, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the sampling plan, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography
Site photography, in general, will consist predominantly of medium- and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

Panoramic
In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35mm or digital camera, the following procedures are recommended:

- Use a stable surface or tripod to support the camera
- Allow a 20- to 30-percent overlap while maintaining a uniform horizon
- Complete two to three photos per series

5.2.3 General Photographic Documentation Using Video Cameras
As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or “show” videotape or DVD recording. The following guidelines are set for documentary videotape or DVD recordings only and should be implemented at the discretion of the site personnel.

Documentary videotape or DVD recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A label should be placed on the videotape or DVD with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.4 Photographic Documentation
Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape/DVD control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.
- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape or DVD to the project management representative to be placed in the project files.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

- Photographs and the associated set of uncut negatives, digital media, and original unedited documentary video recordings will be submitted to the project files and handled according to contract records requirements. The project manager will ensure their proper distribution.
- Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the project manager or FTL.

Note: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. 1992. National Enforcement Investigations Center. *Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p. 85. Revised March.

__________. Region IV. 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Athens, Georgia. November.

Well Development and Purging	SOP 4-3 Revision: 5 Date: March 2007

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1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

2.0 Background

Monitoring wells are developed to repair damage to the formation caused by drilling activities and to settle and remove fines from the filter pack. Wells shall not be developed for at least 24 to 48 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells shall be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum, for low recharge conditions).

2.1 Associated Procedures

- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Electronic water-level meter
- Temperature, conductivity, pH, and turbidity meters
- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

5.0 Procedures

5.1 Well Development

The following steps must be followed when developing wells:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom of the well.

6. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, wire brush, swabbing, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the site and the client.

7. For screened intervals longer than 10 feet (3 meters [m]), develop the well in 2- or 3-foot (0.75- or 1-m) intervals from bottom to top. This will ensure proper packing of the filter pack.

8. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

5.2 Volumetric Method of Well Purging

The following steps shall be followed when purging a well by the volumetric method:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom of well casing according to CDM Federal SOP 1-6, *Water Level Measurement*. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[\frac{D^2\pi}{(4)} \right] dH = \text{volume (in gallons)}$$

   where
   D = casing diameter in feet. (***Note***: This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).
   dH = the distance from well bottom to static water level in feet.
   π = 3.1416.

Note: Record all data and calculations in the field logbook.

6. Prepare the pump and tubing, or bailer, and lower it into the casing.

7. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, temperature, and turbidity shall be measured and recorded. Purging shall continue until the field parameters have stabilized. Groundwater quality parameters are considered stable when three consecutive readings are within ± 0.1 for pH, ±3 percent for conductivity, ±10 mv for redox potential (ORP), and ±10 percent for turbidity if greater than 10 NTU, in accordance with site-specific plans. Efforts shall be made to get turbidity below 10 NTU, especially if groundwater samples are to be collected for metals or PCB analyses.

8. In low recharge aquifers, the following steps shall be followed: (1) If the initial water level is less then 10 feet above the top of the screen, then purge to dryness and allow sufficient recharge to collect samples. (2) If initial water level in the well is more than 10 feet above the top of the screen, then care shall be taken to prevent the dewatering of the screened interval. (3) Continue purging until the water level is between 1 and 5 feet above the top of the screen. (4) Allow well to recharge then continue purging until at least 1 full initial well volume has been purged. (5) Record pertinent data in the field logbook.

9. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with volatiles organic compounds (VOCs). After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.

10. After sampling activities have been completed, remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plan.

5.3 Indicator Parameter Method of Well Purging

1. Review site-specific health and safety plan and project plans before initiating sampling activity.

2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

3. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

5. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.

6. Assemble the pump and tubing, or bailer, and lower into the casing.

7. Begin pumping or bailing the well. Record indicator parameter readings for every 5 minutes or purge volume, whichever is quicker. Maintain a record of the approximate volumes of water produced. Care shall be taken to minimize drawdown (0 to 0.2 feet).

8. Continue pumping or bailing until indicator parameter readings remain stable within ± 0.1 for pH, ±3 percent for conductivity, ±10 mv for redox potential (ORP), and ±10 percent for turbidity if greater than 10 NTU for three consecutive recording intervals and a minimum of 1 well volume is removed, or in accordance with site-specific plans. Purging shall continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets project requirements.

9. For a low recharge aquifer, follow the guidelines of Section 5.2, Paragraph 7.

10. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with VOCs. After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.

11. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

6.0 Restrictions/Limitations

Where flammable, free, or emulsified product is expected, or known to exist on or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 50 feet (15 m) or further from the wellhead and disposal drums.

7.0 References

American Society for Testing and Materials. 2005. Designation: D 5521, *Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers,* Rev. 5, November.

U. S. Army Corps of Engineers. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites, EM 1110-1-4000*, Chapter 6. November 1.

U. S. Department of Energy, Environmental Restoration Project. 2001. *Standard Operating Procedure for Well Development,* ER-2001-0379, Rev. 2, Los Alamos, New Mexico. April 27.

U. S. Environmental Protection Agency, Region III, 1997. *Low-Flow Purging and Sampling of Groundwater Monitoring Wells*, Bulletin No. QAD023, Philadelphia, Pennsylvania. October.

U. S. Environmental Protection Agency. 2002. *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers.* Ground Water Forum Issue Paper, EPA 542-S-02-001, OSWER, Technology Innovative Office, Washington, D.C. May.

Field Equipment Decontamination at Nonradioactive Sites

SOP 4-5
Revision: 7
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1.0 Objective

The objective of this standard operating procedure (SOP) is to describe the general procedures required for decontamination of field equipment at nonradioactive sites. This SOP serves as a general guide and is applicable at most sites; however, it shall be noted that site-specific conditions (i.e., type of contamination, type of media sampled), the governing agency (e.g., EPA, DOE, USACE), and site-specific work plans, sampling and analysis plans and/or quality assurance (QA) project plans may require modifications to the decontamination procedures provided in this SOP. Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants offsite.

2.0 Background

2.1 Definitions

Acid Rinse - A solution of 10 percent nitric or hydrochloric acid made from reagent grade acid and analyte-free water.

Analyte-Free Water - Tap water that has been treated so that the water contains no detectable heavy metals or other inorganic compounds. Analyte-free water shall be stored only in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Clean - Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or noncontaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

Material Safety Data Sheets (MSDS) - These documents discuss the proper storage and physical and toxicological characteristics of a particular substance used during decontamination. These documents, generally included in site health and safety plans, shall be kept on site at all times during field operations.

Organic-Free/Analyte-Free Water - Tap water that has been treated so that the water meets the analyte-free water criteria and contains no detectable organic compounds. Organic-free/analyte-free water shall be stored only in clean glass, Teflon™, or stainless steel containers that can be closed when not in use.

Potable Water - Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling Equipment - Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and spatulas or bowls used to homogenize samples.

Soap - Low-sudsing, nonphosphate detergent such as Liquinox™.

Solvent Rinse - Pesticide grade, or better, isopropanol, acetone, or methanol.

2.2 Associated Procedures

- CDM Federal SOP 1-1 - *Surface Water Sampling*
- CDM Federal SOP 1-3 - *Surface Soil Sampling*
- CDM Federal SOP 1-4 - *Subsurface Soil Sampling*
- CDM Federal SOP 1-5 - *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-7 - *Wipe Sampling*
- CDM Federal SOP 1-9 - *Tap Water Sampling*
- CDM Federal SOP 1-11 - *Sediment/Sludge Sampling*
- CDM Federal SOP 2-2 - *Guide to Handling Investigation-Derived Waste*
- CDM Federal SOP 3-1 - *Geoprobe® Sampling*

3.0 Responsibilities

The project manager or designee, generally the field team leader (FTL), ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this SOP and site-specific work plans. The FTL may also be required to collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QA plan.

4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water*
- Analyte-free water
- Organic-free/analyte-free water
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g., 10 percent and/or 1 percent nitric acid [HNO_3], acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks for temporary storage of decontamination water (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements.

5.0 Procedures

All reusable equipment (nondedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sampled media or personnel using the equipment. Decontamination of equipment shall occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally located decontamination station shall include an appropriately sized bermed and lined area on which equipment decontamination shall occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment shall be transported to and from the decontamination station in a manner to prevent cross contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area shall be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area that then drains into a collection system. Water from the collection system shall be transferred into 55-gallon drums or portable tanks for temporary storage. Typically, decontamination water shall be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined (SOP 2-2, *Guide to Handling Investigation-Derived Waste*). The exact procedure for decontamination waste disposal shall be discussed in the work plan. Also, solvent and acid rinse fluids may need to be segregated from other investigation-derived wastes.

All items that shall come into contact with potentially contaminated media shall be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they shall be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable, analyte-free, and organic-free/analyte-free water shall be free of all contaminants of concern. Following the field QA sampling procedure described in the work plan, analytical data from the water source may be required.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use shall be stated in the work plan.
- All solvents and acids shall be pesticide grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate logbook.

  Note: Solvents and acids are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the site-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all cleaning and field QA sampling shall be recorded in the appropriate logbook.
- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs, well development rigs, and backhoes. Follow these steps when decontaminating this equipment:

- Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the area under investigation.
- With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated media using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.
- Use brushes, soap, and potable water to remove dirt whenever necessary.
- Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.
- Record the equipment type, date, time, and method of decontamination in the appropriate logbook.

- After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, stems, etc. Follow these steps when decontaminating this equipment:

- Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
- Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads shall be upwind of any areas under investigation.
- Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splashback when decontaminating.
- Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
- If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.
- Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.
- Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

- Set up a decontamination line on plastic sheeting. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the ground, table, or other surfaces that the decontaminated equipment is placed for drying.
- Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
- Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films. The items may be steam cleaned using soap and hot water as an alternative to brushing. ***Note*****: Polyvinyl chloride or plastic items shall not be steam cleaned.** Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
- Thoroughly rinse the items with potable water.

- If sampling for metals, thoroughly rinse the items with an acid solution (e.g., 10 percent nitric acid) followed by a rinse using analyte-free water. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using analyte-free water. The specific chemicals used for the acid rinse and solvent rinse phases shall be specified in the work plan. The acid rinsate and solvent rinsate must each be containerized separately. Acids and solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health affects (e.g., skin burns, irritation to the eyes and respiratory system). Appropriate personal protective equipment must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping these chemicals.
- Rinse the items thoroughly using organic-free/analyte-free water.
- Allow the items to air dry completely.
- After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap or in aluminum foil.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable personal protective equipment. Place the contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. Refer to site-specific plans for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

- Set up the decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up four containers: the first container shall contain dilute (nonfoaming) soapy water, the second container shall contain potable water, the third container shall be empty to receive wastewater, and the fourth container shall contain analyte-free water.
- The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the wastewater container above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste container. Scrub the outside of the pump and other wetted parts with a metal brush.
- Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
- Move the pump intake to the analyte-free water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
- Decontaminate the discharge outlet by hand, following the steps outlined in Section 5.3.
- Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered with aluminum foil to prevent the entry of airborne contaminants and particles.
- Record the equipment type, serial number, date, time, and method of decontamination in the appropriate logbook.

5.5 Instrument Probe Decontamination

Instrument probes used for field measurements such as pH meters, conductivity meters, etc. shall be decontaminated between samples and after use with analyte-free, or better, water.

5.6 Waste Disposal

Refer to site-specific plans and SOP 2-2 for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be contained in separate containers.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste.
- Waste liquids shall be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 Restrictions/Limitations

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics, respectively. These steps shall not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

7.0 References

American Society for Testing and Materials. 2002. *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-02. January 10.

Department of Energy. Hazardous Waste Remedial Actions Program. 1996. *Standard Operating Procedures for Site Characterization*, DOE/HWP-100/R1. September.

__________. Hazardous Waste Remedial Actions Program. 1996. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

__________. 1992. *Standard Operating Safety Guidelines*; Publication 9285.1-03. June.

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__________. Region 4. 2001. *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*. November.

Control of Measurement and Test Equipment

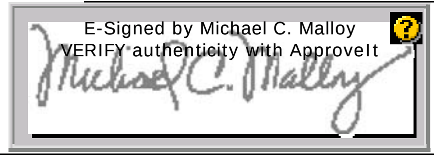
SOP 5-1
Revision: 8
Date: March 2007

Prepared: Dave Johnson

Technical Review: Steve Guthrie

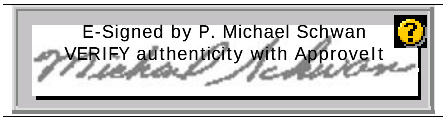
QA Review: Jo Nell Mullins

Approved:



Signature/Date

Issued:



Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 Background

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Associated Procedures

- CDM Federal Technical SOP 4-1, *Field Logbook Content and Control*
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

2.3 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

Note**:** Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Requirements for M&TE

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an equipment log or a field log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.0 Procedures

5.1 Determine if Other Related Project-Specific Requirements Apply

For all M&TE:
The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

For GF M&TE that is to be procured:
Requisitioner - Specify that the maintenance and calibration procedures be included.

For GF M&TE that is acquired as a result of a property transfer:
Receiver - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

For M&TE that is to be rented or leased from an outside vendor:
Requisitioner - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask the procurement division to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

For all M&TE:
PM or Designee - Record all maintenance and calibration events in a field log unless other project-specific requirements apply.

For GF M&TE only (does not apply to rented or leased M&TE):
If an equipment log is a project specific requirement, perform the following:

Receiver - Notify the PM or designee for the overall property control of the equipment upon receipt of an item of M&TE.

PM or Designee and User:
- Prepare a sequentially page numbered equipment log for the item using the maintenance and calibration form (or equivalent) (Figure 1).
- Record all maintenance and calibration events in an equipment log.

5.4 Label M&TE Requiring Calibration

For GF M&TE only (does not apply to rented or leased M&TE):
If calibration labeling is a project specific requirement, perform the following:

PM or Designee:
- Read the maintenance and calibration procedures to determine the frequency of calibration required.
- If an M&TE item requires calibration before use, affix a label to the item stating “Calibrate Before Use.”
- If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who shall perform the next calibration.

5.5 Operating, Maintaining or Calibrating an M&TE Item

For all M&TE:
PM or Designee and User - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.6 Shipment

For GF M&TE:
Shipper - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent equipment log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current equipment log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

For M&TE that is rented or leased from an outside vendor:
Shipper - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact the procurement division and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:
PM or Designee - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

Receiver - Forward the original packing slip to the procurement division and a photocopy to the PM or designee.

PM or Designee and User:
- Maintain all original documents in the equipment file except for the packing slip and field log.
- File the photocopy of the packing slip in the M&TE file.
- Record all maintenance and calibration in an equipment log or field log (as appropriate). File the completed equipment logs in the M&TE records. Forward completed field logs to the PM for inclusion in the project files.

For M&TE rented or leased from an outside vendor:
Receiver - Forward the packing slip to the procurement division.

User:
- Forward the completed field log to the PM for inclusion in the project files.
- Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:
PM or Designee and User:
- When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
- Require certifications for standards that clearly state the traceability.
- Require Material Safety Data Sheets to be provided with standards.
- Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:
PM or Designee
- Immediately discontinue use and segregate the item from other equipment. Notify the appropriate PM and take appropriate action in accordance with the CDM QP 2.3 for nonconforming items.
- Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate PM(s) of the results of the review.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the Headquarters health and safety manager and/or Headquarters quality assurance director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 References

CDM Federal Programs Corporation. 2007. *Quality Assurance Manual.* Rev. 11.

CDM Federal Programs Corporation. 2005. *Government Property Manual*. Rev. 3.

Figure 1

CDM
A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: ____________ Time: ____ (a.m./p.m.)

Employee Name: ____________ Equipment Description: ____________

Contract/Project: ____________ Equipment ID No.: ____________

Activity: ____________ Equipment Serial No.: ____________

Maintenance

Maintenance Performed: ____________

Comments: ____________

Signature: ____________ Date: ____________

Calibration/Field Check

Calibration Standard: ____________ Concentration of Standard: ____________

Lot No. of Calibration Standard: ____________ Expiration Date of Calibration Standard: ____________

Pre-Calibration Reading: ____________ Post-Calibration Reading: ____________

Additional Readings: ____________ Additional Readings: ____________

Additional Readings: ____________ Additional Readings: ____________

Pre-Field Check Reading: ____________ Post-Field Check Reading: ____________

Adjustment(s): ____________

Calibration: ☐ Passed ☐ Failed

Comments: ____________

Signature: ____________ Date: ____________

Appendix B

Health and Safety Plan Form

HEALTH AND SAFETY PLAN FORM
CDM Health and Safety Program

This document is for the exclusive use of CDM and its subcontractors

CDM (Camp Dresser & McKee)
PROJECT DOCUMENT #:

PROJECT NAME Formosa Mine Site

PROJECT# 50993.55919.3380.221

REGION EPA Region 10

SITE ADDRESS N/A, approximately 7 miles south of Riddle Oregon

CLIENT ORGANIZATION US EPA

CLIENT CONTACT Denise Baker-Kircher

CLIENT CONTACT PHONE # 206-553-4303

( ) AMENDMENT TO EXISTING APPROVED H&SP?

( ) H&SP AMENDMENT NUMBER? ______

( ) DATE OF PREVIOUS H&SP APPROVAL ______

OBJECTIVES OF FIELD WORK:
(e.g. collect surface soil samples):

Collect surface water, groundwater, and surface soil and waste rock samples for the purposes of describing the nature and extent of contamination at the Site and to provide data for feasiblity study evaluations.

SITE TYPE: *Check as many as applicable*

Active	( )	Landfill	( )	Unknown	( )
Inactive	(X)	Uncontrolled	(X)	Military	( )
Secure	( )	Industrial	(X)	Other (specify)	
Unsecure	(X)	Recovery	( )	abandoned mine	
Enclosed space	( )	Well Field	( )		

All requirements described in the **CDM Health and Safety Manual** are incorporated in this health and safety plan by reference.

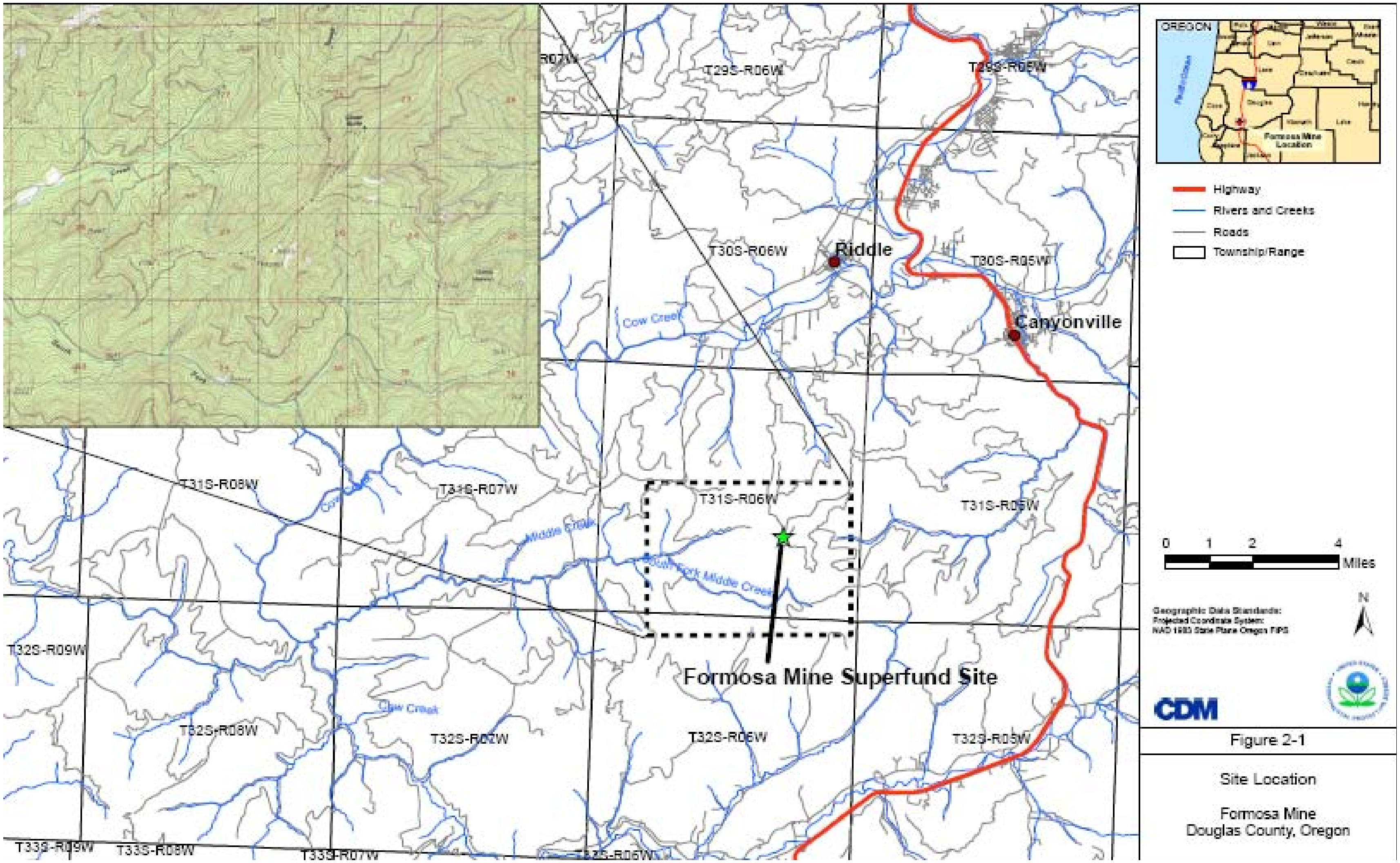
PERSONNEL AND RESPONSIBILITIES NAMES OF WORK CREW MEMBERS	COMPANY or DIVISION	SUPERVISORY TRAINED?	PROJECT OR SITE RESPONSIBILITIES	Tasks On Site?
Dee Warren	FED DEN	NO	Work Assignment Manager	
Nick Anton	ERD DEN	YES	Site Health & Safety Coordinator	1-2-3
Mark Nelson	ERD DEN	YES	2nd Health & Safety Coordinator	1-2-3
Nick Anton	ERD DEN	YES	Site Engineer	1-2-3
Neil Smith	ERD DEN	YES	Site Engineer	1-2-3
Derek Wintle	ERD DEN	NO	Site Engineer	1-2-3
Nathan Smith	ERD DEN	YES	Site Technician	1-2-3
			Subcontractor	

BACKGROUND REVIEW: ( ) Complete ( ) Incomplete

HEALTH AND SAFETY PLAN FORM	*This document is for the exclusive*	**CDM (Camp Dresser & McKee)**
CDM Health and Safety Program	*use of CDM and its subcontractors*	**PROJECT DOCUMENT #:**

SITE MAP: *Show Exclusion, Contamination Reduction, and Support Zones. Indicate Evacuation and Reassembly Points*

note: additional maps provided the Sampling and Analysis Plan



HEALTH AND SAFETY PLAN FORM — *This document is for the exclusive use of CDM and its subcontractors* — **CDM (Camp Dresser & McKee)**

CDM Health and Safety Program — **PROJECT DOCUMENT #:**

HISTORY: *Summarize conditions that relate to hazard. Include citizen complaints, spills, previous investigations or agency actions, known injuries, etc.*

The Formosa Mine Site (Site) is an abandoned underground copper-zinc-gold-silver mine located in Douglas County Oregon, in the Coast Range Klamath Mountains. Historic mining was conducted in the 1920's and 30's and modern mining was conducted from 1990 through 1993. Some reclamation has occured and the Site was abandoned by the mining company in 1996. Both historic and modern mining at the Site created a large volume of waste materials (soil, rock, tailings) that are dispersed in various areas near the mine, including steep sloped areas. These materials may have the potential to form acid rock drainage (ARD) and may contain toxic concentrations of metals. The underground mine area has been completely backfilled and is inaccessible, however, acid rock drainage forms within the underground mine and discharges through adit portals (backfilled access points to the undergound mine) and through groundwater seeps and springs.

r (x) Liquid x) Solid) Sludge ( ) Gas ( ) Unknown ( ) Other, specify:

WASTE CHARACTERISTICS(*Che(k as many as applicable.*

(x) Corrosive ( ) Flammable ( ) Radioactive

(x) Toxic ( ) Volatile ( ) Reactive

( ) Inert Gas ( ) Unknown

( ) Other: ______

WORK ZONES:

There are no defined exclusion, contamination reduction, or support zones defined for the Site. Work to be conducted is for a remedial investigation.

HAZARDS OF CONCERN: *Check as many as applicable.*

(x) Heat Stress	CDM Guideline	( ) Noise	CDM Guideline
(x) Cold Stress	CDM Guideline	(x) Inorganic Chemicals	
( ) Explosive/Flammable		( ) Organic Chemicals	
( ) Oxygen Deficient		( ) Motorized Traffic	
( ) Radiological		( ) Heavy Machinery	
(x) Biological	Poison oak, ticks, bees, mosquitos, flies	(x) Slips & Falls	CDM Guideline
(x) Other:	steep, unstable mountain slopes		
(x) Other:	fast moving water (i.e., streams)		

FACILITY'S PAST AND PRESENT DISPOSAL METHODS AND PRACTICES:

Disposal practices during mining have produced numerous surficial disturbance areas that contain soils, waste rock, or tailings that may form ARD or contain toxic concentrations of metals. Currently ARD water draining the main site adit (Formosa Adit) is collected and diverted through a series of pipelines into a drainage field area. During mining and reclamation, waste materials were backfilled into the underground workings that may have exacerbated the rate of ARD generation in the groundwater near the mine area. Both contaminated runoff from surface materials and contaminated groundwater contribute to surface water contamination at the Site.

This plan incorporates CDM's procedure for: *(Click on the relevant topics to download the hazard guideline. Delete irrelevant topics.)*

- Housekeeping
- Manual Material Handling
- Electrical Safety
- Traffic and Work Zone Safety
- Tools and Power Equipment
- Working Near or Over Water
- Hazardous Waste Site Decontamination
- Hazardous Waste Site Controls
- Fall Protection

HEALTH AND SAFETY PLAN FORM
CDM Health and Safety Program

This document is for the exclusive use of CDM and its subcontractors

CDM (Camp Dresser & McKee)
PROJECT DOCUMENT #:

DESCRIPTION AND FEATURES: *Include principal operations and unusual features (containers, buildings, dikes, power lines, hillslopes, rivers, etc.)*

The mine area is located on a mountain ridge (approximately 3,500 ft above sea level) with steep terrain and surface water drainages in the surrounding area. The steep terrain and water drainages present physical hazards for slips, trips, and falls. Surface soil and waste rock samples will be collected on steep slopes; surface water samples will be collected in steep surface water drainages. Surface water drainages (streams) are steep in areas near the mine, so the streams are fast moving, but have a relatively shallow depth (less than 1 foot deep). The main stream drainage, Middle Creek becomes much less steep about 1 mile away from the mine area, but continues to gain in flow and depth further downstream (13 miles of stream). All areas of Middle Creek and other drainages near the mine are wadeable during any season. Wading streams during winter months should be cautioned due to risk of hypothermia and risk of slipping on icy banks. Middle Creek enters Cow Creek 13 miles from the mine area. Cow Creek is a high flowing and deep river, and a gaining system. Precautions should be adhered to as appropriate to maintain safety during sampling on Cow Creek. There are no buildings or power lines present at the Site, bu there are some culverts and pipes beneath sections of road.

SURROUNDING POPULATION: ( ) Residential ( ) Industrial ( ) Commercial (x) Rural ( ) Urban (x) OTHER: No population near Site

HAZARDOUS MATERIAL SUMMARY: ***Highlight or bold waste types and estimate amounts by category.***

CHEMICALS: *Amount/Units:*	**SOLIDS:** *Amount/Units:*	**SLUDGES:** *Amount/Units:*	**SOLVENTS:** *Amount/Units:*	**OILS:** *Amount/Units:*	**OTHER:** *Amount/Units:*
Acids (acid rock drainage)	Flyash	Paints	Ketones	Oily Wastes	Laboratory
Pickling Liquors	**Mill or Mine Tailings**	Pigments	Aromatics	Gasoline	Pharmaceutical
Caustics	Asbestos	Metals Sludges	Hydrocarbons	Diesel Oil	Hospital
Pesticides	Ferrous Smelter	POTW Sludge	Alcohols	Lubricants	Radiological
Dyes or Inks	Non-Ferrous Smelter	Distillation Bottoms	Halogenated (chloro, bromo)	Polynuclear Aromatics	Municipal
Cyanides	**Metals**	Aluminum	Esters	PCBs	Construction
Phenols	Dioxins		Ethers	Heating Oil	Munitions
Halogens					
Other - *specify*	**Other - Precipitates that form in the streams due to high metals content from ARD discharge.**	Other - *specify*	Other - *specify*	Other - *specify*	Other - *specify*
ARD drains out of the mine adits and through groundwater seeps and springs, into surface water. ARD is a mild sulfuric acid type water with pH 2.5 to 4.5. pH more neutral in stream areas due to dilution.	Large quantity of potentially acid generating and elevated metals-containing soils, waste rock, and tailings present at the Site. Precipitates cover the streambed within the stream areas of about 1-2 miles from the Site.				

HEALTH AND SAFETY PLAN FORM
CDM Health and Safety Program

This document is for the exclusive use of CDM and its subcontractors

CDM (Camp Dresser & McKee)
PROJECT DOCUMENT #:

KNOWN CONTAMINANTS	HIGHEST OBSERVED CONCENTRATION (METAL) *(Soil and Waste Rock mg/kg)*	HIGHEST OBSERVED CONCENTRATION (METAL) *(Surface Water mg/L)*	PEL/TLV *ppm or mg/m3 (specify)*	IDLH *ppm or mg/m3 (specify)*	Warning Concentration *(in ppm)*	SYMPTOMS & EFFECTS OF ACUTE EXPOSURE	PHOTO IONIZATION POTENTIAL
Aluminum (dust)	28,000	129.39	5 mg/m3	NE	Dust	Coughing, spitting, pulmonary	Dust
Aluminum a kyls or soluble salts	28,000	129.39	2 mg/m3	NE	Dust	Coughing, spitting, pulmonary	Dust
Antimony compounds	14	0.0042	500 µg/m3	50 mg/m3	Dust	Irritated nose, cough, headache,	Dust
Arsenic, inorganic	210	1	10 µg/m3	5 mg/m3	Dust	Nasal ulcers, fever, bronchitis,	Dust
Barium (soluble) compounds	1,700	0.169	500 µg/m3	50 mg/m3	NA	Muscle spasms, slow pulse,	NA
Barium sulfate (dust)	1,700	0.169	5 mg/m3	NE	Dust	Few symptoms, chronic baritosis	Dust
Beryllium	NA	0.0136	2 µg/m3	4 mg/m3	Dust	Respiratory symptoms, weakness,	Dust
Boron oxides (includes borates)	NA	0.369	1 mg/m3	2,000 mg/m3	Dust	Nausea, conjunctivitis, diarrhea,	Dust
Cadmium dust	8	1.21	2 µg/m3	9 mg/m3	Dust	Pulmonary edema, tight chest,	Dust
Chromium compounds	5.1	0.0374	500 µg/m3	250 mg/m3	Dust	Lung damage, skin sensitization	Dust
Cobalt (metal) (dust & fumes)	9.6	0.271	20 µg/m3	20 mg/m3	>1 mg/m3	Coughing, respiratory sensitivity,	Dust
Copper (dust)	1,420	83.2	1 mg/m3	NE	Dust	Nasal perforation, metal taste	Dust
Iron oxide (dust)	290,000	602	5 mg/m3	2,500 mg/m3	Dust	Benign pneumoconiosis, cough	Dust
Iron salts (soluble)	290,000	602	1 mg/m3	NE	NA	Skin & stomach irritation	NA
Lead compounds	657	0.0774	50 µg/m3	100 mg/m3	Dust	Fatigue, pallor, colic, insomnia	Dust
Manganese (dust)	1,600	20.5	0.2 mg/m3	500 mg/m3	Dust	Dead face", dry throat, cough	Dust
Mercury and compounds (skin)	3.4	NA	25 µg/m3	10 mg/m3	NA	Severe abdominal pain tremors,	10.40
Molybdenum compounds	NA	0.00206	0.5 mg/m3	1,000 mg/m3	Dust	Loss of appetite, incoordination,	Dust
Nickel (dust)	11	0.5032	1 mg/m3	10 mg/m3	Dust	Skin sensitivity, chest pain,	Dust
Nickel (soluble compounds)	11	0.5032	100 µg/m3		Dust	Skin sensitivity, chest pain,	Dust
Selenium compounds	NA	0.024	200 µg/m3	1 mg/m3	Dust	Headache, chill, fever, garlic breath, disturbed vision	Dust
Silver (dust)	4.9	0.00025	100 µg/m3	10 mg/m3	Dust	Blue-gray eyes & skin, gastrointestinal irritation	Dust
Silver (metal & soluble)	4.9	0.00025	10 µg/m3			Blue-gray eyes & skin, gastrointestinal irritation	Dust
Thallium (skin)	NA	0.2	100 µg/m3	15 mg/m3	NA	Nausea, diarrhea, stomach pain	NA
Tin - inorganic	NA	0.0748	2 mg/m3	100 mg/m3	NA	Irritated eyes & skin, headache	NA
Vanadium Pentoxide (dust)	120	0.0303	50 µg/m3	35 mg/m3	Dust	Green tongue, metal taste, coughing, throat irritation	Dust
Zinc (dusts)	2,500	258	2 mg/m3	NE	Dust	Sweet metal taste, dry throat, cough, tight chest, chills	Dust

NA = Not Available
NE = None Established
U = Unknown

Verify your access to an MSDS for each chemical you will use at the site.

SW = Surface Water
GW = Ground Water
T = Tailings
SL = Sludge
W = Waste
D = Drums
TK = Tanks
L = Lagoons
SD = Sediment
OFF = Off-Site
S = Soil
A = Air

HEALTH AND SAFETY PLAN FORM **CDM Health and Safety Program**	*This document is for the exclusive use of CDM and its subcontractors*	**CDM (Camp Dresser & McKee)** **PROJECT DOCUMENT #:**	
SPECIFIC TASK DESCRIPTIONS	**Disturbing the Waste?**	**TASK - SPECIFIC HAZARDS**	**HAZARD & SCHEDULE**
1 Collect surface water quality field measurements, flow measurements, and samples for laboratory analysis.	**Intrusive** (circled) Non-intrusive	Slips, trips, and falls on stream banks and steep valley slopes; insect bites in forested areas; exposure to poison oak; potential for drowning in fast moving and deep streams; heat stress/cold stress (e.g.,hypothermia)	Medium Hazard All seasons
2 Collect groundwater level measurements, groundwater quality field measurments, and groundwater samples for laboratory analysis.	**Intrusive** (circled) Non-intrusive	Slips trips and falls; insect bites; exposure to poison oak; heat stress/cold stress	Low Hazard All seasons
3 Collect surface soil and waste rock field measurements and collect samples for laboratory analysis.	**Intrusive** (circled) Non-intrusive	Slips, trips, and falls on steep slopes; falling rocks on steep slopes; incidential ingestion or inhalation of soil particles; insect bites, exposure to poison oak; heat stress/cold stress	High Hazard Spring - Fall
4	Intrusive Non-intrusive		
5	Intrusive Non-intrusive		
6	Intrusive Non-intrusive		

SPECIALIZED TRAINING REQUIRED:	**SPECIAL MEDICAL SURVEILLANCE REQUIREMENTS:**
Specialized fall protection training will be required. For surface soil and waste rock sampling on steep slopes and unstable conditions (e.g., scree), skills such as using a safety harness and rope may be required.In addition, training for work over or near fast moving deep water will be required.	**none**

OVERALL HAZARD EVALUATION: ( ) High (x) Medium ( ) Low ( ) Unknow *(Where tasks have different hazards, evaluate each.)*

JUSTIFICATION: The overall risk is medium during this first phase of sampling. Future sampling will likely require work with heavy machinery such as excavators and drill rigs, that would present a higher level of risk. The medium level of risk mostly represents the increased potential for slips, trips, and falls; working around fast-moving water; falls on steep slopes;and exposure to ticks and poison oak.

FIRE/EXPLOSION POTENTIAL: ( ) High ( ) Medium (x) Low ( ) Unknown

HEALTH AND SAFETY PLAN FORM — *This document is for the exclusive use of CDM and its subcontractors* — **CDM (Camp Dresser & McKee)**

CDM Health and Safety Program — **PROJECT DOCUMENT #:**

PROTECTIVE EQUIPMENT: *Specify by task. Indicate type and/or material, as necessary. Group tasks if possible. Use copies of this sheet if needed.*

BLOCK A

TASKS: 1
LEVEL: D - Modified
(x) Primary ( ) Contingency

Respiratory: (x) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
(x) Safety Glasses:
( ) Face Shield:
( ) Goggles:
(x) Hard Hat:
( ) Other:

Boots: ( ) Not needed
(x) Steel-Toe ( ) Steel Shank
(x) Rubber (for hiking in wet forest) (x) Leather
(x) Overboots: hip or chest waiters

Prot Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
(x) Tyvek Coverall (may be used in poison oak areas)
( ) Saranex Coverall
( ) Cloth Coverall:
(x) Other: waterproof and/or warm clothing for winter conditions

Gloves: ( ) Not needed
(x) Undergloves: cotton, for winter sampling
(x) Gloves: nitrile
( ) Overgloves:

Other: specify below
(x) Tick Spray
(x) Flotation Device If Over Water
(x) Hi-Vis Safety Vest
(x) Sun Screen

BLOCK B

TASKS: 2
LEVEL: D - Modified
(x) Primary ( ) Contingency

Respiratory: (x) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
(x) Safety Glasses:
( ) Face Shield:
( ) Goggles:
(x) Hard Hat:
( ) Other:

Boots: ( ) Not needed
(x) Steel-Toe ( ) Steel Shank
(x) Rubber (for hiking in wet forest) (x) Leather
( ) Overboots: Latex

Prot Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
(x) Tyvek Coverall (may be used in poison oak areas)
( ) Saranex Coverall
( ) Cloth Coverall:
(x) Other: waterproof and/or warm clothing for winter conditions

Gloves: ( ) Not needed
(x) Undergloves: cotton, for winter sampling
(x) Gloves: nitrile
( ) Overgloves:

Other: specify below
(x) Tick Spray
( ) Float Device If Over Water
(x) Hi-Vis Safety Vest
(x) Sun Screen

BLOCK C

TASKS: 3
LEVEL: D - Modified
(x) Primary ( ) Contingency

Respiratory: (x) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
(x) Safety Glasses:
( ) Face Shield:
( ) Goggles:
(x) Hard Hat:
( ) Other:

Boots: ( ) Not needed
(x) Steel-Toe ( ) Steel Shank
(x) Rubber (for hiking in wet forest) (x) Leather
( ) Overboots:

Prot Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
(x) Tyvek Coverall (may be used in poison oak areas)
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves:
(x) Gloves: nitrile
( ) Overgloves:

Other: specify below
(x) Tick Spray
( ) Flotation Device
(x) Hi-Vis Safety Vest
(x) Sun Screen
(x) fall protection gear (e g , safety harness, rope, hooks)

BLOCK D

TASKS: NA
LEVEL:
( ) Primary ( ) Contingency

Respiratory: ( ) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
( ) Safety Glasses:
( ) Face Shield:
( ) Goggles:
( ) Hard Hat:
( ) Other:

Boots: ( ) Not needed
( ) Steel-Toe ( ) Steel Shank
( ) Rubber ( ) Leather
( ) Overboots:

Prot Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
( ) Tyvek Coverall
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves:
( ) Gloves:
( ) Overgloves:

Other: specify below
( ) Tick Spray
( ) Flotation Device
( ) Hearing Protection
( ) Sun Screen

This health and safety plan form constitutes hazard analysis per 29 CFR 1910.132

HEALTH AND SAFETY PLAN FORM

CDM (Camp Dresser & McKee)

CDM Health and Safety Program

MONITORING EQUIPMENT: *Specify by task. Indicate type as necessary. Attach additional sheets if needed.* **PROJECT DOCUMENT #:**

INSTRUMENT	TASK	ACTION GUIDELINES		COMMENTS
Combustible Gas Indicator	1-2-3-4-5-6-7-8	0-10% LEL 10-25% LEL >25% LEL 21.0% O2 <21.0% O2 <19.5% O2	*No explosion hazard* *Potential explosion hazard; notify SHSC* *Explosion hazard; interrupt task/evacuate* *Oxygen normal* *Oxygen deficient; notify SHSC* *Interrupt task/evacuate*	(x) Not Needed
Radiation Survey Meter	1-2-3-4-5-6-7-8	3 x Background: >2mR/hr:	*Notify HSM* *Establish REZ*	(x) Not Needed
Photoionization Detector _____eV Lamp Type ____	1-2-3-4-5-6-7-8	*Specify:*		(x) Not Needed
Flame Ionization Detector Type____________	1-2-3-4-5-6-7-8	*Specify:*		(x) Not Needed
Single Gas Type____________ Type____________	1-2-3-4-5-6-7-8	*Specify:*		(x) Not Needed
Respirable Dust Monitor Type____________ Type____________	1-2-3-4-5-6-7-8	*Specify:*		(x) Not Needed
Other *Specify:* Type____________ Type____________	1-2-3-4-5-6-7-8	*Specify:*		( ) Not Needed
Other *Specify:* Type____________ Type____________	1-2-3-4-5-6-7-8	*Specify:*		( ) Not Needed

HEALTH AND SAFETY PLAN FORM CDM Health and Safety Program	*This document is for the exclusive use of CDM and its subcontractors*	CDM (Camp Dresser & McKee)

DECONTAMINATION PROCEDURES

ATTACH SITE MAP INDICATING EXCLUSION, DECONTAMINATION, & SUPPORT ZONES AS PAGE TWO

PROJECT DOCUMENT #:

Personnel Decontamination	**Sampling Equipment Decontamination**	**Heavy Equipment Decontamination**
Summarize below or attach diagram; Nitrile gloves will be used for most tasks, however, personnel should wash hands prior to eating or drinking to minimize metals exposure. Alconox solution and DI water may be used for cleaning hands, and baby wipes should be on-hand as well. ( ) Not Needed	*Summarize below or attach diagram;* Dedicated equipment will be used for most sampling. A metal shovel may be used for some soil and waste rock sampling. The shovel will be decontaminated between sampling locations with a gross debris removal, an alconox solution scrub, and a distilled water rinse. The churn splitter used for compositing depth-width integrated surface water samples will be decontaminated between locations by rinsing with distilled water after sampling, and then rinsing in the stream water for the next location. The groundwater bladder pump for sampling will be decontaminated using a stepped-bucket rinse process. The pump will be dissassembled as appropriate and then rinsed in 5 buckets in order: 1) distilled water; 2) alconox solution; 3) distilled water; 4) nitric acid 10%; 5) distilled water. ( ) Not Needed	*Summarize below or attach diagram;* (x) Not Needed
Containment and Disposal Method None. Dispose on ground surface.	**Containment and Disposal Method** None. Dispose solutions on ground surface.	**Containment and Disposal Method**

HAZARDOUS MATERIALS TO BE BROUGHT ONSITE

Preservatives		*Decontamination*		*Calibration*	
( ) Hydrochloric Acid	( ) Zinc Acetate	(x) Alconox ™	( ) Hexane	( ) 100 ppm isobutylene	( ) Hydrogen Sulfide
(x) Nitric Acid	( ) Ascorbic Acid	(x) Liquinox ™	( ) Isopropanol	( ) Methane	( ) Carbon Monoxide
(x) Sulfuric Acid	( ) Acetic Acid	( ) Acetone	(x) Nitric Acid	( ) Pentane	(x) pH Standards
( ) Sodium Hydroxide	( ) Other:	( ) Methanol	( ) Other:	( ) Hyrogen	(x) Conductivity Std
		( ) Mineral Spirits		( ) Propane	( ) Other:

HEALTH AND SAFETY PLAN FORM	*This document is for the exclusive*	**CDM (Camp Dresser & McKee)**
CDM Health and Safety Program	*use of CDM and its subcontractors*	**PROJECT DOCUMENT #:**

EMERGENCY CONTACTS	
Water Supply	None
Site Telephone	720-302-3786
EPA Release Report #:	800 / 424 - 8802
CDM 24-Hour Emergency #:	FSG 571 / 216 - 7004
Facility Management	N/A
Other (specify)	
CHEMTREC Emergency #:	800 / 424 - 9300

SAFETY NARRATIVE: *Summarize below*

1.) Surface soil and waste rock samples will be collected on steep slopes (between 30-60 degrees) that contain loose rock and on the downslope side of forest roads. Depending on the angle of the slope, use of harness and safety rope may be required to safely move up and down the slope. Specialized fall protection training and equipment will be required during sampling activities on steep slopes. For sampling along forest roads, there is danger that passing vehicle traffic can cause sliding rock. To limit this risk, all sampling along road slopes shall be conducted with a spotter located at the top of the slope along the road. The spotter shall notify vehicle traffic to use cuation and drive slowly using a "SLOW" traffic sign. Spotters will also not locate themselves directly below slope sampling so as to avoid falling rocks/debris from above;and if necessary, spotters will stop traffic when danger of falling rock onto traffic from above exists. .

2.) Some depth-width integrated surface water sampling is planned to be conducted in fast moving and deep rivers, requiring sampling at different width locations across the river. Specialized training and protection measures will be required to be implemented for working near or over fast moving, deep water.

HEALTH AND SAFETY PLAN APPROVALS (H&S Mgr must sign each plan)

Prepared by	Nick Anton	Date	Jun 05, 2009
HSC Signature	[signature]	Date	
HSM Signature	[signature]	Date	Jun 05, 2009

EMERGENCY CONTACT!	**NAME**	**PHONE**
Health and Safety Manager	Shawn Oliveira	406 / 293-1547
Project Manager	Dee Warren	
Site Safety Coordinator	Nick Anton	
Client Contact	Denise Baker-Kircher	206-553-4303
Other *(specify)*		
Environmental Agency	EPA Region 10	
State Spill Number	Oregon	(800) 452-0311
Fire Department		911
Police Department		911
State Police		911
Health Department		
Poison Control Center	Nationwide	800 / 222 - 1222
Occupational Physician	Kenneth Chase	800 / 777 - WOHA

MEDICAL EMERGENCY		**PHONE**
Hospital Name:	Mercy Medical Center	(541) 673-0611
Hospital Address	2700 NW Stewart Parkway, Roseburg, OR 97470	
Name of Contact at Hospital:		
Name of 24-Hour Ambulance:		
Route to Hospital:		

Exit the Site via BLM Road 30-6-35 or 30-6-35.1 heading north towards Riddle, OR. Turn right at Shoestring Road. Turn left at Canyonville Riddle Road. Continue through Riddle (main street) and take right at 5th Avenue (becomes Pruner Road). Continue on Pruner Road and take right at Riddle By Pass Road. Take Riddle by-Pass Road to I-5, and head north on I-5 towards Roseburg, OR. Travel about 21 miles and take Exit 125 for Garden Valley Blvd. Merge onto NW Mulholland Drive (heading north). Turn left at NW Stewart Parkway, hospital on right.

Distance to Hospital: Approximately 30 miles

HEALTH AND SAFETY PLAN SIGNATURE FORM

CDM Health and Safety Plan

All site personnel must sign this form indicating receipt of the H&SP. Keep this original on site. It becomes part of the permanent project files. Send a copy to the Health and Safety Manager (HSM).

SITE NAME/NUMBER: Formosa Mine Site/50993.55919.3380.221

DIVISION/LOCATION: FSG/DENVER

CERTIFICATION:

I understand, and agree to comply with, the provisions of the above referenced H&SP for work activities on this project. I agree to report any injuries, illnesses or exposure incidents to the site Health and Safety Coordinator (SHSC). I agree to inform the SHSC about any drugs (legal and illegal) that I take within three days of site work.

PRINTED NAME	SIGNATURE	DATE

16.2 Housekeeping

These guidelines are for the establishment and administration of a clean and orderly work environment at field project sites. A continuous housekeeping program strongly tends to prevent accidents. A clean and orderly work environment can be achieved and maintained through ongoing housekeeping efforts undertaken by personnel at all levels. Project managers shall initiate participation in housekeeping activities and good work habits, not only at the end of a work assignment, but throughout the evolution of the project.

- To achieve these benefits, the team shall plan the location of equipment and storage facilities to allow the easy flow of personnel, equipment, materials, fire hazards, and to prevent the obstruction of evacuation, fire fighting, or rescue activities.
- Store materials in a manner that facilitates access of material handling equipment and personnel handling limitations. Lack of sufficient workspace and storage capacity leads to the potential for accidents and decreases efficiency.
- Avoid storage of flammable liquids, such as paints and thinners unless they are required for specific project needs. If needed, such storage shall be within a metal storage cabinet that has been labeled and approved for the storage of flammable liquids.
- Continuously maintain work areas in a neat and orderly manner.
- Containers should be provided for the collection of waste, trash, and other non-hazardous refuse. Investigation-derived waste and other waste materials that are potentially hazardous should be stored and labeled in accordance with project specific procedures that meet regulatory and client requirements.
- Deploy leads, hoses, and extension cords so they do not present tripping hazards, and are not subject to contact with moisture or physical stress. Where possible they should be hung overhead with non-conductive material and kept away from walkways, doors, stairs, and ladders.
- Protect protruding rebar and anchor bolts and conspicuously mark them.
- Clean small spills that create slip hazards and or flammability hazards immediately and not leave them unattended.
- Keep walkways, aisles, stairways, and passageways in a clear and unobstructed condition.
- Prohibit eating and drinking in work areas where there is potential exposure to toxic or hazardous materials. Smoking is limited to designated smoking areas where there is no such exposure.

16.3 Manual Material Handling

Camp Dresser & McKee Inc. (CDM) employees should follow the work practices outlined below when lifting and carrying heavy objects.

- Test any load they are required to lift, and compare its weight, volume, and shape to their lifting abilities. Employees shall not attempt to lift beyond their capacity.
- Obtain assistance in lifting heavy objects. Back belts or back braces may be used if desired, however many ergonomists do not believe that these devices create a benefit or provide protection.
- When two or more persons are involved in a manual lift, one person should provide direction of the lift.
- When two or more persons are carrying an object, each employee, if possible, should face the direction in which the object is being carried.
- When two or more persons carry a heavy object that is to be lowered or dropped, there shall be a prearranged signal for releasing the load.
- The right way to lift is easiest and safest. Crouch or squat with the feet close to the object to be lifted, secure good footing, take a firm grip, bend the knees, keep the back vertical, and lift by bending at the knees and using the leg and thigh muscles. Exercise caution when lifting or pulling in an awkward position.
- Employees should avoid twisting or excessive bending when lifting or setting down loads.
- When moving a load horizontally, employees should push the load rather than pull.
- For tasks that require repetitive lifting, the load should be positioned to limit bending and twisting. The use of lift tables, pallets, and mechanical devices should be considered.
- When gripping, grasping, or lifting an object such as a pipe or board, the whole hand and all the fingers should be used. Gripping, grasping, and lifting with just the thumb and index finger should be avoided.

16.4 Electrical Safety

The following work practices can eliminate or minimize the potential for electrical shock, fires, and burns when working or around electrical equipment.

- Treat all electrical circuits as live until their condition has been verified. Treat even low voltages as dangerous.
- Inspect all electrical equipment and tools before each use. Inspect insulation, fixtures, switches, plugs, fuses, etc. Remove from service any faulty equipment and notify the source of the equipment.
- Do not work with electrical equipment with wet hands or standing in wet areas.
- Only a qualified electrician should wire or install electrical systems.
- Ground Fault Circuit Interrupters (GFCIs) should be provided for all areas where electrical equipment or portable electric tools may be used. If a GFCI outlet is not available, a portable GFCI outlet adapter or extension cord should be used. (available from the equipment center)
- Do NOT use your finger or any conductive object to point to circuits, panels, fixtures etc.
- Do not install fuses or circuit breakers larger than the circuit rating.
- Conduct a tool count before beginning work and after work is completed.
- Use lock out/tag out procedures whenever working on electrical equipment.
- Use only approved and properly rated lighting devices and tools in vessels, boilers, and confined spaces.
- Use the following precautions when using electrical cords:
  - Visually inspect electrical cords before each use for fraying, cuts, or other damage.
  - Do not use extension cords for permanent installations.
  - Keep extension cords properly covered or raised overhead to prevent tripping hazards and damage from traffic.
  - Extension cords or cables shall not be secured with staples, hung from nails, or suspended by bare wire
  - Only use electrical cords that are equipped with a grounding pole on the plug (three pole plugs). Never remove a grounding pole from a cord.

- All electrical equipment, including motors, generators, wiring, and controls should be installed so that exposed live parts are properly guarded or insulated to provide adequate protection to operating personnel. Avoid open panels, circuit boxes, and exposed wiring.

- Portable electrically-driven tools must be grounded with a three-wire circuit. Explosion-safe (explosion-proof or intrinsically safe) tools are required in hazardous areas.

- In wet locations:

  - Plugs and receptacles shall be kept out of water unless they are an approved submersible type.

  - Where a receptacle is used in a wet location, it shall be contained in a weatherproof enclosure, the integrity of which is not affected when an attachment plug is inserted.

  - All temporary lighting strings in outdoor or wet locations (such as tunnels, culverts, valve pits, floating plant, etc.) shall consist of lamp sockets and connection plugs permanently molded to the hard service cord insulation.

- If a rescue from electrical equipment is required, use the following precautions:

  - Disconnect the circuit before attempting the rescue.

  - Make sure you are standing on a dry surface.

  - Use a dry belt, rope, coat, or other non-conductive material to loop over the victim and drag them away from the contact.

  - Assess the condition of the victim; do not approach if they are still in contact with the circuit.

  - Apply first aid and/or CPR (if you are qualified) and get medical help.

16.7 Fall Protection

Camp Dresser & McKee Inc. (CDM) employees who visit active construction sites may be exposed to falls. A fall exposure is considered to exist when an employee is within 6 lateral feet of a change in elevation of 6 vertical feet or more. Typical exposures can include:

- Excavations
- Roofs
- Leading edge of a surface (floor)
- Floor openings

All employees should use fall protection 100 percent of the time when exposed to a fall in excess of six feet or when required by rules such as those of a client or the owner or operator of a facility. Fall protection may consist of any of the following:

- Guardrails
- Safety Nets
- Positioning Systems
- Warning Systems
- Personal Fall Arrest Systems

Employees should not use fall arrest equipment until they have been properly trained. Fall protection training can be arranged by contacting your division HSM. Project managers and site managers shall ensure fall protection is available and used as required for all employees for whom they are responsible and that employees receive adequate training in the use of the equipment.

The following work practices and guidelines should be considered for protection against falls:

- Before working or walking on a surface, consider the strength and structural integrity of the surface. Can it can support employees and any needed equipment or material safely? Employees shall work on those surfaces only when the surfaces have the requisite strength and structural integrity.

- When not protected by any other means of fall protection, such as safety nets or scaffold with proper guardrails, employees shall use full body harnesses, lanyards with double-locking snap hooks, and an adequate anchorage (fall arrest equipment). To achieve 100 percent fall protection, employees may need to use a two-lanyard system and/or vertical or horizontal lifelines, retractable lifelines, or other approved positioning devices.

- Employees shall rig fall arrest equipment so that it minimizes the potential for a fall arrest event or any potential free fall, lateral swing, or contact with any lower object. Under no circumstances shall fall arrest equipment be rigged so that an employee can free fall more than 6 feet.

- Anchorage points for fall arrest equipment shall be capable of supporting 5,000 lbs per employee attached. Anchorage points for fall arrest equipment shall be located above the employee's body harness attachment point where practical.

- When vertical lifelines are used, a separate lifeline shall protect each employee. The lifeline shall be properly weighted at the bottom and terminated to preclude a device such as a rope grab from falling off the line.

- Horizontal lifelines should be limited to two persons at one time between supports and maintain a safety factor (strength /requirement) of at least two.

- Before each use, employees shall visually inspect all fall arrest equipment for cuts, cracks, tears or abrasions, undue stretching, overall deterioration, mildew, operational defects, heat damage, or acid or other corrosion. Equipment showing any defect shall be withdrawn from service. All fall arrest equipment subjected to impacts caused by a free fall or by testing shall be removed from service. CDM personnel shall use full body harnesses for personal fall protection. Fall protection equipment is available from the field equipment centers.

- Fall arrest equipment should be stored in a cool dry place not subjected to direct sunlight.

- Fall arrest equipment shall not be used for any other purpose, such as towropes or hoist lines.

- Proper guardrails shall be installed on open sides of all walkways and runways where the fall distance exceeds 4 feet. Proper guardrails shall be installed on open sided floors where the fall distance exceeds 6 feet. All floor openings or floor holes shall be protected by guardrails or hole covers. If hole covers are used, they shall be strong enough to support the maximum intended load, secured against displacement, and properly labeled.

- When guardrails are used for fall protection, they shall consist of a top rail, intermediate rail, and toe board. The top rail shall have a vertical height of 42 inches; the midrail shall be at 21 inches, and the toe board 4 inches. When wood railings are used, the post shall be of at least 2 inch by 4 inch stock spaced not to exceed 8 feet, the top rail shall be of at least 2 inch by 4 inch stock, and the intermediate rail shall be of at least 1 inch by 6 inch stock. If pipe is used, it shall be at least 1 ½ inch nominal diameter. If structural steel is used, it shall be of 2 inch by 2 inch by 3/8-inch angles or equivalent. If wire rope is used for railings, it shall have a diameter of at least 2 inch and shall be stretched taut to allow no more than a 3 inch deflection.

- When operating a scissor-lift work platform, the lift shall have guardrails on all open sides, with the door access chains or rails in place.
- Employees operating aerial lifts shall wear a body harness and lanyard attached to the aerial lift. Employees shall not attach the lanyard to an independent structure.
- Employees riding in a crane-suspended work platform shall wear a body harness and lanyard attached to the grab rail of the platform.
- Employees working on or near wall forms or rebar shall wear a body harness lanyard and/or positioning device when exposed to a fall in excess of 6 feet.
- Positioning devices shall be rigged to prevent a free fall greater than 24 inches.
- Stairs, ladders, or ramps shall be provided for all access ways where there is a change in elevation greater than 19 inches.
- Manila or synthetic rope shall not be used as guardrails.
- Employees shall not stand or sit on guardrails.
- Personal fall arrest systems shall not be attached to guardrail systems.
- If warning lines are used, they should consist of rope, wire, or chain, and be flagged at intervals of 6 feet or less with high-visibility material. The lowest point should be no less and 34 inches from the surface and the highest point should be no more than 39 inches. The warning line should be placed at least 6 feet from the edge.
- Safety net systems should be installed as close to the working surface as practical, but in no case more than 25 feet below the working surface and should extend outward at least 8 –13 feet depending on the vertical fall distance. Safety nets should be drop-tested after initial installation and at 6-month intervals. The maximum size of net mesh should not exceed 36 square inches nor be longer than 6 inches on any side. Mesh opening should be secure to prevent enlargement.
- Body belts should not be used for personal fall arrest. Full body harnesses are required.

16.12 Tools and Power Equipment

16.12.1 Hand Tools

Camp Dresser & McKee Inc. (CDM) employees who have a need to use basic hand tools should use the following work practices:

- All tools used on CDM projects, regardless of ownership, shall be of an approved type and maintained in good condition. Tools are subject to inspection at any time. The project manager has the authority and responsibility to condemn unserviceable tools, regardless of ownership.
- Tag defective tools to prevent their use or removal from the job site.
- Use the proper tool for the job performed.
- Don't use hammers with metal handles, screwdrivers, knives with metal continuing through the handle, and metallic measuring tapes on or near energized electrical circuits or equipment.
- Do not throw tools from place to place or from person to person; tools that must be raised or lowered from one elevation to another shall be placed in tool buckets or firmly attached to hand lines.
- Do not place tools unsecured on elevated places.
- Dress, repair, or replace all impact tools such as chisels, punches, drift pins, etc., that become mushroomed or cracked before further use.
- Use suitable holders or tongs to hold chisels, drills, punches, ground rods, or pipes that are struck by another employee, not the hands.
- Do not use shims to make a wrench fit.
- Do not use wrenches with sprung or damaged jaws.
- Do not use pipe or other means to extend a wrench handle for added leverage unless the wrench was designed for such use.
- Use tools only for the purposes for which they have been designed.
- Store and handle tools with sharp edges so that they will not cause injury or damage. They shall not be carried in pockets.
- Use eye protection when using or working around impact type tools. (e.g., hammer, chisel, ax, hatchet, etc.)
- Replace wooden handles that are loose, cracked, or splintered. The handle shall not be taped, glued, or lashed with wire.

- Keep all cutting tools such as saws, wood chisels, knives, or axes in suitable guards or in special compartments.

- When using such tools as screwdrivers and wrenches, avoid using your wrists in a bent, flexed, extended, or twisted position for long periods of time. Employees should maintain their wrists in a neutral or straight position.

- Do not leave tools lying around where they may cause a person to trip or stumble.

- When working on or above open grating, use a canvas or other suitable covering to cover the grating to prevent tools or parts from dropping to a lower level where others are present, or barricade or guard the danger area.

- Do not depend on the insulation on hand tools to protect users from shock.

16.12.2 Electric Tools

CDM employees who have a need to use electric power tools should use the following work practices:

- The non-current carrying metal parts of portable electric tools such as drills, saws, and grinders shall be effectively grounded when connected to a power source unless the tool is an approved double-insulated type, or the tool is connected to the power supply by means of an isolating transformer or other isolated power supply, such as a 24-volt DC system.

- All power tools shall be examined before use to ensure general serviceability and the presence of all applicable safety devices. The electric cord and components shall be given a thorough examination for cracks, exposed wires or other defects.

- Power tools shall be used only within their capability and shall be operated in accordance with the manufacturers' instructions.

- The use of eye protection is required when using or working around power tools.

- Operators should take care to use appropriate hand positions on cutting tools such as saws, drills, grinders, etc. to avoid hand injury.

- All tools shall be kept in good repair and disconnected from the power source while repairs are being made.

- Electrical tools shall not be used where there is a hazard of flammable vapors, gases, or dusts, until that hazard is firmly under control.

- Ground fault circuit interrupters (GFCI) should be used with all electric power tools.

- All guards and safety interlocks with which the tools were purchased shall be in place and in working order.

- Any tool that is identified as defective should be tagged "not for use", and set aside for repair and/or discarded.
- Do not wear loose or frayed clothing while operating power tools and equipment. Hair should not stick out from hard hats.
- Do not use electrical cords to transport, suspend, hoist, or lower tools.
- Do not allow power cords to lie in water.
- Disconnect rotating tools from the power source before adjusting, servicing, or cleaning them. Follow the lockout procedure described in section 16.5.
- Do not modify tools.

16.12.3 Pneumatic Tools

CDM employees that use pneumatic power tools should use the following work practices:

- Compressed air and compressed air tools shall be used with caution.
- Pneumatic tools shall never be pointed at another person.
- Pneumatic hose connections should be secured by some positive means to prevent them from becoming accidentally disconnected. Chicago fittings have wire holes to allow such security.
- Pneumatic power tools shall be secured to the hose by some positive means to prevent the tool from becoming accidentally disconnected.
- Safety clips or retainers shall be securely installed and maintained on pneumatic impact tools to prevent attachments from being accidentally expelled.
- Compressed air shall not be used for cleaning purposes except when reduced to less than 30 psi and then only with effective chip guarding and personal protective equipment.
- Compressed air shall not be used to blow dust or dirt from clothing (or skin).
- The manufacturer's safe operating pressure for hoses, pipes, valves, filters, and other fittings shall not be exceeded.
- The use of hoses for hoisting or lowering tools shall not be permitted.
- All compressed air hoses exceeding 30 psi shall have a safety device at the source of supply or branch line to reduce pressure in case of hose failure or disengagement of a connection.

- Before making adjustments or changing air tools, the air shall be shut off at the air supply valve ahead of the hose. The hose shall be bled at the tool before breaking the connection. Disconnection at the quick-change connectors is one way to meet this goal.
- Eye protection is required when using or working around pneumatic tools.
- Use hearing protection if noise exposure is a concern, (i.e., if it is too loud to conduct a normal conversation).
- Pneumatic tools shall be operated only by persons trained in their use.
- A pneumatic tool used where it may contact exposed live electrical parts shall have a nonconductive hose and an accumulator to collect moisture.
- Employees shall not use any part of their bodies to locate or attempt to stop an air leak.
- All guards and safety interlocks must be in place and functional.

16.12.4 Engine-Powered Tools

- Stop the engine and allow it to cool before refueling, servicing, or maintenance.
- Use care in refueling. Clean up any small spills of fuel or oil immediately.
- The use of eye protection is required when using or working around engine - powered tools.
- Use hearing protection if noise exposure is a concern, (i.e., if it is too loud to conduct a normal conversation).
- If possible, disconnect the spark plug before performing an adjustment, maintenance or service.
- Use tools in well-ventilated areas to eliminate any accumulation of fumes.
- Do not use tools in a flammable or explosive atmosphere.
- Equip engines with spark-arresting mufflers.
- Avoid contact with hot engine components.
- All guards and safety interlocks should be in place and functional.

16.13 Heat Stress

Camp Dresser & McKee Inc. (CDM) employees may be exposed to hazards associated with hot work environments. Factors that contribute to heat exposure include temperature, humidity, personal protective equipment (PPE) radiant heat, sunlight, access to drinking water, exposure duration, and work activity. Individuals vary widely in their susceptibility to heat stress. Factors that may influence individual susceptibility to heat stress include the following:

- Lack of physical fitness
- Lack of acclimatization
- Age
- Dehydration
- Obesity
- Alcohol and drug use
- Infection
- Sunburn
- Diarrhea
- Chronic disease

The following guidelines should be considered when CDM employees or subcontractors perform work:

- In ambient air temperatures above 80 ° F
- That involves heavy physical labor in temperatures above 70 ° F
- In chemical-protective clothing above 70 ° F.

16.13.1 Hazards Associated With Heat Stress

Heat Stroke – Heat stroke is a serious medical emergency and can lead to death if left untreated. It is an acute and dangerous reaction caused by the failure of heat regulating mechanisms of the body. Persons who are elderly, obese, chronically ill, alcoholic , diabetic, or have circulatory system problems are at greater risk.

- Symptoms include red, hot, dry skin, nausea, headache, weakness, dizziness, elevated body temperature, rapid respiration and pulse, coma, or loss of consciousness.
- Treatment for heat stroke:

- Heat stroke is a serious medical emergency. Emergency medical services (911) should be contacted if heat stroke is suspected.
- Move the victim to a cool place, (shade, air conditioned building, vehicle).
- Remove heavy clothing.
- Cool the victim with ice packs, wet towels, or cloth.
- Keep head and shoulders elevated.
- Keep victim's airway open, check breathing and pulse.

Heat Exhaustion – A state of exhaustion or weakness caused by loss of fluids through perspiration and inadequate fluid replacement. Severe cases may result in loss of consciousness, (fainting). This condition can progress to heat stroke if left untreated.

- Symptoms include:
  - Pale, clammy, moist skin, heavy sweating, and extreme weakness.
  - Body temperature is normal, pulse is weak and rapid, breathing is shallow.
  - The person may have a headache, nausea, or feel dizzy.
- Treatment for heat exhaustion:
  - Remove the victim to a cool location. (e.g., shade, air conditioned building, or vehicle).
  - Allow the victim to lie down and prop their legs up.
  - Cool the victim with wet towels, cloth, or cold packs.
  - If the victim in not nauseous they should drink water slowly.
  - If the victim loses consciousness, transport to local medical facility.
  - Continue treatment until symptoms are gone. Consult with CDM medical consultant prior to returning to work.

Heat Cramps – Heat cramps are a condition that can progress to heat exhaustion or heat stroke. Symptoms include severe cramping of the arms, legs, and abdomen. Treatment incudes:

- Removing the victim to a cool location. Loosen clothing.
- Having the victim slowly drink cool water.

- Resting the cramping muscles.

Heat Rash – Heat rash is a mild red skin rash, in areas where the body is in contact with clothing or protective gear. The area is likely to itch and can be a source of irritation. Treatment includes decreasing the amount of time in protective gear and applying talcum powder to absorb moisture. When possible, wear breathable clothing to prevent a buildup of moisture within the clothing.

16.13.2 Heat Stress Monitoring

Since the susceptibility to heat stress hazards can vary greatly from one individual to another, often the best way monitor for heat stress is through observing employees and individual physiological monitoring. When working in conditions that have the potential to create heat stress, either heart rate (HR) or body temperature (BT) should be monitored in accordance with the suggested frequency given in Table 16-1 below:

Table 16-1 Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

Adjusted Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (225°-253°C)	After each 150 minutes of work	After each 120 minutes of work

[a]For work levels of 250 kilocalories/hour.

[b]Calculate the adjusted air temperature (T_a adj) by using this equation: T_a adj °F = ta °F + (13 X % sunshine). Measure air temperature (T_a) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow, (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine - no shadows).

[c]A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

- Heart Rate (HR) – Heart rate should be measured by the radial pulse for 30 seconds as early as possible in the initial rest period. On an individual basis, if the heart rate exceeds 110 beats per minute (BPM), that individual should not return to work until their heart rate drops below 110 BPM and they are fully recovered. If more than one worker has a heart rate that exceeds 110 BPM, a work rest regimen, or other control measures should be implemented to maintain heart rates below 110 BPM.

- Body Temperature (BT) – The body temperature may be measured using a clinical oral thermometer or a clinical ear thermometer. On an individual basis, if the body temperature exceeds 99.6 ° F, that individual should not return to work until their body temperature drops below 99.6 ° F and they are fully recovered. If more than one worker has a body temperature in excess of 99.6 ° F, a work rest regimen, or other control measures should be implemented to maintain to maintain body temperatures below 99.6 ° F.

- Personnel should monitor themselves and each other for the development of symptoms such as sudden fatigue, nausea, dizziness, irritability, malaise, flu-like symptoms, and lightheadedness.

16.13.3 Heat Stress Controls and Prevention

- Develop work/rest regimen to maintain physiological parameters within limits described above and prevent development of initial symptoms of heat stress-related conditions. If the physiological limits are exceeded or symptoms develop, the work period should be reduced and rest period increased. Rest areas should be cool, in areas such as shade, air conditioned buildings, or vehicles, and away from heat exposure.

- In extreme heat conditions, employees may wear heat-control clothing such as ice vests or cool suits. Physiological monitoring should still be conducted and work/rest regimens implemented to keep physiological parameters within recommended limits.

- Mobile showers or hoses can be used to cool down workers in waterproof protective clothing.

- Shield sources of radiant heat.

- Provide shaded work areas.

- Conduct activities in early morning and late evening to avoid the hottest parts of the day.

- Allow employees to become acclimatized to the heat by performing less strenuous activities for the first few days. Schedule more physically demanding work later.

- Provide adequate, cool drinking water for consumption during break periods.

- Avoid consumption of beverages such as coffee, tea, or colas that act as diuretics and dehydrate the body.

16.14 Cold Stress

Persons working outdoors in low temperatures, especially below freezing, or in wet or snowy weather are potentially subject to cold stress disorders. Factors that contribute to cold stress exposure include temperature, humidity, wind, sunlight, rain, snow, fog, exposure duration, clothing, and work activity. Individual susceptibility to cold stress disorders can vary widely. Individual physical factors that can affect a person's response to cold work environments include a persons general fitness and age.

The following guidelines should be considered when working in ambient air temperatures below 40 ° F, especially when other contributing weather conditions such as snow, rain, or wind are present.

16.14.1 Hazards Associated with Cold Stress

Hypothermia – Hypothermia results from a cooling of the body's core temperature and if left unattended can become a serious condition. Hypothermia can result in the loss of physical skills and impair judgment thereby contributing to the potential for other accidents. Severe hypothermia can result in death. Hypothermia can occur at temperatures above freezing as well as below.

- Symptoms include shivering, teeth chattering, fumbling hands, slurred speech, and loss of coordination. Eventually the pulse and respiratory rate may slow. The victim may appear blue or lose color in the face.

- Treatment for hypothermia is to catch symptoms early and move the individual to a warm environment indoors or in a vehicle. If a warm location is not immediately available the victim should be sheltered from the wind and provided extra clothing such as coats or blankets, and observed to determine if their condition is improving or not. If the victim continues to deteriorate and becomes colder, they should be transported to a medical facility for assistance.

Frostbite – Frostbite is a condition in which the fluids around cells of body tissue freeze. The condition can lead to body tissue damage. The most vulnerable parts of the body are the nose, ears, cheeks, fingers, and toes.

- Symptoms of frostbite include, body parts becoming white, firm, cold to the touch and may feel waxy. The victim will not feel pain in the affected area.

- Treatment of frostbite requires that the victim be brought to a warm environment and the affected areas be allowed to thaw and warm. If frostbite has progressed beyond small patches of skin and affects whole body parts such as a hand, foot, or ear, the victim should be transported to a medical facility for treatment and observation.

16.14.2 Cold Stress Monitoring

Personnel should monitor themselves and each other for signs and symptoms of frostbite and/or hypothermia. If symptoms are observed in an employee or subcontractor, steps should be taken to treat the symptoms by having the individual go to a warm environment either in a nearby structure or vehicle.

16.14.3 Cold Stress Control and Prevention

Cold stress can easily be prevented with proper planning and prevention. Some basic controls and preventative measures are listed below:

- Forecasted conditions. Consider the effect of wind chill, (See Table 16-2 on next page).
- Dress in layers and stay dry. Avoid cotton clothing such as socks or T-shirts. Bring extra clothing.
- Wear hardhat liners and gloves. Wear rain gear in rain and snow.
- Curtail work if extreme weather conditions such as a blizzard, extreme wind chill, (e.g., less than 0° F), torrential cold rains or wind is expected.
- For long-term projects in cold environments, consider setting temporary structures with portable heaters.
- Take warming breaks as needed.
- Avoid beverages with caffeine, alcohol, or medications that restrict blood flow.
- Drink warm non-caffeine containing beverages such as hot chocolate or soups on breaks.

Table 16-2 Wind-chill Index

WINDCHILL INDEX	Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature (under calm conditions)											
Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
Wind speeds greater than 40 mph have little additional effect	**LITTLE DANGER** in < hr. with dry skin. Maximum danger of false sense of security.				**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.			**GREAT DANGER** Flesh may freeze within 30 seconds.				
	From *Fundamentals of Industrial Hygiene*, Third Edition. Plog, B.A., Benjamin, G. S., Kerwin, M.A., National Safety Council, 1988.											

16.16 Working Near or Over Water

When working on, over or near water, basic water safety precautions must be taken. Such areas include riverbanks, channels, dock areas, working from vessels of any kind, aeration basins, or other areas where a danger of drowning may exist. Depending on the circumstances, precautions needed may include any or all of the following:

- Employees should wear Coast Guard approved personal floatation devices (PFDs), (either vests or jackets) where a potential danger of drowning exists. PFDs are required when working from any type of boat or floating platform.
- The PFDs should be inspected before and at the end of each use for wear, torn stitching or straps, inoperable buckles, or other defects.
- Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water, unless the width of the water body is small enough to allow any potential rescue to occur from the bank (as would be the case with most aeration basins)

In some circumstances, these precautions may also be required by OSHA regulations. If you are planning to conduct work where water hazards may be present, be sure to take all appropriate precautions. If you will work in this situation, you should review the full text of the OSHA standard, OSHA Standard for Work Over or Near Water and consult your division health and safety manager or designated health and safety coordinator.

16.20 Hazardous Waste Site Controls

Work sites designated as Hazardous Waste Sites must control access to the work area to only authorized personnel and conform to general work practices expected at hazardous waste site operations as required by the OSHA Standard for Hazardous Waste Operations, 29 CFR 1910.120. The following concepts should be reflected in the health and safety plan for the project.

16.20.1 Access Control

Controlled access to hazardous waste site work areas is required to protect personnel working on the site as well as to limit the potential for transporting contaminants off site. Depending on the size of the work site, hazards and contaminants present, and complexity of the work, access control may range from verbally cautioning non-authorized personnel to stay away from the work area, to a program including site security, signs, or formal sign in and sign out procedures. Details of site-specific access control procedures should be included in the site-specific health and safety plan. Some general work practices for access control are noted below:

For small-scale site investigations that are short-term projects (i.e. days not weeks or months), identify a work area to the work crew and keep persons not associated with the job site out of the work area. If the site is in an area where non-authorized persons are likely to be encountered, traffic cones, caution tape, and signs identifying the area as a controlled access area may be used.

For more extensive projects where work may be done for weeks or longer, the team the should deploy more extensive access controls. They should:

- Set up physical barriers and hire security personnel to prevent non-authorized persons from entering the work site.
- Keep the number of personnel and equipment on site to the minimum required to do the project effectively and safely.
- Establish work zones within the site,(see the next section- work zones).
- Establish controlled access points to be used by authorized personnel.
- Track the entry and exit of personnel through a check-in, checkout system.
- Establish a formal decontamination corridor from exclusion zones.

16.20.2 Work Zones

Field project managers, working under health and safety plans for hazardous waste operations are required to establish work zones to prevent or reduce the spread of site contaminants to non-contaminated areas on or off site. Movement between zones should be restricted to those that need access to a specific area, and entry and exit between zones should be through designated access control points. A description of the three work-zone system for hazardous wastes is provided below.

Exclusion Zone – The exclusion zone should include any area where contamination is known or suspected. Areas of air, water, or soil that are contaminated with hazardous materials (biohazards, radioactive materials, chemicals) should be included in the exclusion zone. The zone should be well known to site workers. On smaller projects, this can be a verbal identification to site workers, such as "A 20-foot radius around the drill rig". On larger projects, or in areas that may be encountered by observers or the general public, the zone may need to be defined with caution tape, traffic cones or in some instances, fencing and barriers. The need will be site specific and the specific method should be identified in the site-specific health and safety plan. Some work practices that should be followed in the exclusion zone include:

- Employees in the exclusion zone must wear the PPE designated in the site health and safety plan for tasks executed within the zone.
- No eating, drinking, chewing gum or tobacco, smoking, application of cosmetics, including application of lip balm, sunscreen, or insect repellant is allowed in the exclusion zone.
- Sitting or kneeling in areas of high concentrations of contaminants should be avoided.
- If any PPE becomes defective, the employee should leave the work area via the designated egress area, decontaminate as needed, and replace the defective PPE before returning to work in the exclusion zone.
- Prescription drugs should not be used within the exclusion zone unless approved by CDM's medical consultant. The use of illegal drugs or consumption of alcohol is prohibited.
- When leaving the exclusion zone, employees should exit via the designated access/egress point(s) and follow decontamination procedures described in the site health and safety plan.

Contaminant Reduction Zone (CRZ)– A CRZ is established to provide a transition between the exclusion zone and the support zone. The CRZ is set up at the access control points of the exclusion zone and will vary in size depending on the complexity of activities that need to occur within the zone. For small site investigations, the CRZ may simply be a designated area near containers set up to collect used disposable PPE and some soap and water. For larger projects, the CRZ may include specific decontamination points and be staffed by personnel specifically designated to participate in the decontamination of personnel and equipment exiting the exclusion zone. Depending on the site contaminants, level of contamination, and decontamination procedures, personnel in the CRZ may be required to wear protective clothing, gloves, or respirators. The specific requirements will be outlined in the site health and safety plan. The CRZ should be placed in an area that is not contaminated at the boundary of the exclusion zone.

Support Zone – The support zone is established near the entrance to the site and is far enough from the exclusion zone and CRZ that specialized protective clothing or respirators are not used. The use of normal field PPE such as hard hats, safety glasses, and safety work boots is expected except for areas such as office trailers, break and lunch areas, or other areas designated as having no known or anticipated hazards. Operational support activities and equipment storage and maintenance areas are located in the support zone. No equipment or personnel should go from the exclusion zone to the support zone without passing through the CRZ and being decontaminated in accordance with the site health and safety plan.

Mobile Work Zone – For those projects that involve brief periods of work in multiple locations, a specific area may be designated as the exclusion zone for the duration of the work performed in that area. The exclusion zone can be terminated (provided there are no ongoing hazards or potential exposures to contaminants) and moved to the next area of work. For example, during soil borings or well installation, the exclusion zone can be defined as, "1.5 times the mast height" of the drill rig. Once the boring has been closed, or well installed and secured, and all drill cuttings have been secured, the area can be opened up and a new exclusion zone established around the next boring location.

16.20.3 Considerations When Establishing Work Zones

Work zones should be large enough to perform tasks within the zone safely, with no exposure to hazards to personnel outside the zone, but they should also be small enough to be able to secure and control access. Some considerations in establishing work zones include:

- Physical and topographical features of the site.
- Dimensions of the contaminated area.
- Weather.
- Physical, chemical, and toxicological characteristics of contaminants and chemicals used in the zone.
- Potential for exposure to site contaminants.
- Known and estimated concentrations of contaminants.
- Air dispersion of contaminants.
- Fire and explosion potential.
- Planned operations and space needed to perform the work safely.
- Surrounding areas.
- Decontamination procedures.
- History of job site.

16.20.4 General Hazardous Waste Site Work Practices

- **Buddy System -** Work should be scheduled so that no person works unobserved within the exclusion zone at any time. Each worker within the exclusion zone should maintain visual contact with at least one other worker on the site. All site personnel should remain aware of each other and monitor each other's condition.

- **Eating, drinking, chewing gum or tobacco, and smoking** - are prohibited within the contaminant reduction and exclusion zones. (Exception for heat stress: Squirt bottles of water, Gatorade, or other fluids may be consumed via squirt bottles in the contaminant reduction zone with the approval of the health and safety manager. Open bottles, cups, etc. should not be permitted.)

- Sitting or kneeling should be avoided in areas of known or suspected areas of contamination.
- Hands and face should be thoroughly washed when leaving the work area.
- Defective PPE should be repaired or replaced immediately.

Sections 5,6, 7, 9, and 11 of this manual are particularly in applicable to health and safety at hazardous waste sites.

16.21 Decontamination at Hazardous Waste Sites

Proper decontamination helps protect employees and prevents the contamination of uncontaminated areas. Decontamination protects all site personnel by minimizing the transfer of harmful materials into clean areas. It helps prevent mixing of incompatible chemicals and protects the community by preventing uncontrolled transportation of contaminants from the site.

16.21.1 Prevention of Contamination

To prevent contamination, Crew members should:

- Follow procedures for proper dressing prior to entry into the exclusion zone. Proper dressing will minimize the potential for contaminants to bypass the PPE and escape decontamination.
- Protect monitoring and sampling instruments by bagging. Make openings in the bags for sample ports and sensors that must contact site materials, or cover equipment and tools with a strippable coating, which can be removed during decontamination.
- Encase any source of contaminants on the site with barriers (e.g., plastic sheeting or over packs).
- Stress work practices that minimize contact with hazardous substances. Use remote sampling, handling, and container-opening techniques.

16.21.2 Decontamination Equipment Selection

In selecting decontamination equipment, consider whether the equipment must be decontaminated for reuse or can be easily disposed of. Recommended equipment for decontamination includes:

- Storage tanks or appropriate treatment systems
- Drains or pumps
- Long-handled brushes
- Wash solutions appropriate for the contaminants present
- Rinse solutions appropriate for the contaminants present
- Pressurized sprayers for washing and rinsing
- Curtains, enclosures, or spray booths
- Long-handled rods and shovels
- Containers to hold contaminants and contaminated soils

- Wash and rinse buckets
- Brooms
- Containers for the storage and disposal of contaminated material

16.21.3 Decontamination Design

Decontamination facilities should be located in the contamination reduction zone (CRZ), i.e., the area between the exclusion zone (the contaminated area) and the support zone (the clean area) and described in the Site H & S Plan.

- Site-specific factors that affect the decontamination facility design must be considered. Typical factors include:
  - The chemical, physical, and toxicological properties of the wastes.
  - The pathogenicity of infectious wastes.
  - The amount, location, and containment of contaminants.
  - The potential for, and location of, exposure based on assigned worker duties, activities, and functions.
  - The potential for wastes to permeate, degrade, or penetrate materials used for personal protective clothing and equipment, vehicles, tools, buildings, and structures.
  - The proximity of incompatible wastes.
  - The movement of personnel and/or equipment among different zones.
  - The emergencies that may arise.
  - The methods available for protecting workers during decontamination.
  - The impact of the decontamination process and compounds on worker health and safety.
- Decontamination Line
  - Decontamination should be an organized process by which levels of contamination are reduced.
  - The decontamination process consists of a series of steps performed in a specific sequence. For example, outer, more heavily contaminated items are decontaminated first, followed by the decontamination and removal of inner, less contaminated items.

- Each step should be performed at separate stations to prevent cross contamination.

- Decontamination stations should allow enough separation to prevent cross contamination and should be arranged in order of decreasing contamination.

- Separate decontamination areas should be provided to isolate workers from different contamination zones containing incompatible wastes or decontamination processes.

- Entry and exit points should be conspicuously marked. Preferably the entry to the CRZ from the exclusion zone should be separate from the entry to the exclusion zone from the CRZ.

- Dress-out stations for entry to the CRZ should be separate from redressing areas for exit from the CRZ.

- Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, must be appropriately decontaminated first.

- Examples of decontamination lines and procedures for personnel wearing various levels of protection are provided in Exhibits 16A and B.

16.21.4 PPE for Decontamination Workers

A rule of thumb is that decontamination workers wear a level of protection one level below the level of protection worn in the exclusion zone. However, consideration should be given to the following when determining the level of protection for a given project.

- The nature of site contamination.
- Degree of contamination expected on workers leaving the exclusion zone.
- The results of wipe tests and onsite air monitoring.

Some site-specific cases may require that decontamination personnel wear the same level of PPE as workers in the exclusion zone. Cases include:

- Workers using a steam jet may need a different type of respiratory protection than other decontamination personnel because of the high moisture content of the steam jets.
- Cleaning solutions used and wastes removed during decontamination may generate harmful vapors, requiring a different type of respiratory or clothing protection.

16.21.5 Decontamination Methods

All personnel, clothing, equipment, and samples leaving the contaminated area of a site should be decontaminated to remove any harmful chemicals, radioactive material, or infectious organisms that may have adhered to them. The extent of decontamination will vary depending on the nature of site activity, site contamination, and other factors.

- Decontamination methods available include:
  - Physical removal
  - Chemical detoxification or disinfections/sterilization.
  - A combination of both physical and chemical methods.
- The selected decontamination method should be reviewed for any safety and health hazards. If the selected method poses a direct health hazard, measures shall be taken to protect both the decontamination personnel and the workers to be decontaminated.
- Physical Removal
  - Physical methods using high pressure and/or heat should be used with caution.
  - Loose contaminants can be removed by using a soap and water rinse with a soft bristle brush to remove dust and vapors that cling to equipment and workers, or that are trapped in small openings, such as clothing or fabric weaving.
- Adhering contaminants can be removed by:
  - Scraping, brushing and wiping.
  - Solidifying.
  - Freezing (using dry ice or ice water).
  - Adsorption or absorption (e.g., kitty litter or powdered lime).
  - Melting.
  - Volatile liquid contaminants can be removed from PPE or equipment by evaporation followed by a water rinse. Evaporation may be expedited by the use of steam jets.

- Chemical Removal
  - Decontamination using chemicals should only be done if recommended by an industrial hygienist or other qualified professional.
  - Any chemical used in the decontamination process must be chemically compatible with the equipment or clothing being decontaminated.
  - Halogenated solvents should only be used for decontamination in extreme cases where other cleaning agents will not remove the contaminant.
- Chemical removal types include the following:
  - Surface contaminants can be dissolved in a solvent.
  - Solidification of liquid or gel contaminants can enhance their physical removal. Typical solidification processes are moisture removal using adsorbents such as grounded clay or powdered lime; and chemical reactions using polymerization chemicals and/or chemical reagents.

16.21.6 Personnel Decontamination

Different levels of personnel protection, as discussed in the PPE guidelines, may be used at any given site. The following is a description of the decontamination process for each level of protection.

- **Level D**
  - An area should be designated for the gross removal of dirt and mud from gloves and boot covers. Paper towels and buckets of rinse water can be made available for this purpose.
  - Typical decontamination steps for level D operations are provided in Exhibit 16-A.
  - Soap and water should be used to wash hands and face before leaving the site.
  - Laundering of personal clothing should be completed as soon as possible once offsite.
- **Level C & B**
  - A decontamination line should be established.
  - Site-specific procedures should be outlined in the site H&S plan. The recommended procedure for this layout is listed in Exhibit 16-B.

- **Level A** -It is not anticipated Camp Dresser & McKee Inc. (CDM) will directly participate in level A operations. If required, site-specific procedures will be developed in coordination with the division H&S manager.

16.21.7 Sampling and Monitoring Equipment Decontamination

Sampling equipment often becomes grossly contaminated. Often trowels or drum thieves are dedicated to a particular site. These should be left in the exclusion zone and disposed of as contaminated waste at the end of site work. Sampling equipment such as split spoons or other equipment that is used to collect several samples must be cleaned and decontaminated between samples to prevent cross contamination. These items should be cleaned and decontaminated in the project operations or sampling plan. Dirt and wash solutions from sampling equipment decontamination should be collected and disposed of as investigation-derived waste.

Once grossly contaminated, testing and monitoring instrumentation can be difficult to decontaminate without causing damage to the instrument. Care should be taken in the field to prevent gross contamination of field instruments by avoiding direct contact between the instrument and contaminated soils, water or surfaces. In some cases it may be necessary to place instruments in plastic bags, leaving small openings for sampling ports, detectors, and exhaust ports. The plastic bags can then be removed as the instrument comes out of the exclusion zone. The outside of instruments can be wiped down with paper towels or brushed off with clean soft brushes.

16.21.8 Heavy Equipment Decontamination

Drill rigs, trucks, backhoes, and other heavy equipment can be difficult to decontaminate. The method generally used is to wash them with water under pressure and scrub accessible areas with soap and warm water. Hot water and steam systems can be effective but may increase air concentrations of contaminants, exposing decon workers. Particular care should be taken where equipment comes into direct contact with contaminated soils such as tires, buckets, or treads. In severe cases, tires may need to be replaced or parts sand blasted clean or disposed of. Equipment should be visually inspected to be sure it is free of any visible signs of contamination. In some cases, wipe tests or other methods may be needed to confirm equipment has been adequately decontaminated before leaving the site.

16.21.9 Decon Solutions, Disposable PPE, and Site Wastes

Potentially contaminated equipment, disposable PPE, respirator cartridges, disposable sampling equipment, brushes, buckets, waste decon solutions etc., should be secured in drums and labeled. Disposal methods for these materials may depend on client requirements and/or results of site investigation data. The confirmed presence of hazardous materials on the site may require disposal of investigation-derived wastes as hazardous wastes.

Care should be taken during work and decontamination activities to minimize waste materials generated.

Exhibit 16-A Minimum Measures For Level D Decontamination

Station 1 - Equipment Drop	Deposit equipment used on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather, a cool down station may be set up in this area.
Station 2 - Outer Garment, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves, and suit with decontamination solution or detergent/water. Rinse off using copious amounts of water.
Station 3 - Hard Hat, Outer Boot, and Glove Removal	Remove hard hat, outer boots and gloves.
Station 4 – Boots, Gloves, and Outer Garment Removal	Remove boots, suit, and inner gloves and deposit in separate containers lined with plastic.
Station 5 - Field Wash	Wash hands and face.

Exhibit 16-B Minimum Measures For Level B, And C Decontamination

Station 1 - Equipment Drop	Deposit equipment used on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather, a cool down station may be set up in this area.
Station 2 - Outer Garment, Hard Hat, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves, and suit with decontamination solution or detergent/water. Rinse off using copious amounts of water.
Station 3 - Tank/Air Canister Change	If a worker leaves the exclusion zone to change an air tank, air canister, or mask, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boots donned, and joints tapped. Worker returns to duty.
Station 4 – Hard Hat, Outer Boot, and Glove Removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 5 – Inner Gloves and Outer Garment Removal	Remove suit, and inner gloves and deposit in separate containers lined with plastic.
Station 6 -SCBA/Respirator Removal	SCBA backpack and face-piece/respirator is removed (avoid touching face with fingers). SCBA or respirator is deposited on plastic sheets.
Station 7 - Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face.

16.22 Traffic and Work Zone Safety

These guidelines apply whenever Camp Dresser & McKee Inc. (CDM) employees or subcontractors work in areas exposed to vehicular traffic on public streets or highways.

- Where vehicular traffic hazards exist because of work at locations near public streets or roads, a system of traffic and work zone controls should be developed to mitigate the hazard. The system should meet the requirements of Part 6 of the Manual of Uniform Traffic Control Devices published by the Federal Highway Administration, or the applicable state version of the MUTCD.

- In general, when the MUTCD allows to use of traffic safety direction devices, like cones, CDM will supplement those direct and devices with a physical barrier, like a truck.

- All traffic control systems on public roads must be coordinated with local traffic control officials as required by applicable law.

- Periodically evaluate effectiveness of temporary traffic control set ups by walking or riding the job area looking for evidence of poor controls and near misses such as swerving traffic, motorists braking quickly, skid marks, blind spots, etc.

- Give motorists plenty of advanced warning of upcoming work zones.

- All employees working within designated work zones or near vehicular traffic should wear high visibility clothing such as orange, yellow or yellow-green shirts, jackets or vests. During wet or inclement weather similarly colored rainwear should be worn.

- During night work, between the hours of sunset and sunrise, high visibility clothing should incorporate reflective striping or fabric and be visible at a distance of 1,000 feet. This clothing should meet ANSI standard #107 for High Visibility Safety Apparel.

- All employees working near traffic and vehicles must maintain situational awareness at all times. Stay mindful that warning signs and cones, inform drivers to take action, but that some may not pay attention and vehicles may still enter the work zone.

Appendix C

EPA Contract Laboratory Program Guidance for Field Samplers

OSWER 9240.0-44
EPA 540-R-07-06

FINAL July 2007

Office of Superfund Remediation and Technology Innovation

Contract Laboratory Program Guidance for Field Samplers

Disclaimer: The final version of the document replaces any prior versions of the document in their entirety.

Foreword

The intent of the Contract Laboratory Program (CLP) Guidance for Field Samplers is to replace the CLP Samplers Guide. This guidance document is designed to provide users with general information regarding environmental sample collection for the United States Environmental Protection Agency's (USEPA) Contract Laboratory Program (CLP). This document provides minimum CLP requirements, an explanation of the general sampling process sequence of events, and any related information. The appendices contain useful reference information and checklists to aid in planning and documenting sampling activities.

CLP users also are encouraged to review the Introduction to the Contract Laboratory Program document that contains a general overview of the CLP, how it works, and how to access the program. The CLP requires samplers to use the functionality provided by the Field Operations Records Management System (FORMS) II Lite™ software, which is the preferred means of creating CLP sample documentation. For guidance in using the software to record and submit sampling data, users should reference the FORMS II Lite User's Guide.

Both the Introduction to the Contract Laboratory Program and the Contract Laboratory Program Guidance for Field Samplers can be downloaded from the CLP Web site at the following address:

http://www.epa.gov/superfund/programs/clp/guidance.htm

The FORMS II Lite User's Guide can be downloaded from the CLP Web site at the following address:

http://dyncsdao1.fedcsc.com/itg/forms2lite/doc.html

For more information regarding the CLP or this guide, please contact Elizabeth Holman via email at Holman.Elizabeth@epa.gov or via telephone at (703) 603-8761.

Key Information

Text in blue and underlined indicates an external link to information outside of this document.

The images below are located throughout the document to draw attention to important information and each are labeled accordingly:

Important

Note

Table of Contents

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List of Figures

List of Tables

ASB	Analytical Services Branch
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CLP PO	CLP Project Officer
CRQL	Contract Required Quantitation Limit
CVAA	Cold Vapor Atomic Absorption
DOT	Department of Transportation
DQO	Data Quality Objective
dbf	Database File
ET	Eastern Time
FORMS II Lite™	Field Operations Records Management System II Lite
FSP	Field Sampling Plan
HCN	Hydrocyanic acid
IATA	International Air Transport Association
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
MS	Matrix Spike
MSD	Matrix Spike Duplicate
$NAHSO_4$	Sodium Bisulfate
NPL	National Priorities List
OSC	On-scene/on-site Coordinator
OSHA	Occupational Safety and Health Administration
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated Biphenyls
PE	Performance Evaluation
PM	Program Manager
ppb	Parts-Per-Billion
ppt	Parts-Per-Trillion
PRP	Potentially Responsible Party
PT	Proficiency Testing
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QASPER	Quality Assurance Sampling Plan for Environmental Response
QATS	Quality Assurance Technical Support
QC	Quality Control
RAS	Routine Analytical Services
RPM	Remedial Project Manager
RSCC	Regional Sample Control Center Coordinator
RSM	Regional Site Manager
SAM	Site Assessment Manager
SAP	Sampling Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDG	Sample Delivery Group
SMC	System Monitoring Compound
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOA	Semivolatile Organic Analyte
TR/COC	Traffic Report/Chain of Custody
txt	Text File
UN	United Nations
USEPA	United States Environmental Protection Agency
VOA	Volatile Organic Analyte
XML	eXtensible Markup Language

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1.0 INTRODUCTION

1.1 About this Guide

This document describes the important organizational roles and responsibilities for those who plan and conduct environmental sample collection projects for analysis through the Superfund's Contract Laboratory Program (CLP). This chapter introduces the structure and purpose of this document. Chapter 2, *Pre-field Activities*, addresses pre-field planning activities that the sampling team could complete prior to the actual sampling event. Chapter 3, *In-field Activities*, addresses those activities that need to be completed during the sampling event.

Appendix A describes the functions within a sampling project which are taken from the Quality Assurance Project Plan requirements. Appendix B and Appendix C contain the sample collection guidelines for Volatile Organic Analytes (VOAs) in soil and in water. Appendix D recommends sampling techniques. Appendix E contains checklists to help the sampler ensure that all necessary steps are completed.

Note: A project and site-specific Quality Assurance Project Plan (QAPP) providing Regional guidance will override guidance given within this document.

1.2 Overview of the CLP

The CLP is a national program of commercial laboratories under contract to support the USEPA's nationwide effort to clean up designated hazardous waste sites by supporting its Superfund program. The Superfund program was originally established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and presently exists under the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The CLP uses state-of-the-art technology to provide users with analytical services. The program provides data of known and documented quality to support USEPA enforcement activities or other user needs. To achieve this goal, the CLP has established strict Quality Control (QC) procedures and detailed documentation requirements. Current CLP users include the USEPA Regions, States and Tribal governments, and other Federal agencies. CLP users also are encouraged to review the *Introduction to the Contract Laboratory Program* document that contains a general overview of the CLP, how it works, and how to access the program.

1.2.1 Key Players Within the CLP

In coordinating Superfund sampling efforts, the Analytical Services Branch (ASB) is supported by the Sample Management Office (SMO) contractor, the Regional CLP Project Officers (CLP POs), the Regional Sample Control Center Coordinators (RSCCs), and the Regional Site Managers (RSMs), including Site Assessment Managers (SAMs), On-scene/On-site Coordinators (OSCs), and Remedial Project Managers (RPMs). Samplers may work directly with the RSCC and/or RSM (or equivalent), and/or an OSC from the Field Support Section during a sampling event. See Table 1-1 for a brief description of the functions performed by key participants (functions may vary by Region).

Table 1-1. Participants in the CLP Sampling Process

Participants	Responsibilities
Analytical Services Branch	USEPA ASB directs the CLP from within the Office of Superfund Remediation and Technology Innovation (OSRTI) in the Office of Solid Waste and Emergency Response (OSWER). ASB responsibilities include: • Development of the Statements of Work (SOWs) that define required analytical methods (including QC, detection/quantitation limits, and holding times) for the analytical services procured under the CLP; • Development and implementation of policies and budgets for Superfund analytical operations; • Development of information management policies and products for analytical data; • Management of SMO and Quality Assurance Technical Support (QATS) contracts; • National administration, evaluation, and management of the CLP; and • Direction of CLP Quality Assurance (QA) activities in coordination with overall OSWER QA activities. To obtain the most current ASB contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/contacts.htm#ASB
CLP Sample Management Office	The contractor-operated SMO provides necessary management, operations, and administrative support to the CLP. SMO receives Regional analytical requests, coordinates and schedules sample analyses, and tracks sample shipments. SMO also receives and checks data for completeness and compliance, processes laboratory invoices, and maintains a repository of sampling records and program data.
CLP Contract Laboratories	The contractor-operated laboratories within CLP provide necessary analytical services for the isolation, detection, and quantitation of the CLP's target compounds and analytes.
Regional CLP Project Officer	The CLP PO monitors the technical performance of the contract laboratories in each Region. The CLP PO works closely with ASB Program Managers (PMs) to identify and resolve laboratory technical issues, and leads laboratory on-site evaluations. To obtain the most current CLP PO contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/polist.htm
Regional Sample Control Center Coordinator	In most Regions, the RSCC coordinates sampling efforts and serves as the central point-of-contact for sampling questions and problems. The RSCC works with SMO to schedule sample shipments to laboratories. In addition, the RSCC's activities may include: informing SMO of sample shipment, cancellations, special instructions, and sampling issues. To obtain the most current RSCC contact list, refer to the following Web site: http://www.epa.gov/superfund/programs/clp/rscclist.htm
Regional Site Manager	The RSM Coordinates the development of acceptance or performance criteria and oversees project-specific contractors, state officials, or private parties conducting site sampling efforts. The RSM could be the SAM, the OSC, or the Remedial Project Manager (RPM).
Field Support Section	The Field Support Section consists of personnel such as the OSC, SAM, and RPM. In most Regions, the Field Support Section develops Standard Operating Procedures (SOPs) for field sampling and related procedures, and assists sampling teams in following those SOPs. The sampling team determines what type(s) of CLP services will be required for a particular sampling event. The Field Support Section reviews Sampling Analysis Plans (SAPs) prepared by sampling teams and oversees sampling teams in the field. The Field Support Section may also prepare their own SAPs, perform sampling activities in the field, and analyze and report the results of their sampling events to the RSM.

1.3 Overview of the Sampling Process

At–a-Glance:
Overview of the Sampling Process

- ✓ Procedures must be consistent.
- ✓ Analytical data must be accurate and defensible.
- ✓ Procedures must meet minimum requirements.

Once USEPA has determined that physical, chemical, and/or biological testing of a site is necessary, samples of material from the site area must be collected. The type of material that must be collected and the analytical method to be used depends upon the physical location of the site, detection level(s), site history (previous sampling), and known or unknown conditions and contaminants. The sampling process includes carefully planned and consistently applied procedures that produce accurate and legally defensible data. The sampling team should consider the procedures and plans presented in this guide as minimum sampling process guidelines to maintain sample integrity and identity. Samples should be collected according to the approved project and site-specific QAPP and SAP. This document does not define specific sampling procedures because specific sampling protocols depend on individual site conditions, Regional requirements, and acceptance and performance criteria. Since Regions may have their own specific requirements for individual sampling programs, they are responsible for generating Region-specific sampling SOPs.

1.3.1 Procedures Must be Consistent

The purpose of sampling is to collect representative portions from a suspected contaminated site. Sample collection is critical to determining the presence, type, concentration, and extent of environmental contamination by hazardous substances, thus it is a crucial part of every sampling and environmental testing effort. Sampling procedures must be consistently written and followed to mitigate risk of error and the expense of re-sampling.

Failure to follow proper sampling and shipping procedures could result in samples that are contaminated, broken, mislabeled, lost during shipping, or unusable because of a missed holding time. If procedures are inconsistently or improperly followed, any resultant analytical data may be inaccurate and may not be defensible in a court of law.

Note: If re-sampling is needed due to improper sampling, the sampling team may incur the cost.

1.3.2 Analytical Data Must be Accurate and Defensible

The data gathered during sampling activities helps to accurately characterize contaminated waste sites so that the impact on human health and the environment can be properly evaluated. Acquiring accurate and defensible data that will be accepted in a court of law is the CLP's primary objective; therefore, the sampler must collect samples according to strict sampling procedures, plans, and guidelines. USEPA and many other Federal agencies use data resulting from analytical testing of soil/sediment/aqueous samples to:

- Determine if a site is contaminated with organic and/or inorganic compounds;
- Identify pollution sources and Potentially Responsible Parties (PRPs);
- Validate remedial design methodologies;
- Assess response and remedial priorities;
- Assess risk to human health and the environment;
- Determine appropriate cleanup actions; and
- Determine cleanup achievements.

1.3.3 Sampling Procedures and Guidelines Must Meet Minimum Requirements

It is imperative that samplers be aware of the minimum CLP and Regional requirements that directly impact and define how a sampling event will take place. It is important to note that the procedures and guidelines set forth in this document are considered minimum CLP requirements. Samplers should reference the following sections within this document that specifically address important requirements that must be met for a successful sampling event:

- Section 1.4.1 CLP Documentation Requirements;
- Section 2.4.1 Request Scheduling of Analysis, SMO-assigned Case Numbers, CLP Sample Numbers, and Laboratory Contact Information;
- Section 2.7 Comply with Transportation and Shipping Requirements;
- Section 2.8 Provide Shipment Notification;
- Section 3.1 Collect Samples; and
- Section 3.2 Complete Documentation.

1.4 Overview of Sampling Documentation Requirements

The sampler must properly document samples collected for analysis in order to uniquely identify each sample and ensure adequate chain-of-custody procedures. When collecting samples, the sampler should always keep in mind that any samples collected may be used in future litigation. This is especially important when samples are from privately owned property. If sampling on privately owned property, samplers should also provide the property owner with a receipt for samples collected and removed from that owner's property. Samplers may also be required by a Region to use a sample label, sample tag, or field operations records documenting information such as daily activities, equipment and materials used, personnel involved, site security, etc. These types of documentation help ensure proper sample identification and provide additional chain-of-custody records.

The documentation required by a Region for a sampling event is outlined in project plans such as the QAPP, SAP, and Field Sampling Plan (FSP).

At–a-Glance:
Overview of the Sampling Document Requirements

✓ Must use FORMS II Lite to create sample documentation. Analytical data must be accurate and defensible.

✓ CLP documentation requirements:
- CLP Sample Number
- SMO-assigned Case Number
- Traffic Report/Chain of Custody (TR/COC) Record
- Sample Labels
- Sample Tags
- Custody Seals
- Field Operation Records

Under no circumstances should the site name appear on any documentation that is sent to the laboratory (for the CLP).

1.4.1 CLP Documentation Requirements

Samplers must:

1) Record the CLP Sample Number on each sample bottle;
2) Complete the Traffic Report/Chain of Custody (TR/COC) Record using the FORMS II Lite software, making sure to indicate on the TR/COC Record if the samples require the use of a Modified Analysis;
3) Complete and attach sample labels;
4) Complete and attach sample tags to meet Regional requirements;
5) Complete and attach custody seals to meet Regional requirements; and
6) Complete field operations records, as necessary.

Please contact your RSCC (see Table 1-1) for information regarding CLP Sample Numbers, SMO-assigned Case Numbers, TR/COC Records, and chain-of-custody seals for sampling events.

For information regarding using FORMS II Lite to create and complete a TR/COC Record, refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/f2lite.htm

1.4.1.1 CLP Sample Number

A CLP Sample Number is unique per sampling location and is used to identify and track samples throughout the sampling and analytical processes and is recorded on many types of sampling documentation (e.g., TR/COC Records, sample labels, and sample tags). CLP Sample Numbers are provided to samplers by their RSCC or SMO.

Samplers must contact their RSCC (or their designee) to obtain CLP Sample Numbers for their sampling event. Samplers must correctly assign the CLP Sample Numbers to the appropriate sample bottle or container. Please refer to Section 3.2.1 for more detailed information regarding the use of CLP Sample Numbers.

Note: If the sampler has any questions regarding the assignment of CLP Sample Numbers, they should contact their RSCC.

1.4.1.2 SMO-assigned Case Number

SMO-assigned Case Numbers are used to track groups of samples throughout the sampling and analytical processes and are recorded on many types of sampling documentation (e.g., TR/COC Records, sample labels, and sample tags). Samplers must correctly assign the SMO-assigned Case Number to the appropriate sample bottle or container. To obtain a SMO-assigned Case Number, samplers must contact their RSCC (or their designee).

1.4.1.3 Laboratory Assignment

Samplers are responsible for shipping samples to the appropriate SMO-assigned laboratory for analysis. Samplers must contact their RSCC (or their designee) to obtain their laboratory assignment or they may be provided by SMO.

1.4.1.4 TR/COC Record

The TR/COC Record is used as physical evidence of sample custody and functions as a permanent record of each sample collected.

Per CLP documentation requirements, each cooler must contain a TR/COC Record that lists all the samples contained therein.

In an effort to automate sample documentation in the field, ASB has developed a stand-alone, Windows-based software application that samplers can use to automatically create and generate sample documentation. The FORMS II Lite software allows users to enter information prior to and during sampling events. It allows users to multi-task and electronically create, edit, and print documentation associated with sampling activities. Users can customize data entry screens throughout the entire documentation process. Users can also customize the format and content of sample labels based on specific requirements.

The program simplifies and accelerates the tedious manual sample documentation process by reducing the generation of handwritten documents by almost 70%. The FORMS II Lite software enables samplers to:

- Increment CLP Sample Numbers or manually assign their own unique, project-specific non-CLP Sample Numbers;
- Input the SMO-assigned Case Number into the appropriate field;
- Create sample labels, sample tags, TR/COC Records, Sample Weight forms, and receipts for samples taken from a site;
- Track samples from the field to the laboratory;

- Electronically capture sample information into databases; and
- Export electronic data as a database File (.dbf), Text (.txt), or eXtensible Markup Language (.xml) file.

USEPA requires samplers to use the FORMS II Lite software for all CLP sampling efforts. For assistance with obtaining or using the FORMS II Lite software, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM Eastern Time (ET). For additional information regarding FORMS II Lite use and training, please refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/f2lite.htm

1.4.1.5 Chain-of-Custody Seals

A chain-of-custody seal is any adhesive label or tape that can be used to seal a sample bottle, container, plastic bag, or shipping cooler such that if it is opened or tampered with, the seal will be broken. Custody seals must be placed on each sample bottle, container, or bag (as appropriate) and each shipping cooler or container. The custody seal is an excellent means of maintaining a record of chain-of-custody, as well as guarding against possible sample contamination or tampering during shipping.

1.4.1.6 Sample Labels

A sample label is a sticker attached to a sample bottle or container that contains a sample. Sample labels are affixed to each sample container as samples are collected in the field or affixed prior to going in the field. A sample label must contain, at a minimum, a CLP Sample Number so that they can be associated with, and listed on, the associated TR/COC Record. The sample label may also include the required analysis/fraction and preservative used (to eliminate confusion at the laboratory). Samplers should refer to their project plans for Region-specific sample label requirements.

1.4.1.7 Sample Tags

A sample tag identifies a sample bottle or container that contains a sample. The tag also provides specific analytical direction and proof that a sample existed. To support the use of sample data in potential enforcement actions, samples with other than in situ measurements (e.g., pH, temperature, conductivity) can be identified with a sample tag. A CLP Sample Number and SMO-assigned Case Number must be recorded on a sample tag to indicate that the sample container comprises the whole sample in the case where there is just one container of sample, or part of the indicated sample in the case of multiple containers of sample. Samplers should refer to their project plans for Region-specific sample tag requirements.

1.4.1.8 Field Operation Records

Samplers should maintain complete, accurate, and legible field operations records as they perform a sampling activity. The following records are included: Field Logbooks; Corrective Action Reports; Sampling Trip Reports; supplemental standardized forms; logs; and records such as maps or photographs that document each step of the work performed in the field. Samplers should refer to their project plans for Region-specific field operations record requirements. These records are very important tools because they are considered part of the official project file when legal issues arise.

1.4.1.9 Weight Logs

A sample weight log identifies the tared, sample and final weights per bottle for VOA samples. In order to support Method 5035 for VOAs, samplers should enter tared and final weights per bottle in the CLP Sample Weight Log.

2.0 PRE-FIELD ACTIVITIES

At-a-Glance:
Pre-field Activities

- ✓ Prepare for and communicate during a sampling event.
- ✓ Review project plans containing Regional requirements.
- ✓ Plan to meet documentation requirements.
- ✓ Obtain any necessary permits, licenses, and clearances.
- ✓ Identify and obtain sampling materials.
- ✓ Comply with transportation and shipping requirements.
- ✓ Provide shipment notification.
- ✓ Perform Readiness Review/Run-through.

This chapter provides instructions for completing the suggested pre-field activities that samplers could complete prior to performing sampling activities. These important pre-field activities will save time and help the sampler to better prepare for the sampling event. Samplers should be aware of issues routinely arise during the sampling process so that samplers can avoid making the same mistakes or having the same problems that could adversely affect their sampling event. Samplers are also expected to review all pertinent project plans and meet both CLP and Regional requirements that directly impact the structure and purpose of a sampling event.

The project plans provide information such as the types and numbers of samples to be collected, the analytical methods to be used based on the desired level of quantitation, and the necessary equipment and supplies. The plans also describe the sampling method which may require different specific sample volumes/masses, containers, preservation, shipping, and handling to maintain the integrity of the samples without degradation or contamination.

In addition to reviewing project plans, samplers should determine if the sampling site is privately or publicly owned and obtain the necessary permission to access the sampling site. If the site is privately owned, samplers should make sure to have receipts for available samples to provide to the owner for all samples collected and removed from their property. Samplers must also prepare to identify and obtain sampling materials, prepare to meet documentation requirements by obtaining and learning to use the required software, comply with transportation and shipping requirements, and perform a readiness review/dry run of the sampling process.

2.1 Prepare for a Sampling Event

Samplers must prepare to meet CLP and Regional requirements for a sampling event, appropriately use the CLP Sample Number and SMO-assigned Case Number, complete the TR/COC Record using the FORMS II Lite software, and complete and attach the custody seal(s). It is very important that the sampler include the correct CLP Sample Number on each sample. It is also imperative that the TR/COC Record be accurately completed and submitted with the sample(s). Finally, the sampler must accurately and legibly complete and attach a custody seal to each sample container, or plastic sample bag (as appropriate), and each shipping cooler or container.

However, meeting the sampling requirements requires more than just the proper application of a CLP Sample Number on each sample, completion of the TR/COC Record, and use of a custody seal. The actual collection of samples, packaging, and shipping of those samples are equally important to a successful sampling event.

For example, if a sampler collects an insufficient volume of a sample, the laboratory may not be able to perform the requested analysis. Insufficient sample volumes may also result in a laboratory being unable to perform laboratory quality control, such as Matrix Spike (MS), Matrix Spike Duplicate (MSD), and Duplicate sample analysis. Additionally, if the laboratory receives a sample that is either unpreserved or the sample pH is outside of the required range, the sample cannot be properly analyzed.

Unfortunately, improper shipping and labeling processes and procedures often result in:

- Samples being shipped to the wrong laboratory;
- Broken or empty samples being received at the laboratory; and
- Custody seals or sealant tape that is missing or broken on sample bottles, containers, plastic bags, or shipping coolers shipped to the laboratories.

The importance of completing the paperwork associated with a sampling event cannot be overemphasized. Samplers must make a conscientious effort to accurately complete the TR/COC Record since this is the main document used to derive vital information about a particular sample. The person completing a TR/COC Record must be careful to avoid errors such as the appropriate sample(s) not being listed, or the wrong samples being listed. In an effort to eliminate such errors and the confusion that can be associated with handwritten TR/COC Records, samplers must use the FORMS II Lite software to complete the TR/COC Record and other associated sampling documentation.

It is extremely important that QC samples, including field sample duplicates, field samples for Matrix Spike and Matrix Spike Duplicate analyses, and Proficiency Testing (PT) samples, also known as Performance Evaluation (PE) samples, be designated and labeled per Regional guidance by samplers in the field. Mislabeling of QC samples can result in improper and/or inaccurate analysis of a sample at the laboratory.

2.2 Communicate During a Sampling Event

Communication is a key element in planning, administrating, and conducting a sampling event. It is extremely important that all parties involved in a sampling event be in contact throughout the sampling process. The procedures and recommendations outlined in this guide are based on more than 20 years of experience. It has been demonstrated that approximately 50% of all sampling efforts have been negatively affected by incorrect sampling procedures and poor communication among participants.

The key elements of communication for a sampling event include the relationship between the RSCC, SMO, the samplers in the field, and the laboratories who will be accepting the samples. For instance, the samplers must contact the RSCC to start the process for setting up a sampling event. The RSCC will in turn contact SMO who will schedule the sampling event, establish laboratory availability, and arrange for the laboratory to accept projected samples. SMO will then communicate the laboratory assignment to the Region and possibly the sampler.

The sampler should contact the RSCC (per Regional guidelines) and allow enough time for the RSCC to contact SMO at least a week prior to the sampling event.

SMO provides SMO-assigned Case and CLP Sample Numbers in time for the sampling event. SMO also schedules a laboratory and makes sure the laboratory will not have any capacity problems. Communication is also important because if there is a change in the sampling event due to a cancellation or an increase or decrease in the number of samples that will be sent to the laboratory, the sampler can contact the RSCC who can work with SMO to remedy potential capacity, availability, or overbooking problems.

2.3 Review Project Plans Containing Regional Requirements

In addition to meeting CLP requirements, the sample collection process must fulfill numerous Regional requirements. These requirements are determined by a variety of factors that affect how samples should be collected for an individual sampling event. These factors include:

- The type of samples being collected (organic/inorganic, water, soil/sediment, etc.);
- The method by which the samples will be analyzed;
- The acceptance or performance criteria (i.e., Data Quality Objectives [DQOs]); and
- The type of data needed.

The QAPP for each sampling project is written to meet requirements outlined in the documents *EPA Requirements for Quality Assurance Project Plans* (QA/R-5), *EPA Guidance on Quality Assurance Project Plans* (G-5), and Regional QAPP preparation documents. The QAPP is prepared in advance of field activities and is used by samplers to develop any subsequent plans such as the Sampling SAP or the FSP. Samplers should review the QAPP and any subsequent project plans for information outlining the basic components of a sampling activity. QAPP and project plans should be finalized and approved by appropriate Regional QA personnel, the OSC, SAM, or the RPM before providing them to the sampling team. This should be done prior to the start of field activities. Appendix A explains the functions within a sampling project (as these functions relate to a sampling event) and the elements of that function as described in a typical QAPP. Copies of all project plans and relevant SOPs should be maintained in the field for the duration of the sampling project.

2.4 Plan to Meet Documentation Requirements

> **At-a-Glance:**
> **Plan to meet documentation requirements.**
>
> - ✓ Request SMO-assigned Case and CLP Sample Numbers.
> - ✓ Prepare sample cooler return documentation.
> - ✓ Prepare to use the FORMS II Lite software.

Sampling events require a variety of accurate and complete documentation. Samplers should review their project plans to determine the types of documentation that must be completed for a sampling project and to ensure that the appropriate documentation will be on-hand in the field. The CLP documentation requirements include the CLP Sample Number, the SMO-assigned Case Number, the TR/COC Record, sample labels, sample tags, custody seals, and field operations records (as necessary). Samplers need to request SMO-assigned Case and CLP Sample Numbers for each sampling event prior to starting field activities. Samplers also need to make sure that the correct TR/COC Records (Organic TR/COC Record for organic analysis or Inorganic TR/COC Record for inorganic analysis) are being used within the FORMS II Lite software. Finally, samplers should be prepared to complete the appropriate shipping cooler return documentation.

Since samplers are required to use the FORMS II Lite software to prepare and submit sampling project documentation and maintain sample chain-of-custody, software users must be familiar with all emergency back up procedures that should be followed in the event of a system failure. Samplers must have access to FORMS II Lite-generated TR/COC Records at sampling events. If problems are experienced while using the FORMS II Lite software, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

In the event of a system crash, samplers must have backup hardcopies of FORMS II Lite TR/COC Records. For information regarding emergency backup procedures, please refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/trcoc.htm

2.4.1 Request Scheduling of Analysis, SMO-assigned Case Numbers, CLP Sample Numbers, and Laboratory Contact Information

SMO-assigned Case Numbers are assigned based on a request for CLP Routine Analytical Services (RAS), which is processed though the RSCC (or his/her designee). The sampler must request the RSCC to schedule CLP RAS analysis. The CLP does have the capacity to schedule sampling on an emergency basis, however the sampler must contact the RSCC (or his/her designee) to obtain details regarding how to handle such a situation. When scheduling a sampling event that will last for more than one week, it is recommended that the sampler contact the RSCC (or his/her designee) on a weekly basis to provide updates. This contact between the sampler, the RSCC (or his/her designee), and SMO is very important because it will ensure better availability of laboratory capacity.

In addition to SMO-assigned Case and CLP Sample Numbers, samplers should make sure to have accurate laboratory contact information, such as:

- Laboratory name;
- Laboratory address;
- Contact name; and
- Laboratory phone number.

This information is used for both TR/COC Records and chain-of-custody documentation and shipping paperwork such as address labels and airbills.

The SMO-assigned Case Number is used to track groups of samples throughout the sampling and analytical processes. Samplers must correctly indicate the assigned Case Number on the appropriate sample bottle or container.

Note: The RSCC (or his/her designee) provides the CLP Case Numbers and Sample Numbers for each sampling event to samplers. Once the CLP Sample Numbers have been provided to the sampler, the sampler can use FORMS II Lite to print them onto sample labels.

The following characters are not to be used in generating CLP Sample Numbers and should never appear on any paperwork submitted to the laboratory: I, O, U, and V.

A CLP *Sample Number* is defined **as** a number that is unique per sampling location and identifies each CLP sample (see Section 1.4.1.1). Since samples must be identified per analytical program (either organic or inorganic), there are two types of TR/COC Records and two letter codes to denote organic vs. inorganic analysis.

A CLP *sample* is defined as one discrete portion of material to be analyzed that is contained at one concentration level, from one station location for each individual or set of analytical fractions -- provided the fractions are all requested for the same CLP analytical service (i.e., organic or inorganic), and identified by a unique Sample Number.

Note: When samples are collected from several station locations to form a composite sample, the composite sample should be assigned either a number from one of the station locations used during collection, or a unique number that represents the composite sample for tracking purposes. The numbering scheme used internally at a sampling event for identifying composite samples should also be documented appropriately (e.g., in the field logs).

Organic CLP Sample Numbers begin with the Regional letter code, followed by four letters and/or numbers. Inorganic CLP Sample Numbers begin with "M", followed by the Regional letter code and then four letters and/or numbers. See Table 2-1 for Region and letter codes for each sample type (i.e., organic or inorganic).

Table 2-1. CLP Sample Number Letter Codes

Region	Letter Code	
	Organic	Inorganic
1	A	MA
2	B	MB
3	C	MC
4	D	MD
5	E	ME
6	F	MF
7	G	MG
8	H	MH
9	Y	MY
10	J	MJ

According to CLP guidelines, each individual inorganic water sample may be analyzed for total metals or dissolved metals, but not both. Therefore, water samples collected for total metal and dissolved metal analyses from the same sampling location must be assigned separate (unique) CLP Sample Numbers. A sampler can use the same CLP Sample Number for an inorganic soil or water sample collected for total metals, mercury and cyanide analyses.

Organic soil and water samples may be collected for analysis under the SOM01 SOW to detect:

- Aroclors;
- Semivolatile Organic Analytes (SVOAs);
- Pesticides;
- Volatile Organic Analytes (VOAs); and/or
- Trace Volatile Analytes

Inorganic soil and water samples may be collected for analysis for cyanide, and for metals using Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) and Cold Vapor Atomic Absorption (CVAA), under the ILM05.X SOW.

Inorganic water only samples may be collected for analysis for cyanide, and for metals using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and CVAA, under the ILM05 SOW.

2.4.2 Prepare Sample Cooler Return Documentation

CLP laboratories must routinely return sample shipping coolers to the appropriate sampling office within 14 calendar days following receipt of shipment from the sampler. For sample coolers to be returned, the sampler must complete the appropriate cooler documentation and work with Regions and government agencies to provide a cost-effective mechanism for laboratories to return the empty coolers to the appropriate sampling office. The sampling cooler return documentation can be prepared in advance and provided to samplers before field activities begin. **The sampler (<u>not</u> the CLP laboratory) is responsible for paying for return of the cooler and should also include shipping airbills bearing the sampler's account number, as well as a return address to allow for cooler return.**

To maintain consistency among cooler transportation programs, samplers should:

- Minimize the use of multiple transportation carriers to avoid confusion;
- Use multiple-copy labels so the laboratory and the sampling team can each retain a copy for their records;
- Prepare labels in advance so that the laboratory can simply affix a completed shipping label on the cooler;
- Include third-party billing information (i.e., their shipping account number) on labels so the laboratory will not be billed by the transportation carrier;
- Confirm that the laboratory knows which transportation carrier to use; and
- Include the SMO-assigned Case Number on return information.

2.5 Obtain Municipal Permits, Licenses, and Clearances

At-a-Glance:
Obtain permits, licenses, and clearances.

- ✓ Request access to County, State, Tribal, military, and/or Federal property.
- ✓ Contact private property owner(s).
- ✓ Contact utility companies.

Before starting a sampling event, samplers must make sure to obtain the proper municipal permits, accesses to the property, and any government clearances, if required. The sampler must also contact any appropriate utility companies to ascertain where any underground pipes, cables, etc., may be located.

2.5.1 Request Access to County, State, Tribal, Military, and/or Federal Property

Proper access to perform sampling activities is important not only for legal reasons, but also to eliminate delays in work and possible refusal to allow sampling to take place. It is crucial that the appropriate permits, licenses, and clearances be secured to obtain access for sampling activities that will be performed on County, State, Tribal, military, and/or Federal property. The sampler must contact the appropriate government offices or personnel well in advance to determine what kinds of approval are required. Pre-approval may be required for specific types of sample collection such as drilling or excavation. For example, drilling on a military base requires pre-approval. Base security may require clearances for all members of the sampling team, including subcontractors. This process may take two or more days.

If arrangements are not made in advance, the team may not be allowed to enter the site until their clearances are processed and the team has been approved to drill. As a result, the sampling schedule is delayed, costing extra time and money.

2.5.2 Contact Private Property Owners

The sampler must obtain written permission from the private property owner(s) before sampling on their property, even if verbal permission has been granted. It is recommended that samplers obtain verbal permission prior to their arrival at the sampling location, but written permission can be obtained on the day of sampling. If a property owner refuses to grant access to their property, it may be necessary for sampling participants to contact the appropriate authorities for assistance.

2.5.3 Contact Utility Companies

The sampler should contact local utility companies (e.g., power, phone, gas, cable, sanitation, etc.) at least one week prior to the sampling event to have underground cables, lines, and pipes flagged and marked. This is required by law. A national one-call directory can be found at:

http://www.digsafely.com/contacts.htm.

This will eliminate potential safety hazards and service disruption. For example, soil sampling in a residential area may require digging below the soil's surface. It is very important to know where utility lines and pipes are located so that samplers do not hit live electrical wires or rupture gas lines. Samplers should follow Regional or other appropriate program procedures for the procurement of such services. The utility service(s) disruption dates should be confirmed at least two days prior to sampling activities.

Note: Pre-payment of survey fees to local utility companies may be required.

2.6 Identify and Obtain Sampling Materials

> **At-a-Glance:**
> **Identify and obtain sampling materials.**
> ✓ Procure appropriate equipment and supplies.
> ✓ Procure sample containers.
> ✓ Procure shipping supplies.

Samplers must make sure to be prepared for a sampling project with the appropriate sampling materials (equipment, supplies, sample containers, packing materials, and shipping materials). The equipment and supplies must be properly cleaned, calibrated, and tested as necessary to meet the needs of the sampling project.

2.6.1 Procure Appropriate Equipment and Supplies

Each sampling event requires the procurement of equipment and materials to collect, document, identify, pack, and ship samples. The proper field sampling equipment is vital to a successful sample collection. Regional or other samplers should obtain, and arrange in advance, all of the equipment and supplies required for each sampling event. Samplers should review the project plans to verify that the proper equipment is being used for sample collection.

At a minimum, the following materials are generally required during a sampling event:

- Sample storage containers;
- Packing material;
- Sample containers;
- Shipping containers;
- Access to the FORMS II Lite software for creating sample labels, stickers, tags, and TR/COC Records;
- Custody seals; and
- Sampling equipment such as bowls, augers, pumps, etc.

Sampling events may also require specific items such as:

- Cooler temperature blanks;
- Trip blanks for VOA analysis;
- Preservation supplies (e.g., ice or acid); and
- Specially prepared sample vials (e.g., for SW-846 Method 5035A).

2.6.2 Procure Sample Containers

The analytical protocol(s) to be used for sample analysis often requires the use of a particular type of sample container. The type of container also may depend on the sample matrix and analysis. It is recommended that samplers use borosilicate glass containers, which are inert to most materials, when sampling for pesticides and/or other organics. Conventional polyethylene is recommended when sampling for metals because of the lower cost and absorption rate of metal ions.

Using the wrong container may result in breakage, gathering of an insufficient volume needed to perform sample analysis, or the container material may interfere with the analysis. Therefore, samplers should identify and use the correct sample containers for each sampling event.

Containers procured for a sampling event are usually pre-cleaned and shipped ready-for-use from the manufacturer to the sampling site. Regardless of the type of container used, samplers must ensure that the containers have been analyzed or certified clean to levels below concern for the project. These containers must meet the USEPA container type specifications listed in Table 2-2.

Table 2-2. Container Type Specifications

Reference Number	Container Type	Specifications	
		Closure	Septum
1	40 mL amber glass vial, 24 mm neck finish.	Polypropylene or phenolic, open-top screw-cap, 15 cm opening, 24-400 size.	24 mm disc of 0.005 in. Polytetrafluoroethylene (PTFE) bonded to 0.120 in. silicone for total a thickness of 0.125 in.
2	1 L high density polyethylene, cylinder-round bottle, 28 mm neck finish.	Polyethylene cap, ribbed, 28-410 size; F217 polyethylene liner.	N/A
3	8 oz short, wide mouth, straight-sided, glass jar, 70 mm neck finish.	Polypropylene or phenolic cap, 70-400 size; 0.015 in. PTFE liner.	N/A
4	4 oz (120 mL) tall, wide mouth, straight-sided, glass jar, 48 mm neck finish.	Polypropylene or phenolic cap, 48-400 size; 0.015 in. PTFE liner.	N/A
5	1 L amber round glass bottle, 33 mm pour-out neck finish.	Polypropylene or phenolic cap, 33-430 size; 0.015 in. PTFE liner.	N/A
6	500 mL high density polyethylene, cylinder-round bottle, 28 mm neck finish.	Polypropylene cap, ribbed, 28-410 size; F217 polyethylene liner.	N/A
7	Coring tool used as a transport device (e.g., 5 g Sampler).	Has built-in closing mechanism.	N/A
8	250 mL high density polyethylene, cylinder-round bottle, 28 mm neck finish.		N/A

The information contained in this table is also cross-referenced in the sample collection parameters discussed in Chapter 3. The container Reference Numbers are used in Tables 3-2 and 3-3 under the Containers column. For example, samples collected for low-level soil VOA analysis using SW-846 Method 5035A may require the sampler to use pre-prepared, tared closed-system purge-and-trap vials with a preservative (refer to Appendix B).

Note

Have extra containers readily available for each sampling event in case of breakage, loss, or contamination.

2.6.3 Procure Shipping Supplies

Samples should be correctly packaged into the appropriate shipping containers to reduce the risk of breakage or leakage, and the shipping containers should be appropriately prepared for shipment. Before heading into the field, samplers should refer to the appropriate project plans to determine the types of samples that will be taken during the sampling project so that samplers will have the proper packaging materials at the site for all pertinent samples container types and sample matrices. Samplers should also make sure to obtain the appropriate shipping paperwork (e.g., shipping forms required by the delivery service).

2.7 Comply with Transportation and Shipping Requirements

Samplers are expected to review the applicable project plans to be aware of all State, Federal, Department of Transportation (DOT), and International Air Transport Association (IATA) regulations governing environmental and hazardous sample packaging. The person who ships the samples is responsible for being in compliance with applicable packaging, labeling, and shipping requirements.

Samplers should request and receive sample permits for outside the continental United States, prior to shipping.

Additional information can be obtained on Hazardous Materials Safety Program regulations from the DOT's Research and Special Programs Administration. Federal transportation regulations can be found in 49-CFR Parts 100-185, are available on the Internet at:

http://www.myregs.com/dotrspa/

2.8 Provide Shipment Notification

Some Regions may require that samplers notify their RSCC (or his/her designee) when samples are shipped. Some Regions allow samplers to contact SMO directly to provide shipment notification. It is recommended that samplers contact the RSCC of sample origin to verify if such notification is necessary. If samplers are shipping samples after 5:00 PM ET, samplers must notify the RSCC (or designee) or SMO by 8:00 AM ET on the following business day.

For Saturday delivery at the laboratory, samplers MUST contact the RSCC (or designee) or SMO so that SMO will receive the delivery information by 3:00 PM ET on the Friday prior to delivery.

2.9 Perform Readiness Review/Dry Run

A readiness review/dry run is a test run of the proposed sampling event. This is a recommended practice since it gives samplers a chance to check all plans, documentation software (i.e., FORMS II Lite), and equipment lists for accuracy and completeness prior to sampling activities. It also provides an opportunity to consult with sampling team members to make sure all the elements are in place and everyone understands their tasking before actually going out to the field. Sampling project managers should provide the test or dry run dates and schedules to samplers so that samplers can prepare accordingly.

3.0 IN-FIELD ACTIVITIES

This chapter addresses the in-field activities a sampler will focus on during a sampling event such as: determining the type of samples to be collected; collecting the samples; meeting volume, preservation, and holding time requirements; completing documentation; and packing and shipping samples.

When performing a sampling event, the sampler is expected to follow prescribed sampling techniques. The sampler should also be aware of any special sampling considerations, contamination issues, and sample compositing and mixing methods that could affect their sampling efforts. Please refer to Appendix D for more detailed information.

At-a-Glance:
In-field Activities

- ✓ Collecting samples
- ✓ Completing documentation
- ✓ Sampling considerations
- ✓ Procuring shipping supplies

Note: Appropriate Regional guidance and procedures should be consulted for detailed sample collection, preservation, handling and storing, equipment decontamination, and QA/QC procedures.

3.1 Collect Samples

CLP RAS are generally used to analyze samples from Superfund sites. The matrices can be water, soil, or sediment. In some instances, a mixed-matrix sample may be collected which contains either a supernate (for a sediment/soil sample) or a precipitate (for a water sample). In this event, samplers should consult their management plans and/or discuss the required procedures with the RSM or their designee.

A CLP sample consists of all sample aliquots (portions):

- for each individual or set of analytical fractions;
- from one station location;
- for one sample matrix;
- at one concentration level;
- for one laboratory; and
- for one analytical program;

provided that the fractions are all requested from the same CLP analytical service.

In general, it is recommended that two individual samples be collected by separating the aqueous layer from the solid/precipitate layer at the point of collection. They may be assigned two different sample IDs (e.g., Sample IDs ABC124 and ABC125 for Sample ID ABC123), along with a note in the field sample log or tracking system that the sample IDs are derived or related to the same sample ID, to ensure correct follow-up upon receipt of results from the laboratory. Alternatively, they may be assigned the same sample ID, along with a notation of each individual sub-sample or fraction (e.g., Sample IDs ABC123-1 and ABC123-2 or Sample ID ABC123 Fraction 1 and Sample ID ABC123 Fraction 2 for Sample ID ABC123).

3.1.1 Determine Types of Samples to be Collected

Samplers may be required to take several types of samples or sample aliquots during a sampling event. They should refer to their project plans to determine the types of samples or aliquots to be taken, the volumes needed of each sample or aliquot, and the preservation needed for each sample. For an explanation of the various sample types and the requirements for collecting and submitting each particular type, refer to Table 3-1.

Table 3-1. QC Sample Types and CLP Submission Requirements

Sample Type	Purpose	Collection[1]	CLP Sample Number
Field Duplicate	To check reproducibility of laboratory and field procedures. To indicate non-homogeneity.	Collect from areas that are known or suspected to be contaminated. Collect one sample per week or 10% (Regions may vary) of all field samples per matrix, whichever is greater.	Assign two separate (unique) CLP Sample Numbers (i.e., one number to the field sample and one to the duplicate). Submit blind to the laboratory.
Field Blanks	To check cross-contamination during sample collection, preservation, and shipment, as well as in the laboratory. Also to check sample containers and preservatives.	Collect for each group of samples of similar matrix per day of sampling. Organics - Use water (demonstrated to be free of the contaminants of concern). Inorganics - Use metal-free (deionized or distilled) water.	Assign separate CLP Sample Numbers to the field blanks.
Trip Blank (Volatile Organic Analysis Only)	To check contamination of VOA samples during handling, storage, and shipment from field to laboratory.	Prior to going into the field, prepare and seal one sample per shipment per matrix using water demonstrated to be free of the contaminants of concern (deionized water is appropriate). Place this sample in the cooler used to ship VOA samples.	Assign separate CLP Sample Numbers to the trip blanks.
Equipment Blank or Rinsate Blank	To check field decontamination procedures.	Collect when sampling equipment is decontaminated and reused in the field or when a sample collection vessel (bailer or beaker) will be used. Use blank water (water demonstrated to be organic-free, deionized or distilled for inorganics) to rinse water into the sample containers.	Assign separate CLP Sample Numbers to the equipment blanks.
Matrix Spike (MS) and Duplicate (MSD)[2] (Organic Analysis Only)	To check accuracy and precision of organic analyses in specific sample matrices.	Collect from areas that are known or suspected to be contaminated. For smaller sampling events (i.e., 20 samples or less), MS/MSD additional volume should be collected in the first round of sampling and included in the first shipment of samples to the laboratory. Collect double or triple volume[3] for aqueous samples and soil VOA samples designated for MS/MSD analyses. Additional sample volume is not required for soil samples requiring SVOA, Pesticide, and/or Aroclor analysis. See Appendix B for VOA collection volumes.	Assign the same CLP Sample Number to the field sample and the extra volume for MS/MSD. Identify the sample designated for MS/MSD on the TR/COC Record.
Matrix Spike (MS) and Duplicate (MSD) (Inorganic Analysis Only)	To check accuracy and precision of inorganic analyses in specific sample matrices.	Collect from areas that are known or suspected to be contaminated. For smaller sampling events (i.e., 20 samples or less), Matrix Spike and Duplicates should be collected in the first round of sampling and included in the first shipment of samples to the laboratory. Additional sample volume may be required for inorganic analysis.[4]	Assign the same CLP Sample Number to the field sample and extra volume (if collected). Identify the sample(s) designated for Matrix Spike and Duplicates on the TR/COC Record.
PE Samples	Specially-prepared QC samples used to evaluate a laboratory's analytical proficiency.	The PE samples contain analytes with concentrations unknown to the laboratory. Designated Regional or authorized personnel (depending on Regional policy) arrange for Case-specific CLP PE samples to be prepared and shipped by the QATS contractor. The PE samples can be shipped to the site, or shipped per Regional direction. QATS provides the appropriate preparation instructions and chain-of-custody materials.	Samplers have no direct interaction with the PE sampling process, but should be aware that such samples do exist within the CLP sampling process. Samplers must, however, order PE samples and ship them to the laboratory if required by the Region.

[1] Consult Regional or Project Manager Guidance for field QC sample frequencies; laboratory QC sample frequencies are generally fixed in the laboratory subcontracts or specified in analytical methods. Current frequency for MS/MSD (organic) and MS/duplicate (inorganic) for the CLP is one sample per twenty field sample of similar matrix.

[2] Samples sent under the Organic SOW (SOM01) do not require an MS or MSD for Trace VOA, VOA and BNA fractions, but the Region may opt to send them at their discretion.

[3] Example of double volume: An aqueous sample for SVOA analysis would require the field sampler to collect at least 2 L of field sample and at least 1 L each for the MS and MSD samples for a total volume of 4 L. If Pesticide or Aroclor MS/MSD analyses are required for the same sample, an additional 4 L must be collected. Double volume is the MINIMUM allowable volume for samples designated for MS/MSD analysis. Triple volume may be sent for MS/MSD samples to allow for sufficient volume for these analyses in the event sample volume is lost as a result of samples breaking, leaking, or laboratory accidents.

[4] Double volume may be sent for inorganic aqueous MS and MSD samples to allow for sufficient volume for these analyses in the event sample volume is lost as a result of samples breaking, leaking or laboratory accidents.

3.1.1.1 Collect Field QC Samples

Samplers can collect field QC samples and laboratory QC samples to verify that sample quality is maintained during a sampling project.

Field QC samples are designed to assess variability of the media being sampled and to detect contamination and sampling error in the field. The types of field QC samples that are generally collected include field duplicates and field blanks (such as equipment, trip, or rinse blanks). Generally, field duplicate samples should remain "blind" to the laboratory (i.e., they should have separate CLP Sample Numbers).

3.1.1.2 Collect Laboratory QC Samples

A laboratory QC sample is an additional analysis of a field sample, as required by the laboratory's contract. There are three types of laboratory QC samples:

- MS [for organic and inorganic samples];
- MSD [for organic samples only]; and
- Duplicates [for inorganic samples only].

Note: Samplers should obtain Regional guidance regarding the collection of MS and MSD samples (especially for organics analyses).

Samplers should select one sample per matrix per 20 samples as a "laboratory QC" sample. Designated organic laboratory QC samples should be noted on the Organic TR/COC Record. Designated inorganic laboratory QC samples should be noted on the Inorganic TR/COC Record. The laboratory QC sample must not be designated only in the "Field QC Qualifier" column on either the Organic or Inorganic TR/COC Records. Make sure that the laboratory QC sample is included in TR/COC Record samples to be used for the Laboratory QC field.

The sampler should select a field sample as the laboratory QC sample. If the sampler does not select a field sample as the laboratory QC sample, then it is possible that the laboratory could select the field blank (e.g., an equipment or rinsate blank) sample to meet contractual QC requirements. The use of field blanks for laboratory MS/MSD/Duplicate analysis reduces the usability of the data to assess data quality.

Note: In the event of multiple sample shipments during a sampling event, it is recommended that the sampler submit laboratory QC samples in the first sample shipment.

3.1.2 Meet Volume, Preservation, and Holding Time Requirements

Samplers should refer to their project plans to obtain the specific sample volumes to be collected, the preservation needed for those samples, and the technical holding times under which they must submit samples to the scheduled CLP laboratory. Sample collection parameters (to include sample volumes, preservatives, and technical holding times) for organic collection and analysis are listed in Tables 3-2 and 3-3. Sample collection parameters for inorganic analysis and collection are listed in Table 3-4.

3.1.2.1 Collect Sample Volume

Collecting sufficient sample volume is critical. There must be sufficient physical sample volume for the analysis of all required parameters and completion of all QC determinations. The type of analytical procedure(s) to be performed will often dictate the sample volume to collect. For example, each water sample collected for VOA analysis by CLP SOW SOM01 or ILM05 requires a minimum of three vials, each filled completely to a 40 mL capacity. See Appendix C for information regarding the collection of VOAs in water. It is extremely important that samplers refer to their specific project plans to identify and collect the correct sample volume during each sampling event.

When sampling for VOAs in soils, samplers must use SW-846 Method 5035A guidelines included in Appendix B.

3.1.2.2 Preserve Samples

Degradation of some contaminants may occur naturally (e.g., VOAs). The sampler must chemically preserve some water samples for certain analytes before shipping them to the laboratory. The sampler should preserve and immediately cool all samples to 4°C (±2°C) upon collection and samples should remain cooled until the time of analysis (do not freeze water samples). Preservation techniques vary among Regions so the sampler should obtain Region-specific instructions and review the appropriate project plans and SOPs. See Appendix C for information regarding the collection of VOAs in water.

3.1.2.3 Ship within Holding Times

Samplers should ship samples to scheduled CLP laboratories as soon as possible after collection. Daily shipment of samples to CLP laboratories is preferred whenever possible. If samples cannot be shipped on a daily basis, they must be properly preserved and maintained to meet CLP-specified temperatures, holding times, and custody requirements.

The technical holding times are the maximum time allowed between a sample collection and the completion of the sample extraction and/or analysis. In contrast, contractual holding times are the maximum lengths of time that the CLP laboratory can hold the sample prior to extraction and/or analysis. These contractual holding times are described in the appropriate CLP SOW. Contractual holding times are shorter than the technical holding times to allow for sample packing and shipping.

Note

If samplers are shipping samples after 5:00 PM ET, they must notify the RSCC (or designee) or SMO by 8:00 AM ET on the following business day. When making a Saturday delivery, samplers shall contact the RSCC (or designee) or SMO by 3:00 PM ET on the Friday prior to delivery.

Table 3-2. Sample Collection Requirements for CLP SOW SOM01 (VOAs)

Matrix	Container Type	Sample Type	Minimum Number of Containers Needed				Minimum Volume/ Mass	Important Notes	Preservative	Technical Holding Time
			with Water	Dry	% Moisture	TOTAL				
Water	See Table 2-2, Reference Number 1.	Samples Only	-	-	-	**3**	Fill to capacity	Containers/vials must be filled to capacity with no headspace or air bubbles. Refer to Appendix C for samples requiring QC analyses.	Preserve to a pH of 2 with HCl and cool to 4°C (±2ºC) immediately after collection. DO NOT FREEZE water samples.	14 days
		Samples with SIM	-	-	-	**4**				
		Samples with MS/MSD	-	-	-	**6**				
		Samples with SIM and MS/MSD	-	-	-	**8**				
Soil/ Sediment	**OPTION 1** Closed-system Vials See Table 2-2, Reference Number 1.	Samples Only	-	3	1	**4**	5g	Place samples on side prior to being frozen. Refer to Appendix B for samples requiring QC analyses.	Frozen (-7°C to -15°C) or iced to 4° (±2°C).	14 days
		Samples with MS/MSD	-	9	1	**10**				48 hours
	OPTION 2 Closed-system Vials containing Water See Table 2-2, Reference Number 1.	Samples Only	2	1	1	**4**	5g	Containers/vials must be filled to capacity with no headspace or air bubbles. Place samples on side prior to being frozen. Refer to Appendix B for samples requiring QC analyses.	Frozen (-7°C to -15°C) or iced to 4° (±2°C). DO NOT FREEZE water samples.	14 days
		Samples with MS/MSD	6	1	5	**12**				48 hours
	OPTION 3 See Table 2-2, Reference Number 7.	Samples Only	-	3	1	**4**	5g	Refer to Appendix B for samples requiring QC analysis.	Frozen (-7°C to -15°C) or iced to 4°C (±2°C).	48 hours
		Samples with MS/MSD	-	9	1	**10**				48 hours

Notes

1. Minimum volume/mass to be collected in order to ensure sample analysis can be performed.
2. Check Regional guidance regarding use of acid as a preservative of samples that may contain carbonates, residual chlorine, and other oxidants.
3. This technical holding time is calculated from the time of sample collection to sample extraction. Sample extracts are to be analyzed within 40 days of extraction. It is recommended that samplers ship samples to the laboratory on the same day that they are collected, or as soon as possible thereafter.
4. Check Regional guidance regarding use of acid preservatives when testing for carbonates, residual chlorine, and other oxidants.

Table 3-3. Sample Collection Requirements for CLP SOW SOM01 (SVOAs, Pesticides and Aroclors)

Analysis	Matrix	Containers	Minimum Volume/ Mass	Important Notes	Preservative	Technical Holding Time
Semivolatile Analytes	Water	See Table 2-2, Reference Number 5.	2L	If amber containers are not available, the samples should be protected from light.	Cool all samples to 4°C (±2°C) immediately after collection. DO NOT FREEZE water samples.	7 days
	Soil/ Sediment	See Table 2-2, Reference Numbers 3 and 4.	Fill to capacity		Cool all samples to 4°C (±2°C) immediately after collection.	14 days
Pesticides/ Aroclors	Water	See Table 2-2, Reference Number 5.	2L	If amber containers are not available, the samples should be protected from light.	Cool all samples to 4°C (±2°C) immediately after collection. DO NOT FREEZE water samples.	7 days
	Soil/ Sediment	See Table 2-2, Reference Numbers 3 and 4.	Fill to capacity		Cool all samples to 4°C (±2°C) immediately after collection.	14 days

Notes

[1] Minimum volume/mass to be collected in order to ensure sample analysis can be performed.
[2] Check Regional guidance regarding use of acid as a preservative of samples that may contain carbonates, residual chlorine, and other oxidants.
[3] This technical holding time is calculated from the time of sample collection to sample extraction. Sample extracts are to be analyzed within 40 days of extraction. It is recommended that samplers ship samples to the laboratory on the same day that they are collected, or as soon as possible thereafter.
[4] Check Regional guidance regarding use of acid preservatives when testing for carbonates, residual chlorine, and other oxidants.

Table 3-4. Sample Collection Requirements for CLP SOW ILM05

Analysis	Matrix	Containers	Minimum Volume/ Mass[1]	Important Notes	Preservative	Technical Holding Time[4]
Metals/ICP-AES and/or Mercury by CVAA	Water	See Table 2-2, Reference Number 2.	1L	If collecting for both ICP-AES AND ICP-MS methods, a separate 1L volume of sample must be collected for each method per sample location.	Acidify to pH < 2 with HNO_3 and cool to 4°C (±2°C) immediately after collection.[2] DO NOT FREEZE water samples.	6 months for all metals except Mercury (28 days)
	Soil/ Sediment	See Table 2-2, Reference Number 3.	Fill to capacity		Cool to 4°C (±2°C) immediately after collection.	6 months
Cyanide/ Spectrophotometric Determination[3]	Water	See Table 2-2, Reference Number 2.	1L		To neutralize residual chlorine, immediately upon collection, add 0.6 g ascorbic acid for each liter of sample collected. Add NaOH until pH >12 and cool to 4°C (±2°C) immediately after collection.[5] DO NOT FREEZE water samples.	14 days
	Soil/ Sediment	See Table 2-2, Reference Number 3.	Fill to capacity		Cool to 4°C (±2°C) immediately after collection.	14 days

Notes

1 Minimum volume/mass to be collected in order to ensure sample analysis can be performed.

2 Check Regional guidance regarding use of acid as a preservative of samples that may contain carbonates, residual chlorine, and other oxidants.

3 Samplers must test for sulfide and oxidizing agents (e.g., chlorine) in aqueous samples in the field upon collection. Please refer to the SAP and Appendix C for guidance. Sulfides adversely affect the analytical procedure. The following can be done to test for and neutralize sulfides. Place a drop of the sample on lead acetate test paper to detect the presence of sulfides. If sulfides are present, treat 25 mL more of the sample than that required for the cyanide determination with powdered cadmium carbonate or lead carbonate. Yellow cadmium sulfide or black lead sulfide precipitates if the sample contains sulfide. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate test paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate measure the sample to be used for analysis. Avoid a large excess of cadmium carbonate and a long contact time in order to minimize a loss by complication or occlusion of cyanide on the precipitated material. Sulfide removal should be performed in the field, if practical, prior to pH adjustment with NaOH.

4 This technical holding time is calculated from the time of sample collection to sample extraction. Sample extracts are to be analyzed within 40 days of extraction. It is recommended that samplers ship samples to the laboratory on the same day that they are collected, or as soon as possible thereafter.

3.2 Complete Documentation

Samplers must complete all documentation, including the recording of the CLP Sample Number on the sample container or bottle, sample labels, and chain-of-custody seals (as appropriate), the completion of the TR/COC Record, and the completion of field operations records (as necessary).

Samplers should use the FORMS II Lite software to create and print sample labels and the TR/COC Record. Samplers can create and print out two copies of a sample label and attach one to the sample container or bottle, and place the other on the sample tag that may be attached to the sample container or bottle.

Samplers are expected to review their project plans to determine what documentation they are expected to include during a sampling event. It is highly recommended that samplers provide documentation, even if the Region does not require it.

Note: Under no circumstances should the site name appear on any documentation being sent to the laboratory.

An example of a packaged sample is shown in Figure 3-1. A description of each type of documentation and instructions for accurate completion are included in the following sections.

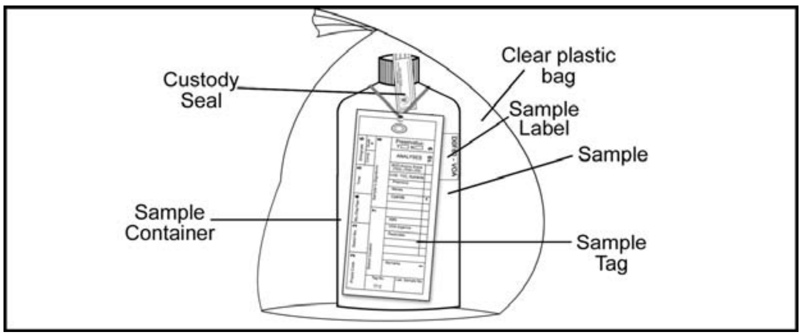

Figure 3-1. Packaged Sample with Identification and Chain-of-Custody Documentation (Excluding TR/COC Record)

3.2.1 Identify a Sample with a CLP Sample Number and SMO-assigned Case Number

The CLP Sample Number and SMO-assigned Case Number **must** be recorded on each sample taken during a sampling event (see Section 1.4.1.1). Samplers can record these numbers on the sample bottle or container using permanent ink. The numbers must also be recorded on the sample tag, if required.

Note: Dissolved metal samples and total metal samples taken from the same sampling location cannot have the same CLP Sample Number because two different sets of data will be generated.

3.2.2 Complete TR/COC Records

A Traffic Report is used as physical evidence of sample custody and as a permanent record for each sample collected. A chain-of-custody record documents the exchange and transportation of samples from the field to the laboratory.

The ASB requires samplers to use the FORMS II Lite software to create documentation for all CLP sampling efforts. For assistance with obtaining or using the FORMS II Lite software, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

To meet CLP sample documentation and chain-of-custody requirements, the sampler must attach a separate TR/COC Record to each cooler they ship. The TR/COC Record must document each sample within the cooler. Samples shipped in other coolers should not be documented. This practice maintains the chain-of-custody for all samples in case of incorrect shipment.

If more than one TR/COC Record is used for the samples within one cooler, all of the records must have complete header information and original signatures. Samplers are responsible for the care and custody of samples from the time of collection to the time of shipment to the laboratories for analysis. A sample is considered under custody if:

- It is in possession or in view after being in possession;
- It was in possession and then secured or sealed to prevent tampering; or
- It was in possession when placed in a secured area.

Each time the custody of samples is turned over to another person, the TR/COC Record must be signed off by the former custodian and accepted by the new custodian. Samplers are, therefore, responsible for properly completing any forms or other Region-required documentation used to establish the chain-of-custody for each sample during a sampling event.

3.2.2.1 Complete a TR/COC Record Using the FORMS II Lite Software

Once the sampler inputs sample collection information into FORMS II Lite, a TR/COC Record will be generated electronically. The software automatically displays only the information to be entered by the sampler. FORMS II Lite then generates a laboratory and a Regional copy of the TR/COC Record (see Figures 3-2 through 3-5). The sampler can print out multiple copies of the TR/COC Record as necessary. The sampler must sign and submit original copies of the TR/COC Record as appropriate.

An electronic TR/COC Record created using the FORMS II Lite software contains basic header information; however, the sampler can also include some additional detailed information. For example, not only is the sample matrix listed on the electronic TR/COC Record, but the name of the sampler taking the sample can also be entered. Samplers should note that certain information will not appear on the electronic TR/COC Record (e.g., matrix and preservative descriptions).

3.2.2.2 Indicate Modified Analysis on FORMS II Lite TR/COC Records

When completing a TR/COC Record using FORMS II Lite, the sampler should identify any samples that will be analyzed using a CLP Modified Analysis. Samplers should indicate use of a Modified Analysis by creating a new analysis within the FORMS II Lite Wizard or through the FORMS II Lite Reference Tables. This newly-created analysis should contain the Modification Reference Number within the name assigned to the analysis. For example, if a Region submits a Modified Analysis for an additional analyte, and SMO assigns the Modification Reference Number 1301.0, the FORMS II Lite analysis could be named "VOA by M.A. 1301.0". The associated abbreviation for this analysis could be "VOA M.A.". If you have any questions regarding identification of Modified Analysis using FORMS II Lite, please contact the FORMS II Lite Help Desk at 703-818-4200 from 9:00 AM - 5:00 PM ET.

3.2.2.3 Make Manual Edits to Printed FORMS II Lite TR/COC Records

If a FORMS II Lite TR/COC Record has been printed and deletions or edits need to be made by the sampler, the following procedures must be followed:

- If making a deletion, manually cross out the information to be disregarded from the TR/COC Record, initial and date the deletion.
- If making an addition, enter the new information and initialsign and date the newly added information.

Note: All modifications made on a printed TR/COC Record must be initialed and dated.

EPA **USEPA Contract Laboratory Program**
Organic Traffic Report & Chain of Custody Record

Case No:	**39400**
DAS No:	DAS9000
SDG No:	

L

Date Shipped:	2/20/2001
Carrier Name:	DHL
Airbill:	121212
Shipped to:	Organic Laboratory 1234 Smith Drive Anywhere, USA 12345 (123) 456-7890

Chain of Custody Record — Sampler Signature:

Relinquished By	(Date / Time)	Received By	(Date / Time)
1			
2			
3			
4			

For Lab Use Only

Lab Contract No:	
Unit Price:	
Transfer To:	
Lab Contract No:	
Unit Price:	

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No.	FOR LAB USE ONLY Sample Condition On Receipt
C0075	Industrial Process Wastewater/ BOBBY SAMPLER	H/C	BNA/PEST (21), VOA (21)	6486, 6487 (2)	LOCATION ONE	S: 2/20/2001 16:02 E: 2/23/2001 16:02	MC0075	
C0076	Ground Water/ JOE SAMPLER	L/C	BNA/PEST (21), VOA (21)	6494, 6495 (2)	LOCATION TWO	S: 2/20/2001 16:01 E: 2/21/2001 16:01	MC0076	
C0077	Industrial Effluent Wastewater/ JOE SAMPLER	M/G	BNA/PEST (21), VOA (21)	6502, 6503 (2)	LOCATION ONE	S: 2/16/2001 15:55 E: 2/20/2001 15:55	MC0077	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC: C0077	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:
Analysis Key:	Concentration: L = Low, M = Low/Medium, H = High	Type/Designate: Composite = C, Grab = G	Custody Seal Intact? __	Shipment Iced? __

BNA/PEST = CLP TCL Semivolatiles and Pesticides/PC, VOA = CLP TCL Volatiles

TR Number: 3-103823254-022001-0001

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, Attn: Heather Bauer, CSC, 15000 Conference Center Dr., Chantilly, VA 20151-3819; Phone 703/818-4200; Fax 703/818-4602

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Figure 3-2. Organic Traffic Report & Chain of Custody Record (Laboratory Copy)

USEPA Contract Laboratory Program
Inorganic Traffic Report & Chain of Custody Record

Case No: 39400
DAS No: DAS9000
SDG No:

L

Date Shipped: 2/20/2001 **Carrier Name:** DHL **Airbill:** 121212 **Shipped to:** Inorganic Laboratory 1234 Smith Drive Anywhere, USA 12345 (123) 456-7890	**Chain of Custody Record**		**Sampler Signature:**		**For Lab Use Only**
	Relinquished By	**(Date / Time)**	**Received By**	**(Date / Time)**	**Lab Contract No:**
	1				**Unit Price:**
	2				**Transfer To:**
	3				**Lab Contract No:**
	4				**Unit Price:**

INORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	FOR LAB USE ONLY Sample Condition On Receipt
MC0075	Industrial Process Wastewater/ BOBBY SAMPLER	H/C	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6481, 6482, 6483, 6484, 6485 (5)	LOCATION ONE	S: 2/20/2001 16:02 E: 2/23/2001 16:02	C0075	
MC0076	Ground Water/ JOE SAMPLER	L/C	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6489, 6490, 6491, 6492, 6493 (5)	LOCATION TWO	S: 2/20/2001 16:01 E: 2/21/2001 16:01	C0076	
MC0077	Industrial Effluent Wastewater/ JOE SAMPLER	M/G	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6497, 6498, 6499, 6500, 6501 (5)	LOCATION ONE	S: 2/16/2001 15:55 E: 2/20/2001 15:55	C0077	

Shipment for Case Complete?N	Sample(s) to be used for laboratory QC: MC0077	Additional Sampler Signature(s):	Cooler Temperature Upon Receipt:	Chain of Custody Seal Number:
Analysis Key:	**Concentration:** L = Low, M = Low/Medium, H = High	**Type/Designate:** Composite = C, Grab = G		**Custody Seal Intact?** __ **Shipment Iced?** __

Al = Aluminum, Ba = Barium, Ca = Calcium, Cr = Chromium, TM/CN = CLP TAL Total Metals and Cyanide

TR Number: 3-103823254-022001-0003

LABORATORY COPY

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Figure 3-3. Inorganic Traffic Report & Chain of Custody Record (Laboratory Copy)

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

Case No:	39400		R
DAS No:	DAS9000		

Region:	3	**Date Shipped:**	2/20/2001	**Chain of Custody Record**	**Sampler Signature:**
Project Code:	QW-123	**Carrier Name:**	DHL	**Relinquished By (Date / Time)**	**Received By (Date / Time)**
Account Code:	ACCT000	**Airbill:**	121212	1	
CERCLIS ID:		**Shipped to:**	Organic Laboratory 1234 Smith Drive Anywhere, USA 12345 (123) 456-7890	2	
Spill ID:	ID3			3	
Site Name/State:	REAL SITE, UT			4	
Project Leader:	DAN SAMPLER				
Action:	Other				
Sampling Co:	SMITH CO.				

ORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	INORGANIC SAMPLE No.	QC Type
C0075	Industrial Process Wastewater/ BOBBY SAMPLER	H/C	BNA/PEST (21), VOA (21)	6486, 6487 (2)	LOCATION ONE	S: 2/20/2001 16:02 E: 2/23/2001 16:02	MC0075	--
C0076	Ground Water/ JOE SAMPLER	L/C	BNA/PEST (21), VOA (21)	6494, 6495 (2)	LOCATION TWO	S: 2/20/2001 16:01 E: 2/21/2001 16:01	MC0076	Spike
C0077	Industrial Effluent Wastewater/ JOE SAMPLER	M/G	BNA/PEST (21), VOA (21)	6502, 6503 (2)	LOCATION ONE	S: 2/16/2001 15:55 E: 2/20/2001 15:55	MC0077	--

Shipment for Case Complete? N	**Sample(s) to be used for laboratory QC:** C0077	**Additional Sampler Signature(s):**	**Chain of Custody Seal Number:**
Analysis Key:	**Concentration:** L = Low, M = Low/Medium, H = High	**Type/Designate:** Composite = C, Grab = G	**Shipment Iced?** ________

BNA/PEST = CLP TCL Semivolatiles and Pesticides/PC, VOA = CLP TCL Volatiles

TR Number: 3-103823254-022001-0001

REGION COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.

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Figure 3-4. Organic Traffic Report & Chain of Custody Record (Region Copy)

USEPA Contract Laboratory Program
Inorganic Traffic Report & Chain of Custody Record

Case No: Y6767 DAS No: DAS9000 **R**

Region:	3	**Date Shipped:**	2/20/2001	**Chain of Custody Record**	**Sampler Signature:**
Project Code:	QW-123	**Carrier Name:**	DHL	**Relinquished By (Date / Time)**	**Received By (Date / Time)**
Account Code:	ACCT000	**Airbill:**	121212	1	
CERCLIS ID:		**Shipped to:**	Clayton Environmental Consultants, Inc 22345 Roethel Drive Novi MI 48375 (248) 344-1770	2	
Spill ID:	ID3			3	
Site Name/State:	REAL SITE, UT			4	
Project Leader:	DAN SAMPLER				
Action:	Other				
Sampling Co:	SMITH CO.				

INORGANIC SAMPLE No.	MATRIX/ SAMPLER	CONC/ TYPE	ANALYSIS/ TURNAROUND	TAG No./ PRESERVATIVE/ Bottles	STATION LOCATION	SAMPLE COLLECT DATE/TIME	ORGANIC SAMPLE No.	QC Type
MC0075	Industrial Process Wastewater/ BOBBY SAMPLER	H/C	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6481, 6482, 6483, 6484, 6485 (5)	LOCATION ONE	S: 2/20/2001 16:02 E: 2/23/2001 16:02	C0075	--
MC0076	Ground Water/ JOE SAMPLER	L/C	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6489, 6490, 6491, 6492, 6493 (5)	LOCATION TWO	S: 2/20/2001 16:01 E: 2/21/2001 16:01	C0076	Spike
MC0077	Industrial Effluent Wastewater/ JOE SAMPLER	M/G	Al (21), Ba (21), Ca (21), Cr (21), TM/CN (21)	6497, 6498, 6499, 6500, 6501 (5)	LOCATION ONE	S: 2/16/2001 15:55 E: 2/20/2001 15:55	C0077	--

Shipment for Case Complete? N	**Sample(s) to be used for laboratory QC:**	**Additional Sampler Signature(s):**	**Chain of Custody Seal Number:**
Analysis Key:	**Concentration:** L = Low, M = Low/Medium, H = High	**Type/Designate:** Composite = C, Grab = G	**Shipment Iced?** ________
Al = Aluminum, Ba = Barium, Ca = Calcium, Cr = Chromium, TM/CN = CLP TAL Total Metals and Cyanide			

TR Number: 3-103823254-022001-0003

PR provides preliminary results. Requests for preliminary results will increase analytical costs.

Send Copy to: Sample Management Office, Attn: Heather Bauer, CSC, 15000 Conference Center Dr., Chantilly, VA 20151-3819; Phone 703/818-4200; Fax 703/818-4602

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Figure 3-5. Inorganic Traffic Report & Chain of Custody Record (Region Copy)

3.2.3 Complete and Attach Custody Seals

Custody seals are usually pre-printed stickers that are signed (or initialed) and dated by the sampler after sample collection and placed on sample bottles or containers and/or shipping coolers or containers (see Figure 3-6). The custody seals document who sealed the sample container and verifies that the sample has not been tampered with. The seals must be placed such that they will break if the sample bottle or container or the shipping cooler or container is tampered with or opened after leaving custody of samplers. Custody seals can also be used to maintain custody of other items such as envelopes containing videotapes of the sample collection process.

Custody seals should never be placed directly onto a coring tool used as a transport device (e.g., 5 g Sampler) or tared, 40 mL closed-system vials. The seals must be placed on the bag for the coring tool used as a transport device, or on the bag used to enclose the vials. Refer to Appendix B for details.

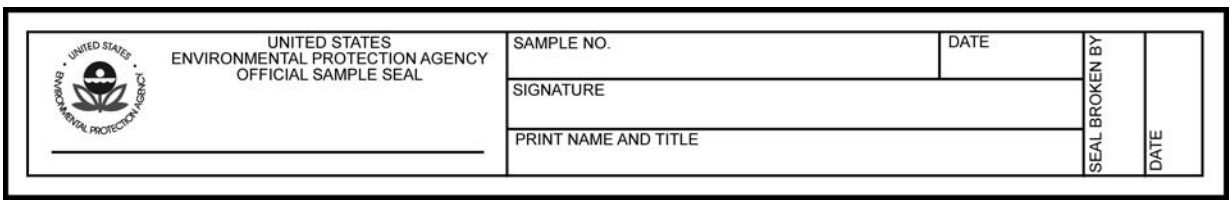

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
OFFICIAL SAMPLE SEAL
SAMPLE NO.
DATE
SIGNATURE
PRINT NAME AND TITLE
SEAL BROKEN BY
DATE

Figure 3-6. Custody Seal

Instructions for completing and attaching a custody seal are included in Table 3-5.

Table 3-5. Completing and Attaching a Custody Seal

Step	Action	Important Notes
1	Record the CLP Sample Number.	The space for the CLP Sample Number does not need to be completed on custody seals being placed on the opening of a cooler, only on those being placed on the opening of sample bottles or containers.
2	Record the month, day, and year of sample collection.	
3	Sign the seal in the Signature field.	
4	Print your name and title in the Print Name and Title field.	
5	Place the custody seal over the edge of the sample bottle or container such that it will break if tampered with.	Custody seals can be placed directly on any sample container except for coring tools used as a transport device (e.g., 5 g Samplers) and tared VOA bottles. If packing coring tools used as a transport device or tared VOA bottles, place them in a clear plastic bag and place the custody seal on the outside of the bag.
6	If possible, cover the custody seal with clear plastic tape to protect it.	Take special care to not place the protective tape over the seal in such a way that it can be removed and then re-attached without signs of tampering.

The use and type of custody seals can vary by Region or collecting organization. Samplers should obtain the appropriate custody seals and specific instructions for correctly attaching them from the RSCC.

3.2.4 Complete and Attach Sample Labels

Samplers affix sample labels to each sample container. A sample label must contain the associated CLP Sample Number (either written or pre-printed), SMO-assigned Case Number, and the preservative used. It must also denote the analysis/fraction. Samplers may also include additional information such as the station location or the date/time of collection. Samplers should use FORMS II Lite to create and print sample labels. The sampler can print two labels and attach one to the sample container or bottle, and place the other label on the sample tag that should also be attached to the sample container or bottle. The labels should then be covered with clear packaging tape to protect the label and maintain legibility. If handwriting a sample label, the sampler should complete the label information using waterproof ink, place the label on the outside of the sample bottle or container, then cover the label with clear packaging tape to protect the label and maintain legibility (see Figure 3-1).

Do not attach labels to tared VOA sample vials. A label should already be pre-attached to the tared vial.

3.2.5 Complete and Attach Sample Tags

To support use of sample data in potential enforcement actions, sample characteristics other than on-site measurements (e.g., pH, temperature, conductivity) can be identified with a sample tag. Typically, site-specific information is written on the tags using waterproof ink. The use and type of sample tags may vary by Region. For each sampling event, samplers should receive the required sample tags and type of information to include from the RSCC. The sampler can use FORMS II Lite to create and print out multiple sample labels, one of which can be attached to the sample tag and then covered with clear packaging tape to protect the label and maintain legibility. If FORMS II Lite-created sample labels are not available, a detailed set of instructions for completing and attaching a handwritten sample tag are included in Table 3-6.

The use and type of sample tags may vary among Regions.

Table 3-6. Completing and Attaching a Handwritten Sample Tag

Step	Action	Important Notes
1	Under the "Remarks" heading, record the CLP Sample Number and SMO-assigned Case Number.	Make sure to record the correct CLP Sample Number and SMO-assigned Case Number in a legible manner.
2	Record the project code (e.g., Contract Number, Work Assignment Number, Interagency Agreement Number, etc.) assigned by USEPA.	
3	Enter the station number assigned by the sampling team coordinator.	
4	Record the month, day, and year of sample collection.	
5	Enter the military time of sample collection (e.g., 13:01 for 1:01 PM).	
6	Identify the designate and place an "X" in either the "Comp." or "Grab" box if the sample is either a composite or grab sample.	
7	Record the station location.	
8	Sign the sample tag in the Signature area.	
9	Place an "X" in the box next to Yes or No to indicate if a preservative was added to the sample.	
10	Under "Analyses", place an "X" in the box next to the parameters for which the sample is to be analyzed.	
11	Leave the box for "Laboratory Sample Number" blank.	
12	It is recommended that the sample tag be attached to the neck of the sample bottle or container using regular string, stretch string, or wire (see Figure 3-1).	Do **NOT** use wire to attach a sample tag to a metals sample.

An example of a completed sample tag is included in Figure 3-7 below:

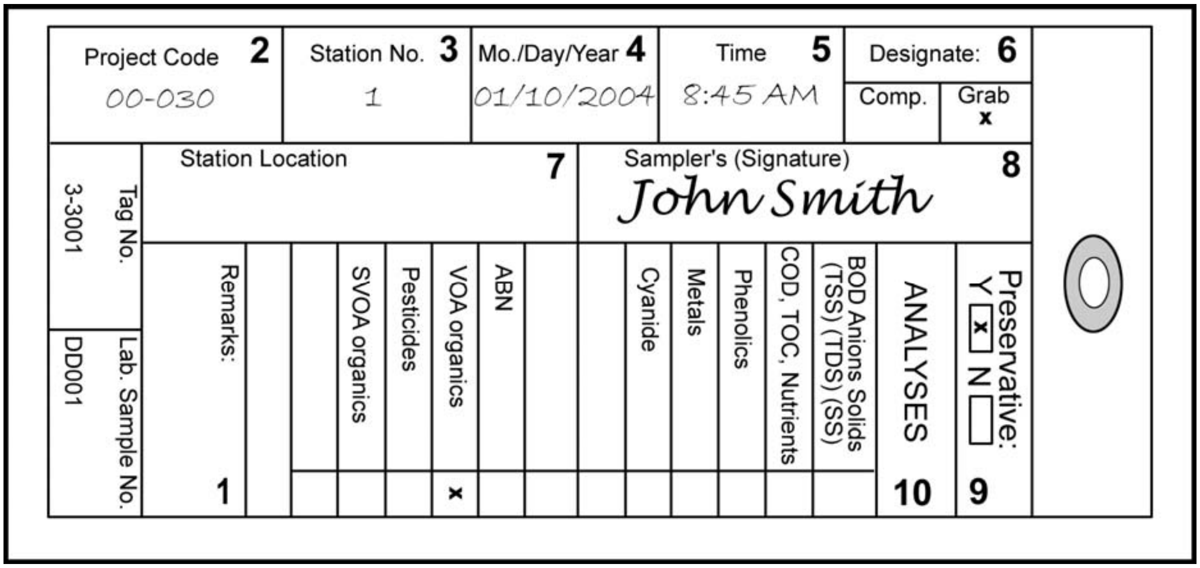
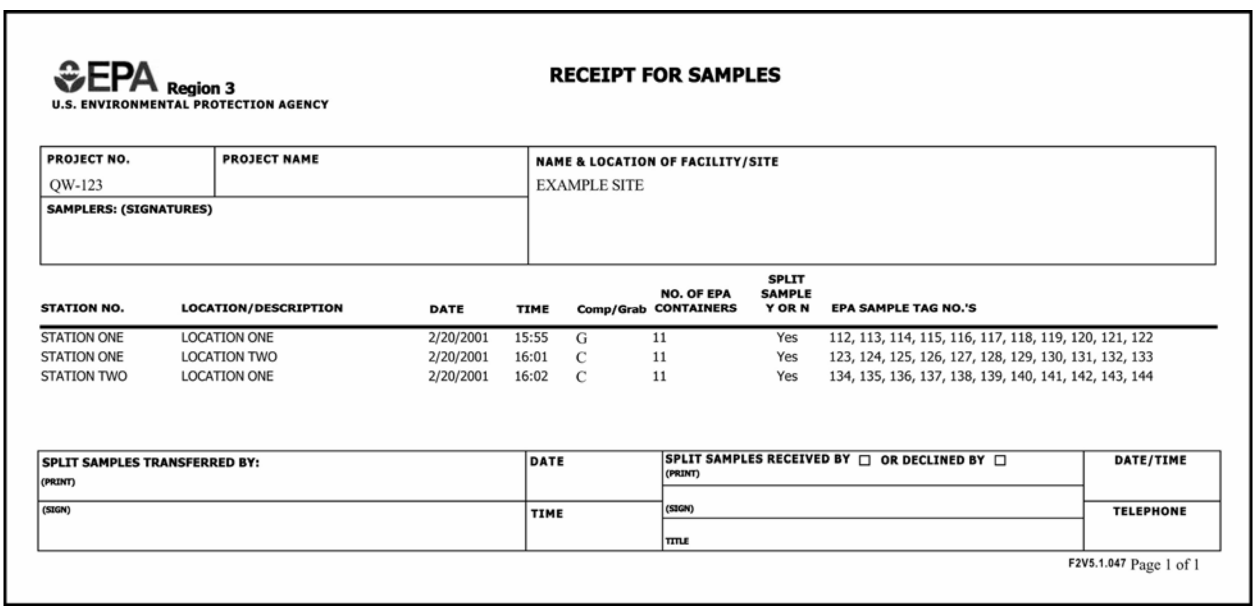

Project Code 2
00-030
Station No. 3
1
Mo./Day/Year 4
01/10/2004
Time 5
8:45 AM
Designate: 6
Comp. | Grab
x
Tag No.
3-3001
Lab. Sample No.
DD001
Station Location 7
Sampler's (Signature) 8
John Smith
Remarks: 1
SVOA organics
Pesticides
VOA organics x
ABN
Cyanide
Metals
Phenolics
COD, TOC, Nutrients
BOD Anions Solids (TSS) (TDS) (SS)
ANALYSES 10
Preservative: Y [x] N [ ] 9

Figure 3-7. Completed Sample Tag

3.3 Provide Sample Receipt

After samples have been taken from private property, the sampler should prepare a receipt for these samples and provide this receipt to the property owner. This is especially important when sampling on private property since these samples could be used during future litigation and the receipt will verify that the owner granted approval for the removal of the samples from the property. An example of a sample receipt created using FORMS II Lite is shown in Figure 3-8.


EPA Region 3
U.S. ENVIRONMENTAL PROTECTION AGENCY

RECEIPT FOR SAMPLES

PROJECT NO.: QW-123
PROJECT NAME:
NAME & LOCATION OF FACILITY/SITE: EXAMPLE SITE
SAMPLERS: (SIGNATURES)

STATION NO.	LOCATION/DESCRIPTION	DATE	TIME	Comp/Grab	NO. OF EPA CONTAINERS	SPLIT SAMPLE Y OR N	EPA SAMPLE TAG NO.'S
STATION ONE	LOCATION ONE	2/20/2001	15:55	G	11	Yes	112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122
STATION ONE	LOCATION TWO	2/20/2001	16:01	C	11	Yes	123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133
STATION TWO	LOCATION ONE	2/20/2001	16:02	C	11	Yes	134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144

SPLIT SAMPLES TRANSFERRED BY: (PRINT) (SIGN)
DATE
TIME
SPLIT SAMPLES RECEIVED BY ☐ OR DECLINED BY ☐ (PRINT) (SIGN) TITLE
DATE/TIME
TELEPHONE
F2V5.1.047 Page 1 of 1

Figure 3-8. Sample Receipt Created Using the FORMS II Lite Software

3.4 Pack and Ship Samples

Once the samples have been collected, it is very important that the sampler properly package the samples for shipment and ensure that the samples are sent to the appropriate laboratory as quickly as possible. Prompt and proper packaging of samples will:

- Protect the integrity of samples from changes in composition or concentration caused by bacterial growth or degradation from increased temperatures;
- Reduce the chance of leaking or breaking of sample containers that would result in loss of sample volume, loss of sample integrity, and exposure of personnel to toxic substances; and
- Help ensure compliance with shipping regulations.

3.4.1 Sample Containers

Once samples are collected, they must be stored in conditions that maintain sample integrity. All samples should be placed in shipping containers or other suitable containers with ice to reduce the temperature as soon as possible after collection. Ideally, all samples should be shipped the day of collection for overnight delivery to the laboratory. If samples cannot be shipped on the day of collection, the sample temperature should be maintained at 4°C (±2°C) until they are shipped to the laboratory.

One CLP RAS sample may be contained in several bottles and vials. For example, one soil sample may consist of all containers needed for three of the analytical fractions available under this service (i.e., SVOA fraction, Pesticide fraction, and Aroclor fraction), even though the fractions are collected in separate containers. Therefore, the analysis to be performed and the matrix type will determine the type of container(s) that will be used, as well as the volume that must be collected for that particular sample fraction.

3.4.2 Inventory of Samples and Documentation

Prior to shipment, samplers should conduct an inventory of the contents of the shipping cooler or container against the corresponding TR/COC Record when packing for shipment to laboratories. An inventory will ensure that the proper number of containers have been collected for each analysis of the samples, that the required PE and QC samples and cooler temperature blanks are included, and the correct Sample Numbers and fractions have been assigned to each sample.

3.4.3 Shipping Regulations

Sample shipping personnel are legally responsible for ensuring that the sample shipment will comply with all applicable shipping regulations. For example, hazardous material samples must be packaged, labeled, and shipped in compliance with all IATA Dangerous Goods regulations or DOT regulations and USEPA guidelines. Refer to Appendix B for detailed shipping guidelines when using SW-846 Method 5035A to preserve and ship samples.

3.4.4 Sample Packaging for Shipment

Samplers are responsible for the proper packaging of samples for shipment. To ensure that samples are appropriately packaged (e.g., to avoid breakage and/or contamination) the sampler should consult their respective project plans to determine the proper packing and shipping procedures. The sampler must determine the sample type, pack the shipping containers correctly, include necessary paperwork, label and seal shipping containers or coolers, and ship the samples.

3.4.4.1 Determine the Sample Type and Container

Samplers should know what kinds of samples they are handling to ensure proper packaging. Samplers should refer to their appropriate project plans to determine which type of sample container should be used for each type of sample being taken during the sampling event.

Please follow Regional guidance with reference to samples containing dioxin or radioactive waste.

3.4.4.2 Pack Shipping Containers

It is imperative that samples are correctly and carefully packed in shipping containers to prevent the sample containers from breaking or leaking. Samplers must prepare and pack a shipping cooler or container according to the instructions outlined in Table 3-7.

Table 3-7. Packing Samples for Shipment

Step	Action	Important Notes
1	Seal all drain holes in the shipping container, both inside and out, to prevent leakage in the event of sample breakage.	
2	Check all lids/caps to make sure the samples are tightly sealed and will not leak.	
3	Seal samples within a clear plastic bag.	Custody seals can be placed directly on any sample container except for coring tools used as a transport device (e.g., 5 g Samplers) and tared VOA bottles. If packing coring tools used as a transport device or tared VOA bottles, place them in a clear plastic bag and place the custody seal on the outside of the bag.
4	Fully chill samples to 4°C (±2°C) prior to placement within suitable packing materials.	
5	Prior to placing samples within the shipping cooler, it is recommended that samplers line shipping containers with non-combustible, absorbent packing material.	
6	Place samples in CLEAN, sealed, watertight shipping containers (metal or hard plastic coolers).	
7	Conduct an inventory of the contents of the shipping cooler/container against the corresponding TR/COC Record.	
8	Cover samples in double-bagged ice to prevent water damage to packing materials.	Do NOT pour loose ice directly into the sample cooler. The ice is used to maintain the temperature of the samples within the shipping cooler.
9	It is recommended a temperature blank be included within each cooler being shipped.	The temperature blank is generally a 40 L vial filled with water and labeled “temperature blank” but does not have a Sample Number.
10	Ensure that the site name or other site-identifying information does not appear on any documentation being sent to the laboratory.	The laboratory should not receive any site-identifying information.

3.4.4.3 Include Necessary Paperwork

Samplers must properly place the necessary paperwork in the shipping cooler. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping cooler lids (see Figure 3-9).

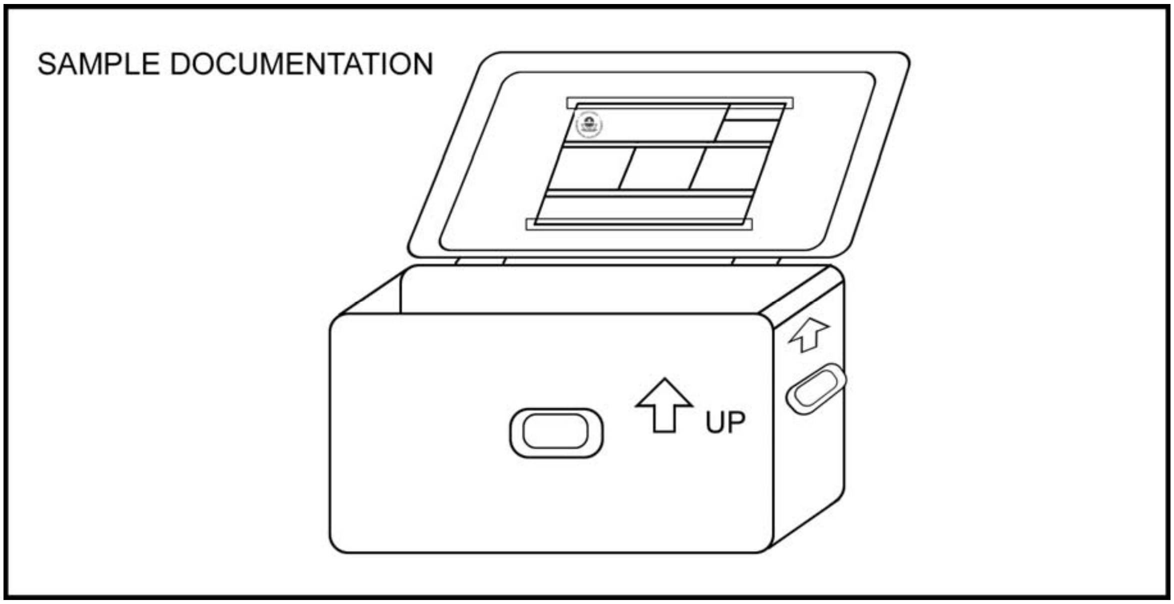


Figure 3-9. Sample Cooler with Attached TR/COC Record and Cooler Return Documentation

Necessary paperwork includes TR/COC Records and sample weight logs (see Figure 3-10), if required (for VOA samples). Samplers should contact their RSCC (or designee) for specific paperwork requirements.

USEPA Contract Laboratory Program
Sample Weight Log

Shipped to: AAA Testing Laboratory
1700 Mill Avenue
Houston TX 77099
(281) 983-1234

Case No. 39563
DAS No. DAS34
Date Shipped: 9/29/2003

Sample No.	Matrix	Analysis	Preservative	Bottle/ Tag Number	Tared Weight (g)	Final Weight (g)	Sample Weight (g)	Laboratory Weight	Traffic Report No.
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199548	32.80	37.20	4.40		3-103018225-092903-0001
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199547	32.10	38.30	6.20		3-103018225-092903-0001
C0036	Subsurface Soil (>12")	CLP TCL Volatiles	Ice Only	199549	31.20	38.60	7.40		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199552	32.00	36.90	4.90		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199551	32.40	37.10	4.70		3-103018225-092903-0001
C0037	Surface Soil (0"-12")	CLP TCL Volatiles	Ice Only	199550	31.90	35.90	4.00		3-103018225-092903-0001

Completed By:	Date:

All weights are measured in grams

Figure 3-10. Sample Weight Log

3.4.4.4 Return Sample Shipping Coolers

CLP laboratories must routinely return sample shipping coolers within 14 calendar days following shipment receipt. Therefore, the sampler should also include cooler return instructions with each shipment. The sampler (not the CLP laboratory) is responsible for paying for return of the cooler and should also include shipping airbills bearing the sampler's account number, as well as a return address to allow for cooler return.

3.4.4.5 Label and Seal Sample Shipping Coolers

After samples are packaged within shipping coolers, samplers must carefully secure the top and bottom of the coolers with tape, place return address labels clearly on the outside of the cooler, and attach the required chain-of-custody seals (see Figure 3-11).

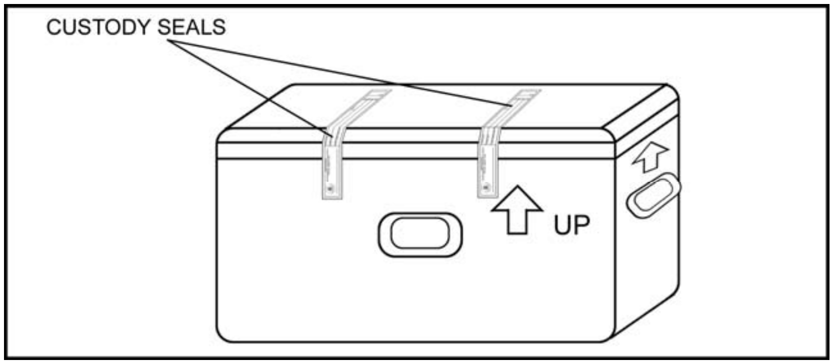


Figure 3-11. Shipping Cooler with Custody Seals

If more than one cooler is being delivered to a laboratory, samplers should mark each cooler as "1 of 2", "2 of 2", etc. In addition, samplers must accurately complete and attach shipping airbill paperwork for shipment of the samples to the laboratory. An airbill, addressed to the Sample Custodian of the receiving laboratory, should be completed for each cooler shipped. Samplers should receive the correct name, address, and telephone number of the laboratory to which they must ship samples from the RSCC or SMO. To avoid delays in analytical testing, samplers should make sure they are sending the correct types of samples to the correct laboratory when collecting samples for multiple types of analysis. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory.

3.4.4.6 Ship Samples

The sampling contractor should ensure that samplers know the shipping company's name, address, and telephone number. In addition, they should be aware of the shipping company's hours of operation, shipping schedule, and pick-up/drop-off requirements.

Overnight Delivery

It is imperative that samples be sent via overnight delivery. Delays caused by longer shipment times may cause technical holding times to expire, which in turn may destroy sample integrity or require the recollection of samples for analysis.

Saturday Delivery

For shipping samples for Saturday delivery, the sampler MUST contact the RSCC (or their designee) or SMO so that SMO will receive the delivery information by 3:00 PM ET on the Friday prior to delivery.

3.4.5 Shipment Notification

When samples are shipped to CLP Laboratories, samplers **must immediately** report all sample shipments to the RSCC (or their designee) or to SMO. **Under no circumstances should the sampler contact the laboratory directly.** If samplers are shipping samples after 5:00 PM ET, they must notify the RSCC (or designee) or SMO by 8:00 AM ET on the following business day. Samplers should receive the name and phone number of the appropriate SMO coordinator to contact from the Region/RSCC.

Samplers must provide the following information to the RSCC (or their designee) or to SMO:

- Name and phone number at which they can easily be reached (preferably closest on-site phone number if still in the field);
- SMO-assigned Case Number (see Section 2.4.1);
- Number, concentration, matrix and analysis of samples being shipped;
- Name of laboratory (or laboratories) to which the samples were shipped;
- Airbill number(s);
- Date of shipment;
- Case status (i.e., whether or not the Case is complete);
- Problems encountered, special comments, or any unanticipated issues;
- When to expect the next anticipated shipment; and
- An electronic export of the TR/COC Record (must be sent as soon as possible after sample shipment). For information regarding electronic export of TR/COC Records, refer to the following Web site:

http://www.epa.gov/superfund/programs/clp/f2lsubmit.htm

Note: For Saturday delivery, samplers MUST contact the RSCC (or their designee) or SMO so that SMO will receive the delivery information by 3:00 PM ET on the Friday prior to delivery.

Samplers should be aware if their Region requires them to notify the RSCC (or designee) and/or SMO of sample shipment.

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Appendix A: Functions within a Sampling Project

The following table describes Quality Assurance Project Plan (QAPP) requirements taken from *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5).

Functions Within a Sampling Project	Elements of that Function
Project Management	
Project/Task Organization	Identifies the individuals or organizations participating in the project and defines their specific roles and responsibilities.
Problem Definition/Background	States the specific problem to be solved or decision to be made and includes sufficient background information to provide a historical and scientific perspective for each particular project.
Project/Task Description	Describes the work to be performed and the schedule for implementation to include: • Measurements to be made during the course of the project; • Applicable technical, regulatory, or program-specific quality standards, criteria, or objectives; • Any special personnel and equipment requirements; assessment tools needed; and • A work schedule and any required project and quality records, including types of reports needed.
Quality Objectives and Criteria	Describes the project quality objectives and measurement performance criteria.
Special Training/Certification	Ensures that any specialized training for non-routine field sampling techniques, field analyses, laboratory analyses, or data validation should be specified.
Documents and Records	• Itemizes the information and records that must be included in the data report package and specifies the desired reporting format for hard copy and electronic forms, when used. • Identifies any other records and/or documents applicable to the project such as audit reports, interim progress reports, and final reports that will be produced. • Specifies or references all applicable requirements for the final disposition of records and documents, including location and length of retention period.
Data Generation and Acquisition	
Sampling Process Design (Experimental Design)	• Describes the experimental design or data collection design for the project. • Classifies all measurements as critical or non-critical.
Sampling Methods	• Describes the procedures for collecting samples and identifies sampling methods and equipment. Includes any implementation requirements, support facilities, sample preservation requirements, and materials needed. • Describes the process for preparing and decontaminating sampling equipment to include the disposal of decontamination by-products, selection and preparation of sample containers, sample volumes, preservation methods, and maximum holding times for sampling, preparation, and/or analysis. • Describes specific performance requirements for the method. • Addresses what to do when a failure in sampling occurs, who is responsible for corrective action, and how the effectiveness of the corrective action shall be determined and documented
Sample Handling and Custody	• Describes the requirements and provisions for sample handling and custody in the field, laboratory, and transport, taking into account the nature of the samples, the maximum allowable sample holding times before extraction and analysis, and the available shipping options and schedules. • Includes examples of sample labels, custody forms, and sample custody logs.

Analytical Methods	• Identifies the analytical methods and equipment required, including sub-sampling or extraction methods, waste disposal requirements (if any), and specific method performance requirements. • Identifies analytical methods by number, date, and regulatory citation (as appropriate). If a method allows the user to select from various options, the method citations should state exactly which options are being selected. • Addresses what to do when a failure in the analytical system occurs, who is responsible for corrective action, and how the effectiveness of the corrective action shall be determined and documented. • Specifies the laboratory turnaround time needed, if important to the project schedule. • Specifies whether a field sampling and/or laboratory analysis Case Narrative is required to provide a complete description of any difficulties encountered during sampling or analysis.
Quality Control (QC)	• Identifies required measurement QC checks for both the field and laboratory. • States the frequency of analysis for each type of QC check, and the spike compounds sources and levels. • States or references the required control limits for each QC check and corrective action required when control limits are exceeded and how the effectiveness of the corrective action shall be determined and documented. • Describes or references the procedures to be used to calculate each of the QC statistics.
Instrument/Equipment Testing, Inspection, and Maintenance	• Describes how inspections and acceptance testing of environmental sampling and measurement systems and their components will be performed and documented. Identifies and discusses the procedure by which final acceptance will be performed by independent personnel. • Describes how deficiencies are to be resolved and when re-inspection will be performed. • Describes or references how periodic preventative and corrective maintenance of measurement or test equipment shall be performed. • Identifies the equipment and/or system requiring periodic maintenance. • Discusses how the availability of spare parts identified in the operating guidance and/or design specifications of the systems will be assured and maintained.
Instrument/Equipment Calibration and Frequency	• Identifies all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data collection activities affecting quality that must be controlled, and at specific times, calibrated to maintain performance within specified limits. • Identifies the certified equipment and/or standards used for calibration. • Describes or references how calibration will be conducted using certified equipment and/or standards with known valid relationships to nationally recognized performance standards. If no such standards exist, documents the basis for calibration. • Indicates how records of calibration shall be maintained and traced to the instrument.
Inspection/Acceptance of Supplies and Consumables	• Describes how and by whom supplies and consumables shall be inspected and accepted for use in the project. • States acceptance criteria for such supplies and consumables.
Non-direct Measurements	• Identifies any types of data needed for project implementation or decision-making that are obtained from non-measurement sources (e.g., computer databases, programs, literature files, historical databases). • Describes the intended use of data. • Defines the acceptance criteria for the use of such data in the project. • Specifies any limitations on the use of the data.
Data Management	• Describes the project data management scheme, tracing the data path from generation in the field or laboratory to their final use or storage. • Describes or references the standard record-keeping procedures, document control system, and the approach used for data storage and retrieval on electronic media.

Appendix B: CLP Sample Collection Guidelines for VOAs in Soil by SW-846 Method 5035A

A. Preferred Options for the Contract Laboratory Program (CLP) are Options 1, 2, and 3:

Note: Soil samples must be placed on their sides prior to being frozen.

Option 1.

Closed-system Vials:

Container - tared or preweighed 40 mL VOA Vials containing a magnetic stir bar.

Collect 5 g of soil per vial (iced or frozen in the field).

Regular Samples	3 Vials - Dry (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 4 Total Vials
Regular Samples Requiring QC Analysis	9 Vials - Dry (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 10 Total Vials

Option 2.

Closed-system Vials Containing Water:

Container - tared or pre-weighed 40 mL VOA vials containing a magnetic stir bar and 5 mL water.

Collect 5 g of soil per vial (iced or frozen in the field).

Regular Samples	2 Vials with water added (5 g soil and 5 mL water per vial) 1 Vial - Dry (5 g soil in vial) 1 Vial - Dry (filled with soil, no headspace) 4 Total Vials (2 with water and 2 dry)
Regular Samples Requiring QC Analysis	6 Vials with water added (5 g soil and 5 mL water per vial) 5 Vials - Dry (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 12 Total Vials (6 with water and 6 dry)

Option 3.

Coring Tool used as a Transport Device

Container - 5 g Samplers or equivalent.

Note: All Samplers should be iced or frozen in the field and bagged individually.

Regular Samples	3 Samplers (5 g soil per Sampler) 1 Vial - Dry (filled with soil, no headspace) 4 Total (3 Samplers and 1 Vial)
Regular Samples Requiring QC Analysis	9 Samplers (5 g soil per Sampler) 1 Vial - Dry (filled with soil, no headspace) 10 Total (11 Samplers and 1 Vial)

B. Options 4, 5, and 6 are NOT preferred options for the CLP:

Option 4.

Closed-system Vials:

Container - tared or preweighed 40 mL VOA Vials containing a magnetic stir bar and preservative.

Collect 5 g of soil per vial and add Sodium bisulfate ($NaHSO_4$) preservative (5 mL water + 1 g $NaHSO_4$) - iced or frozen in the field.

Caution: **This option is NOT a Preferred Option for the CLP because:**

NaHSO4 preservation creates low pH conditions that will cause the destruction of certain CLP target analytes (e.g., vinyl chloride, trichloroethene, trichlorofluoromethane, cis- and trans-1,3-dichloropropene). Projects requiring the quantitation of these analytes should consider alternative sample preservation methods. NaHSO4 also cannot be used on carbonaceous soils. Check the soil before using this method of collection! Soil can be checked by placing a test sample in a clean vial, then adding several drops of NaHSO4 solution. If the soil bubbles, use Option 4b and note this issue on the TR/COC Record.

Option 4a. Samples preserved in the field

Regular Samples	2 Vials with $NaHSO_4$ preservative added (5g soil per vial) 1 Vial without $NaHSO_4$ preservative added (5g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 4 Total Vials (2 with $NaHSO_4$ preservative and 2 without)
Regular Samples Requiring QC Analyses	4 Vials with $NaHSO_4$ preservative added (5g soil per vial) 5 Vials without $NaHSO_4$ preservative added (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 10 Total Vials (4 with $NaHSO_4$ and 6 without)

Option 4b. Samples are preserved by the laboratory (No $NaHSO_4$ preservative is added to these samples in the field).

Regular Samples	3 Vials - Dry (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 4 Total Vials
Regular Samples Requiring QC Analyses	9 Vials - Dry (5 g soil per vial) 1 Vial - Dry (filled with soil, no headspace) 10 Total Vials

Option 5.

Methanol Preservation (medium-level analysis only):

Container - tared or pre-weighed 40 mL VOA vials containing 5-10 mL methanol.

Collect 5 g of soil per vial (iced in the field).

Caution: This is NOT a preferred option for the CLP because:

Samples preserved with methanol can only be analyzed by the medium-level method. Low-level Contract Required Quantitation Limit (CRQLs) cannot be achieved when samples are preserved this way.

Additional problems associated with use of methanol as a preservative in the field include:

- Possible contamination of the methanol by sampling-related activities (e.g., absorption of diesel fumes from sampling equipment);
- Leakage of methanol from the sample vials during shipping, resulting in loss of VOAs prior to analysis.

Regular Samples	2 Vials (5 g soil and 5-10 mL methanol per vial) 1 Vial - Dry (filled with soil, no headspace) 3 Total Vials (2 with methanol and 1 dry)
Regular Samples Requiring QC Analysis	6 Vials (5 g soil and 5-10 mL methanol per vial) 1 Vial -Dry (filled with soil, no headspace) 7 Total Vials (6 with methanol and 1 dry)

Note: If shipping samples containing methanol as a preservative, a shipping label must be used to indicate methanol. This label must also contain the United Nations (UN) identification number for methanol (UN 1230), and indicate Limited Quantity.

Option 6.

Glass Containers filled with sample - No Headspace:

Container - 4 oz Glass Jars.

Glass container filled with soil with no headspace and iced.

Caution: This is NOT a preferred option for the CLP because:

Samples collected in this manner lose most of their volatile analytes prior to analysis when the sample containers are opened and sub-sampled in the laboratory. This option is only available due to Regional requirements.

Regular Samples	2 Glass Jars (4 oz) filled with sample, no headspace 1 Vial - Dry (filled with soil, no headspace) 3 Total Containers
Regular Samples Requiring QC Analysis	2 Glass Jars (4 oz) filled with sample, no headspace 1 Vial - Dry (filled with soil, no headspace) 3 Total Containers

C. Caution:

1. Extreme care must be taken to ensure that frozen samples do not break during shipment.
2. Before adding soil to pre-weighed vials containing a stir bar, weigh the vials to confirm the tared weight. If the weight varies by more than 0.1 g, record the new weight on the label and the sample documentation. Do NOT add labels to these vials once the tared weight has been determined/confirmed.

D. Dry Samples:

All options include taking a sample in a dry 40 mL VOA vial (or a 4 oz wide mouth jar) with no headspace. No additional water, $NaHSO_4$, or methanol is added to this sample. This sample is taken to determine moisture content; therefore, it does not need to be tared or have a stir bar.

E. Iced or Frozen Samples:

1. Iced means cooled to 4°C (±2°C) immediately after collection.
2. Frozen means cooled to between -7°C and -15°C immediately after collection.

F. Sample Delivery:

CLP strongly recommends that all samples reach the laboratory by COB the next day after sample collection.

G. Notes:

1. For Option 4, samples can be preserved with $NaHSO_4$ either:
   - In the field; or
   - In the laboratory upon receipt. In this case, the sampler should put the following information in the Preservation Column of the TR/COC Record - "To be preserved at lab with $NaHSO_4$". This Regional Request should also be communicated to SMO so that the laboratory can be notified.
2. Regional QAPPs may require the use of Option 5. Please note that this option is for medium-level analysis ONLY.
3. If water, methanol, or $NaHSO_4$ preservative is added to the vials in the field, a field blank containing the appropriate liquid used in the vials should be sent to the laboratory for analysis.

H. Number of Containers Rationale:

The rationale for the number of containers (vials or samplers) required for the field sample and the required laboratory QC for each option is given as follows:

Option 1.

Rationale for Regular Vials:	1 vial for low-level analysis (water purge) 1 vial for backup low-level analysis 1 vial for medium-level analysis (methanol extraction)
Rationale for QC Vials:	2 vials for MS and MSD low-level analysis 2 vials for MS and MSD medium-level analysis 2 vials for backup (MS and MSD) low-level or medium-level analysis

Option 2.

Rationale for Regular Vials:	1 vial for low-level analysis (water purge) 1 vial for back up low-level analysis 1 vial dry for medium-level analysis (methanol extraction)
Rationale for QC Vials:	2 vials for MS and MSD low-level analysis 2 vials for MS and MSD medium-level analysis 2 vials for backup (MS and MSD) low-level or medium-level analysis
Medium-level: Analysis	Methanol will be added in the laboratory

Option 3.

Rationale for Regular Samples:	1 sampler for low-level analysis (water purge) 1 sampler for back up low-level analysis 1 sampler for medium-level analysis (methanol extraction)
Rationale for QC Samples:	2 samplers for MS and MSD low-level analysis 2 samplers for backup MS and MSD low-level analysis 2 samplers for MS and MSD medium-level analysis 2 samplers for backup MS and MSD medium-level analysis

Option 4a ($NaHSO_4$ added in the field).

Rationale for Regular Vials:	1 vial with water for low-level analysis (water purge) 1 vial with water for backup low-level analysis 1 vial dry for medium-level analysis (methanol extraction)
Rationale for QC Vials:	2 vials with water for MS and MSD low-level analysis 2 vials dry for MS and MSD medium-level analysis 2 vials for backup (MS and MSD) low-level or medium-level analysis

Option 4b ($NaHSO_4$ added in the laboratory).

Rationale for Regular Vials:	1 vial for low-level analysis (water purge) 1 vial for backup low-level analysis 1 vial for medium-level analysis (methanol extraction)
Rationale for QC Vials:	2 vials for MS and MSD low-level analysis 2 vials for MS and MSD medium-level analysis 2 vials for backup (MS and MSD) low-level or medium-level analysis

Option 5.

Rationale for Regular Samples:	1 vial for regular medium-level analysis 1 vial for back up medium-level analysis
Rationale for QC Samples:	2 samples for MS and MSD 2 samples for backup MS and MSD

Option 6.

In this option, all Regular and QC samples for both low-level and medium analysis are taken as subsamples from the same container.

Rationale for Regular Analysis	1 glass jar for low-level analysis and medium-level analysis **1 glass jar for backup low-level analysis and medium-level analysis**
Rationale for QC Analysis:	1 glass jar for low-level analysis and medium-level analysis **1 glass jar for backup low-level analysis and medium-level analysis**

Appendix C: General CLP Sample Collection Guidelines VOAs in Water

Regional guidance and/or specific Project Plan requirements will supersede the guidelines listed below.

Collect the following:

- At least two 40 mL glass containers with polytetrafluoroethylene (PTFE)-lined septa and open top screw-caps that are filled to capacity with no air bubbles, preserved to a pH of 2 with HCl, and cooled to 4°C (±2°C) immediately after collection. DO NOT FREEZE THE SAMPLES.
- If Selected Ion Monitoring (SIM) analysis is requested, at least two additional 40 mL glass containers with PTFE-lined septa and open top screw-caps that are filled to capacity with no air bubbles, preserved to a pH of 2 with HCl, and cooled to 4°C (±2°C) immediately after collection.

Test for Carbonates, Residual Chlorine, Oxidants, and Sulfides:

- It is very important that samplers obtain Regional guidance when testing and ameliorating for:
  - Carbonates;
  - Residual chlorine (e.g., municipal waters or industrial waste waters that are treated with chlorine prior to use or discharge); or
  - Oxidants.
- VOA samples containing carbonates react with the acid preservative causing effervescence (due to formation of carbon dioxide), which can cause loss of volatile analytes.
- Residual chlorine present in VOA samples can continue to react with dissolved organic matter. This continuous reaction may lead to inaccurate quantitation of certain analytes present in the sample at the time of collection.
- Residual chlorine and oxidants present in VOA samples can cause degradation of certain volatile analytes (e.g., styrene).

Perform the following for *Pre-Preserved* Vials:

1. Pour the sample slowly down the edge of the sample vial to avoid excess aeration or agitation of the sample during filling.
2. Fill the vial completely so that a reverse (convex) meniscus is present and ensure that there are no air bubbles present (either in the body or especially at the top of the vial).
3. Place the septum on the vial so that the PTFE side is in contact with the sample, and then firmly tighten the cap.
4. Gently flip the vial a few times to ensure that the sample is mixed with the acid preservative.
5. While holding the vial upright, gently tap the sample to check for air bubbles (either in the body or especially at the top of the vial).
6. If air bubbles are present, discard the sample and select a new vial in which to recollect a new sample. Repeat Steps 1 - 5 above.
7. Do NOT mix or composite samples for VOAs.
8. Cool sample to a temperature of 4°C (±2°C). Samplers should begin the cooling process in the field as samples are being collected. Double-bagged ice should be used. DO NOT FREEZE WATER SAMPLES.
9. Immediately transfer the vial to the sample shuttle (device that contains a "set" of VOA vials) once it has been collected. Do NOT allow ice to touch the vials.

Perform the Following for *Empty* Vials:

1. Rinse the vial with sample water prior to actual sample collection and preservation.

   Regions vary in their approach to pre-rinsing and/or re-using sample vials (e.g., some Regions do not recommend pre-rinsing and/or re-use of pre-cleaned containers using sample water). Be sure to follow Regional guidance.

2. Add 1-2 mL of acid preservative to the vial. Check to ensure that the sample you are collecting requires a preservative (follow Regional guidance).
3. Pour the sample slowly down the edge of the sample vial to avoid excess aeration and agitation of the sample.
4. Fill the vial completely so that a reverse (convex) meniscus is present and ensure that there are no air bubbles present (either in the body or especially at the top of the vial).
5. Place the septum on the vial so that the PTFE side is in contact with the sample, and then firmly tighten the cap.
6. Gently flip the vial a few times to ensure that the sample is mixed with the acid preservative.
7. While holding the vial upright, gently tap the vial to check for air bubbles (either in the body or especially at the top of the vial).
8. If air bubbles are present, discard the sample and recollect a new sample using the same sample vial. Repeat Steps 1 - 7 above.
9. Check the recollected sample for air bubbles. If air bubbles are present, additional sample water may be added to the vial to eliminate air bubbles. If there are air bubbles after three consecutive attempts to eliminate air bubbles by the addition of sample water, the entire sample and sample vial should be discarded and a new sample collected.
10. Do NOT mix or composite samples for VOAs.
11. Cool sample to a temperature of 4°C (±2°C). Samplers should begin the cooling process in the field as samples are being collected. Double-bagged ice should be used. DO NOT FREEZE WATER SAMPLES.
12. Immediately transfer the vial to the sample shuttle (device which contains a “set” of VOA vials) once it has been collected. Do NOT allow ice to touch the vials.

Things to Remember:

- Samples must be shipped as soon as possible, preferably on the same day as sample collection to avoid exceeding sample holding times. If overnight transit is not possible, samples should be maintained at 2 - 4°C until they are shipped to the laboratory.
- If samples are not preserved (a requirement for certain analytes), the technical holding time is shortened to 7 days.

Appendix D: Sampling Techniques and Considerations

During a sampling event, the sampler is expected to follow prescribed sampling techniques. The sampler should also be aware of any special sampling considerations, contaminant issues, and sample compositing and mixing methods that could affect their sampling efforts.

Note: Regional guidance will take precedence over any of the techniques and considerations listed below.

D.1 General Sampling Techniques

Information regarding surface water, sediment, soil, and groundwater sampling can be found in many documents including, but not limited to, the following sources:

- Compendium of ERT Surface Water and Sediment Sampling Procedures, EPA/540/P-91/005;
- Compendium of ERT Soil Sampling and Surface Geophysics Procedures, EPA/540/P-91/006;
- Compendium of ERT Groundwater Sampling Procedures, EPA/540/P-91/007;
- Quality Assurance Sampling Plan for Environmental Response (QASPER) software, Version 4.1, ERT; and
- *Requirements for the Preparation of Sampling and Analysis Plans*; United States Army Corps of Engineers, February 1, 2001, EM 200-1-3.

When working with potentially hazardous materials, samplers should follow USEPA and OSHA requirements, specific health and safety procedures, and DOT requirements.

D.2 Special Sampling Considerations

Samplers should refer to Regionally-developed SOPs to obtain specific procedures for properly collecting and preserving samples in the field. For additional guidance regarding sampling for VOAs in soil and water, see Appendices B and C. Samplers should obtain Regional guidance when testing and ameliorating for:

- Carbonates in VOA soil and water;
- Residual chlorine in VOA soil and water, or cyanide water;
- Oxidants in VOA soil and water; or
- Sulfides in cyanide.

D.3 Contaminant Sampling

Certain compounds can be detected in the parts-per-billion (ppb) and/or parts-per-trillion (ppt) range. Extreme care MUST be taken to prevent cross-contamination of these samples. The following precautions should be taken when trace contaminants are a concern:

- Disposable gloves should be worn each time a different location is sampled.
- When collecting both surface water and sediments, surface water samples should be collected first. This reduces the chance of sediment dispersal into surface water, and the resulting loss of surface water sample integrity.
- Sampling should occur in a progression from the least to the most contaminated area, if this information is known to the sampling team.
- Samplers should use equipment constructed of PTFE, stainless steel, or glass that has been properly pre-cleaned for collection of samples for trace organic and/or inorganic analyses. Equipment constructed of plastic or polyvinyl chloride (PVC) should NOT be used to collect samples for trace organic compound analyses.
- Equipment constructed of stainless steel should NOT be used to collect samples for trace metals analysis.

D.4 Sample Compositing

Sample compositing is a site-specific activity that must be conducted according to the SAP. Compositing is typically used for large sites under investigation to improve the precision (i.e., lower the variance) of the estimated average contaminant concentrations. **Samples for VOA analysis should NOT be composited to minimize loss of VOAs/analytes.**

Composite samples consist of a series of discrete grab samples that are mixed together to characterize the average composition of a given material. The discrete samples are usually of equal volume, but may be weighted to reflect an increased flow or volume. Regardless, all discrete samples must be collected in an identical manner and the number of grab samples forming a composite should be consistent. There are several compositing techniques that may be required such as:

- Flow-proportioned – Collected proportional to the flow rate during the compositing period by either a time-varying/constant volume or a time-constant/varying volume method. This technique is usually associated with wastewater or storm water runoff sampling.
- Time – Composed of a varying number of discrete samples collected at equal time intervals during the compositing period. This technique is typically used to sample wastewater and streams, and in some air sampling applications.
- Areal – Collected from individual grab samples collected in an area or on a cross-sectional basis. Areal composites are comprised of equal volumes of grab samples where all grabs are collected in an identical manner. This technique is typically used for estimating average contaminant concentrations in soils or sediments. This technique is useful when contaminants are present in nugget form (i.e., TNT chunks, lead shot, etc.), thus exhibiting large differences in concentration over a small sample area.
- Vertical – Collected from individual grab samples but taken from a vertical cross section. Vertical composites are comprised of equal volumes of grab samples where all grab samples are collected in an identical manner. Examples would include vertical profiles of a soil borehole or sediment columns.
- Volume – Collected from discrete samples whose aliquot volumes are proportional to the volume of sampled material. Volume composites are usually associated with hazardous waste bulking operations where the sample represents combined or bulked waste.

When compositing solid samples (i.e., sediment, soil, or sludge) for analysis of compounds present in trace quantities, use a stainless steel or PTFE bowl and spatula.

D.5 Sample Mixing and Homogenizing

Mixing of the sample for the remaining parameters is necessary to create a representative sample media. It is extremely important that solid samples be mixed as thoroughly as possible to ensure that the sample is as representative as possible of the sample location. Please refer to the project-specific SAP regarding instructions on removal of any extraneous materials (e.g., leaves, sticks, rocks, etc.). The mixing technique will depend on the physical characteristics of the solid material (e.g., particle size, moisture content, etc.). The mixing container should be large enough to hold the sample volume and accommodate the procedures without spilling. Both the mixing container (generally a bowl or tray) and the mixing implement should be properly decontaminated before use. Samples should be homogenized according to procedures listed in the project-specific SAP.

Samples for VOA analysis should not be mixed to minimize loss of volatile analytes.

Table D-1 provides a short procedure for mixing a soil sample with a small particle size (less than 1/4 in) and filling sample containers in the field.

Table D-1. Mixing a Sample and Filling Sample Containers

Step	Action
1	Roll the contents of the compositing container to the middle of the container and mix.
2	Quarter the sample and move to the sides of the container.
3	Mix each quarter individually, then combine and mix OPPOSITE quarters, then roll to the middle of the container.
4	Mix the sample once more, and then quarter the sample again.
5	Mix each quarter individually, then combine and mix ADJACENT corners, then roll to the middle of the container. The goal is to achieve a consistent physical appearance before sample containers are filled.
6	Flatten piled material into an oblong shape.
7	Using a flat-bottomed scoop, collect a strip of soil across the entire width of the short axis and place it into a sample container.
8	Repeat Step 7 at evenly-spaced intervals until the sample containers are filled.
9	Record the approximate quantity of each subsample in the field log book.

Appendix E: Sampling Checklists

Appendix E-1: Personnel Preparation Checklist

(Page 1 of 1)

Personnel Briefing	Yes	No	Comments:
1. Did you review sampling team responsibilities and identify individual(s) responsible for corrective actions?			
2. Did you ensure that you have met the appropriate personal safety and protection requirements?			
3. Did you identify sampling locations and receive permission to access them, as appropriate?			
4. Did you contact the appropriate utility companies PRIOR to the start of sampling? Note: By law, utility companies must be contacted prior to the start of digging/sampling so that any underground utilities (gas lines, water lines, electrical lines, etc.) can be marked. A list of one-call centers for each state may be found at: http://www.digsafely.com/contacts.htm.			
5. If sampling on private property, do you have sample receipts to provide to the property owner for all samples taken and removed from the property?			
6. Have you determined the number and type of samples to be collected?			
7. Did you review sample collection methods?			
8. Have you reviewed sample container requirements?			
9. Did you review decontamination requirements, procedures, and locations?			
10. Did you determine holding times and conditions?			
11. Did you determine Performance Evaluation (PE) and Quality Control (QC) sample requirements?			
12. Have you obtained shipping cooler temperature blanks, if required?			
13. Did you review sample label and tag requirements?			
14. Did you review Traffic Report/Chain of Custody (TR/COC) Record and custody seal requirements?			
15. Have you obtained the laboratory name, shipping addresses, and telephone number?			
16. Did you review cooler return instructions?			
17. Have you obtained shipping company information (name, telephone number, account number, pickup schedule)?			
18. Have you obtained shipping schedules?			
19. Did you review shipment reporting requirements and the appropriate contact names and telephone numbers for reporting?			
20. Have you included any sampler comments regarding sampling issues (e.g., low volumes, matrix, suspected concentrations based on field measurements)?			

Appendix E-2: General Sample Collection Checklist

(Page 1 of 1)

General Sample Collection	Yes	No	Comments:
1. Did you identify and mark the sampling location with buoys, flags, or stakes according to the sampling plans, maps, and grids?			
2. If the sampling location is inaccessible, did you contact the appropriate field or Regional personnel for instructions?			
3. Did you use the correct sampling equipment?			
4. Did you follow the correct decontamination procedures?			
5. Did you follow the correct collection procedures?			
6. Did you use the correct sample containers for each sample collected?			
7. Did you collect the correct volume for each sample?			
8. Did you collect the correct type of sample, including primary samples and Quality Control (QC) samples?			
9. Did you properly preserve each sample collected?			
10. Did you correctly document and label each sample with all necessary information? Under no circumstances should the site name appear on any documentation being sent to the laboratory.			
11. If sampling on private property, did you provide a sample receipt to the owner of the property for all samples taken and removed from the property?			

Appendix E-3: Completing Field Logbook Checklist

(Page 1 of 1)

Completing Field Logbook	Yes	No	Comments:
1. Did you use waterproof ink when writing in the field logbook?			
2. Did you document sampling project information such as: • Project name, ID, and location; • Names of samplers; • Geological observations, including maps; • Atmospheric conditions; • Field measurements; and • Sampling dates, times, and locations? Under no circumstances should the site name appear on any documentation being sent to the laboratory.			
3. Did you record sampling activity information such as: • Sampling dates and times; • Sample identifications; • Sample matrices; • Sample descriptions (e.g., odors and/or colors); • Number of samples taken; • Sampling methods/equipment; and • Description of QC samples?			
4. Did you document any and all deviations from the sampling plan?			
5. Did you document any and all difficulties in sampling and/or any unusual circumstances?			
6. Were all errors corrected by crossing a line through the error, initialing the error, dating the error, and then adding the correct information?			

Appendix E-4: Completing Handwritten Sample Labels Checklist

(Page 1 of 1)

Completing Handwritten Sample Labels	Yes	No	Comments:
1. Did the Region provide CLP Sample Numbers and SMO-assigned Case Numbers?			
2. If additional CLP Sample Numbers were needed, did you contact the appropriate Regional personnel?			
3. Were the CLP Sample Numbers and SMO-assigned Case Numbers on the labels correct? Organic CLP Sample Numbers begin with the Regional letter code, followed by letters and numbers. Inorganic CLP Sample Numbers begin with "M", followed by the Regional letter code, and then letters and numbers. Note: The following characters are not used in generating CLP Sample Numbers and should never appear on any paperwork send to the laboratory: I; O; U; and V. Also, the last character of a CLP Sample Number will never be a letter.			
4. Were samples uniquely numbered and designated to only one sample? Note: Samples collected for total metal and dissolved metal analyses must receive separate, unique, CLP Sample Numbers.			
5. Were Quality Control (QC) samples numbered accordingly?			
6. Were the specific requirements followed for total and dissolved metals analysis, QC and Performance Evaluation (PE) samples, and SW-846 Method 5035A?			
7. Were all temperature blanks labeled with "TEMPERATURE BLANK"?			
8. Was a sample label containing the CLP Sample Number, SMO-assigned Case Number, location, concentration, preservative, and the fraction/analysis, attached to each sample bottle or container as the sample was collected? Under no circumstances should the site name appear on any documentation being sent to the laboratory.			
9. Was clear tape placed over the sample labels to protect the labels from moisture and to help the labels adhere to the sample bottle?			
10. Were all errors corrected by crossing a line through the error, initialing the error, dating the error, and then adding the correct information?			

Appendix E-5: Completing Handwritten Sample Tags & Custody Seals Checklists

(Page 1 of 1)

Completing Handwritten Sample Tags		Yes	No	Comments:
1.	Was waterproof ink used on the sample tags?			
2.	If Regionally required for individual sample containers, was the project code on the sample tag completed?			
3.	Was the station number on the sample tag completed?			
4	Was the date filled in using the format MM/DD/YYYY?			
5.	Was the time of sample collection indicated in military time format HH:MM?			
6.	Was the box checked indicating composite or grab sample?			
7.	Was the station location on the sample tag completed?			
8.	Did you indicate whether or not the sample was preserved by checking “yes” or “no?”			
9.	Was the appropriate analysis indicated on the sample tag?			
10.	Were the appropriate CLP Sample Number and SMO-assigned Case Number indicated and cross-referenced with the numbers on the sample label?			
11.	Did you sign the sample tags?			
12	Did you attach the sample tag to the neck of the sample bottle with striang, stretch string, or wire (recommended method)? Do **NOT** use wire to attach a sample tag to a metal sample.			
13.	Were all errors corrected by crossing a line through the error, initialing the error, dating the error, and then adding the correct information?			

Completing Custody Seals		Yes	No	Comments:
1.	Did you sign and date the custody seal?			
2.	Did you attach a completed custody seal to the sample bottle, container, or plastic bag, placing the seal over the cap or lid of each sample bottle or container or on the bag opening such that it will be broken if the sample bottle, container, or bag is opened or tampered with?			
3.	As appropriate, did you attach the completed custody seal to the sample shipping container or cooler, placing the seal such that it will be broken if the container or cooler is opened or tampered with?			
4.	Were all errors corrected by crossing a line through the error, initialing the error, dating the error, and then adding the correct information?			

Appendix E-6: Packing Sample Container Checklist

(Page 1 of 1)

Packing Sample Container	Yes	No	Comments:
1. Did you follow all State, Federal, Department of Transportation (DOT), and International Air Transportation Association (IATA) regulations governing the packaging of environmental and hazardous samples? Note: If samples contain methanol preservation (e.g., samples to be analyzed by SW-846 Method 5035A), refer to the packaging instructions in Appendix A.			
2. Were all CLP Sample Numbers, SMO-assigned Case Numbers, fractions/analyses, labels, tags, and custody seals attached to the correct sample containers?			
3. Was an inventory conducted of CLP Sample Numbers, SMO-assigned Case Numbers, fractions/analyses, and containers, and verified against the TR/COC Records?			
4. Were the correct number and type of Performance Evaluation (PE) and Quality Control (QC) samples collected?			
5. Were all sample containers sealed in clear plastic bags with the sample label and tag visible through the packaging?			
6. Were all soil/sediment samples known to contain dioxin securely enclosed in metal cans (e.g., paint cans) with the lids sealed?			
7. Was suitable absorbent packing material placed around the sample bottles or containers?			
8. Were the outsides of metal containers labeled properly with the CLP Sample Number, SMO-assigned Case Number, and the fraction/analysis of the sample inside?			

Appendix E-7: Packing Shipping Container Checklist

(Page 1 of 1)

Packing Shipping Container	Yes	No	Comments:
1. Were you shipping samples in a clean waterproof metal or hard plastic ice chest or cooler in good condition?			
2. Were all non-applicable labels from previous shipments removed from the container?			
3. Were all inside and outside drain plugs closed and covered with suitable tape (e.g., duct tape)?			
4. Was the inside of the cooler lined with plastic (e.g., large heavy-duty garbage bag)?			
5. Was the lined shipping cooler packed with noncombustible absorbent packing material?			
6. Were sample containers placed in the cooler in an upright position not touching one another?			
7. Was a sample shipping cooler temperature blank included in the cooler?			
8. Did the documentation in the cooler only address the samples in that cooler?			
9. Was the site name absent from all documentation? Under no circumstances should the site name appear on any documentation being sent to the laboratory.			
10. Was there sufficient packing material around and in between the sample bottles and cans to avoid breakage during transport?			
11. If required, was double-bagged ice placed on top and around sample bottles to keep the samples cold at 4°C (± 2° C)? Note Do Not Pack Loose Ice Into the Cooler!			
12. Was the top of the plastic liner fastened and secured with tape?			
13. Was a completed custody seal placed around the top of the fastened plastic liner (if required by the Region)?			
14. Were all sample documents enclosed within the cooler (e.g., TR/COC Record and cooler return instructions) in a waterproof plastic bag?			
15. Was the plastic bag, containing the documentation, taped to the underside of the cooler lid?			
16. Were cooler return instructions and airbills, if required, taped to the underside of the cooler lid?			
17. Was the return address of the cooler written with permanent ink on the underside of the cooler lid?			
18. Was tape placed around the outside of the entire cooler and over the hinges?			
19. Were the completed custody seals placed over the top edge of the cooler so the cooler cannot be opened without breaking the seals?			
20. Was the return address label attached to the top left corner of the cooler lid?			
21. Were instructional labels attached to the top of the cooler, as necessary (e.g., “This End Up,” “Do Not Tamper With,” or “Environmental Laboratory Samples”)?			
22. If shipping hazardous samples, were the correct labels attached to the cooler (e.g., “Flammable Liquids”, “Caution”, or “Poison”)?			
23. If shipping samples containing methanol as a preservative (e.g., samples to be analyzed by SW-846 Method 5035A), was a label used to indicate methanol, the United Nations (UN) identification number for methanol (UN 1230), and Limited Quantity?			

Appendix E-8: Shipping & Reporting CLP Samples Checklist
(Page 1 of 1)

Shipping CLP Samples	Yes	No	Comments:
1. Did you follow all State, Federal, Department of Transportation (DOT), and International Air Transportation Association (IATA) regulations governing the shipment of environmental and hazardous samples?			
2. Was a separate airbill filled out for each cooler being shipped?			
3. Was the airbill filled out completely, including correct laboratory name, address, and telephone number, identification of recipient as "Sample Custodian," and appropriate delivery option (e.g., overnight or Saturday)?			
4. Was the completed airbill attached to the top of the cooler with the correct laboratory address?			
5. If more than one cooler was being shipped to the same laboratory, were they marked as "1 of 2," "2 of 2," etc.?			
6. Were the samples being shipped "overnight" through a qualified commercial carrier?			
Reporting CLP Samples	**Yes**	**No**	**Comments:**
1. Did you contact the Contract Laboratory Program Sample Management Office (SMO) on the same day samples were shipped?			
2. If the samples were shipped after 5:00 PM Eastern Time (ET), were they reported to the RSCC (or designee) or to SMO by 8:00 AM ET the following business day?			
3. Did you notify the RSCC (or designee) or SMO so that SMO will receive the delivery information by 3:00 PM ET on Friday for sample shipments that will be delivered to the laboratory on Saturday?			
4. Did you provide the RSCC (or designee) or SMO with: • Your name, phone number, and Region number; • Case Number of the project; • Exact number of samples, matrix(ces), concentration(s), and type of analysis; • Laboratory(ies) to which the samples were shipped; • Carrier name and airbill number; • Date of shipment; • Date of next shipment; and • Any other information pertinent to the shipment?			

Appendix F: Glossary

Analyte -- The element, compound, or ion that is determined in an analytical procedure; the substance or chemical constituent of interest.

Analytical Services Branch (ASB) -- Directs the Contract Laboratory Program (CLP) from within the United States Environmental Protection Agency's (USEPA's) Office of Superfund Remediation and Technology Innovation (OSRTI) in the Office of Solid Waste and Emergency Response (OSWER).

Aroclor -- Polychlorinated biphenyls (PCBs) or a class of organic compounds with 1 to 10 chlorine atoms attached to biphenyl and a general chemical formula of $C_{12}H_{10-x}Cl_x$. PCBs, commercially produced as complex mixtures containing multiple isomers at different degrees of chlorination, were marketed in North America under the trade name Aroclor.

Case -- A finite, usually predetermined, number of samples collected over a given time period from a particular site. Case Numbers are assigned by the Sample Management Office (SMO). A Case consists of one or more Sample Delivery Groups (SDGs).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) -- Initiated in December 1980, CERCLA provided broad federal authority to respond directly to the release or possible release or hazardous substances that may endanger human health or the environment. CERCLA also established a trust fund to provide for cleanup when no responsible party could be identified; hence CERCLA is commonly referred to as "Superfund".

Contract Laboratory Program (CLP) -- A national program of commercial laboratories under contract to support the USEPA's nationwide efforts to clean up designated hazardous waste sites by providing a range of chemical analytical services to produce environmental data of known and documented quality. This program is directed by USEPA's Analytical Services Branch (ASB).

Contract Laboratory Program Project Officer (CLP PO) -- Monitors technical performance of the contract laboratories in each Region.

Contract Laboratory Program Sample Management Office (CLP SMO) -- A contractor-operated facility operated under the CLP, awarded and administered by the USEPA, which provides necessary management, operations, and administrative support to the CLP. SMO coordinates and schedules sample analyses, tracks sample shipments and analyses, receives and tracks data for completeness and compliance, and processes laboratory invoices.

Custody Seal -- An adhesive label or tape that is used to seal a sample bottle or container that maintains chain-of-custody and that will break if the sample bottle or container is opened or tampered with.

Cyanide (Total) -- Cyanide ion and complex cyanides converted to hydrocyanic acid (HCN) by reaction in a reflux system of a mineral acid in the presence of magnesium ion.

Data Quality Objective (DQO) -- The requirements established to maintain the quality of the data being collected.

Data Validation -- Data validation is based on Region-defined criteria and limits, professional judgment of the data validator, and (if available) the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP).

Equipment Blank -- A sample used to check field decontamination procedures. See Field Blank.

Field Blank -- Any blank sample that is submitted from the field. Each field blank is assigned its own unique USEPA Sample Number. A Field Blank checks for cross-contamination during sample collection, sample shipment, and in the laboratory. A field blank includes trip blanks, rinsates, equipment blanks, etc.

Field Duplicate -- Checks reproducibility of laboratory and field procedures and indicates non-homogeneity.

Field Operations Reporting Management System (FORMS) II Lite -- A stand-alone, Windows-based software application that enables samplers to automatically create and generate sample documentation both prior to and during a sampling event.

Field QC Sample -- Used to detect for contamination or error in the field.

Field Sample -- Primary sample material taken out in the field from which other samples, such as duplicates or split samples are derived. A field sample can be prepared in the field and sent for analysis in one or multiple containers, and is identified by a unique EPA Sample Number.

Field Sampling Plan (FSP) -- Developed to outline the actual steps and requirements pertaining to a particular sampling event, and explains, in detail, each component of the event to all involved samplers.

Holding Time -- The elapsed time expressed in hours, days, or months from the date of collection of the sample until the date of its analysis.

> **Contractual** -- The lengths of time that the CLP laboratory must follow to comply with the terms of the contract, and are described in the CLP analytical services Statements of Work (SOWs).
>
> **Technical** -- The maximum lengths of time that samples may be held from time of collection to time of preparation and/or analysis and still be considered valid.

Laboratory Blank -- See Method Blank.

Laboratory Duplicate -- A sample required by the laboratory's contract to check the precision of inorganic analyses.

Laboratory QC Sample -- An additional volume of an existing sample, as required by the laboratory's contract, used to detect contamination or error in the laboratory's practices.

Matrix -- The predominant material of which a sample to be analyzed is composed.

Matrix Spike (MS) -- Sample required by the laboratory's contract to check the accuracy of organic and inorganic analyses. It is an aliquot of a sample (water or soil) that is fortified (spiked) with known quantities of a specific compound and subjected to the entire analytical procedure. See Matrix Spike Duplicate.

Matrix Spike Duplicate (MSD) -- Sample required by the laboratory's contract to check the accuracy and precision of organic analyses. It is a second aliquot of the same matrix as the Matrix Spike (MS) that is spiked to determine the precision of the method. See Matrix Spike.

Method Blank -- An analytical control consisting of all reagents, internal standards and surrogate standards [or System Monitoring Compounds (SMCs) for volatile organic analysis], that is carried throughout the entire analytical procedure. The method blank is used to define the level of laboratory, background, and reagent contamination, also referred to as laboratory blank when defining the level of laboratory contamination.

Performance Evaluation (PE) Sample -- A sample of known composition provided by the USEPA for contractor analysis. Used by USEPA to evaluate contractor performance.

Pesticides -- Substances intended to repel, kill, or control any species designated a "pest", including weeds, insects, rodents, fungi, bacteria, and other organisms. Under the CLP, only organochlorine pesticides are analyzed (e.g., DDT, Dieldrin, Endrin, etc.).

Polychlorinated Biphenyls (PCBs) -- A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as a lubricant. The sale and new use of PCBs were banned by law in 1979.

Quality Assurance (QA) -- An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Assurance Project Plan (QAPP) -- Document written to meet requirements outlined in the document *EPA Guidance for Quality Assurance Project Plans* (EPA QA/R-5). Prepared in advance of field activities and used by samplers to develop any subsequent plans such as the Sampling Analysis Plan (SAP) or the Field Sampling Plan (FSP).

Quality Control (QC) -- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.

Regional Sample Control Center (RSCC) Coordinator -- In most Regions, coordinates sampling efforts and serves as the central point-of-contact for sampling questions and problems. Also assists in coordinating the level of Regional sampling activities to correspond with the monthly projected demand for analytical services.

Regional Site Manager -- Coordinates the development of data quality objectives and oversees project-specific remedial or removal contractors, State officials, or private parties conducting site sampling efforts.

Rinse Blank -- A sample used to check decontamination procedures. Also see Field Blank.

Routine Analytical Service (RAS) -- The standard inorganic and organic analyses available through the CLP.

Sample -- A discrete portion of material to be analyzed that is contained in single or multiple containers, and identified by a unique Sample Number.

Sample Delivery Group (SDG) – A unit within a sample Case that is used to identify a group of samples for delivery. An SDG is defined by the following, whichever is most frequent:

- Each Case of field samples received; or
- Each 20 field samples (excluding PE samples) within a Case; or
- Each 7 calendar day period (3 calendar day period for 7-day turnaround) during which field samples in a Case are received (said period beginning with the receipt of the first sample in the SDG).

In addition, all samples and/or sample fractions assigned to an SDG must have been scheduled under the same contractual turnaround time. Preliminary Results have no impact on defining the SDG. Sample may be assigned to SDGs by matrix (e.g., all soil samples in one SDG, all water samples in another) at the discretion of the laboratory.

Sample Label -- An identification label attached to a sample bottle or container to identify the sample.

Sample Number -- A unique number used to identify and track a sample. This number can be recorded on a sample label or written on the sample bottle or container using indelible ink.

Sample Tag -- A tag attached to a sample that identifies the sample and maintains chain-of-custody.

Sampling Analysis Plan (SAP) -- A document that explains how samples are to be collected and analyzed for a particular sampling event.

Semivolatile Organic Analyte (SVOA) -- A compound amenable to analysis by extraction of the sample using an organic solvent.

Statement of Work (SOW) -- A document that specifies how laboratories analyze samples under a particular Contract Laboratory Program (CLP) analytical program.

Superfund -- The program operated under the legislative authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act (SARA) that funds and carries out USEPA removal and remedial activities at hazardous waste sites. These activities include establishing the National Priorities List (NPL), investigating sites for inclusion on the list, determining their priority, and conducting and/or supervising cleanup and other remedial actions.

Superfund Amendments and Reauthorization Act (SARA) -- The 1986 amendment to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Traffic Report/Chain of Custody (TR/COC) Record -- A record that is functionally similar to a packing slip that accompanies a shipment of goods. Used as physical evidence of sample custody and functions as a permanent record for each sample collected.

Trip Blank -- A sample used to check for contamination during sample handling and shipment from field to laboratory. Also see Field Blank.

Volatile Organic Analyte (VOA) -- A compound amenable to analysis by the purge-and-trap technique. Used synonymously with the term purgeable compound.

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Appendix D

Field Forms

PHOTOLOG

SITE NAME: ________________________________

CAMERA # ____

Photograph #	Description	Date/Time	Photographer

REV 5/01

EQUIPMENT CALIBRATION LOG

SITE NAME: ____

Instrument (Name/Model No./Serial No.): ____

Manufacturer: ____

Calibration Date	Initial Setting	Standard/ Gas Used (Concentration)	Lot Control No. Expiration Date	Adjustments Made	Final Reading	Comments Pass/Fail	Signature

SOIL AND WASTE ROCK SAMPLING FIELD DATA SHEET

PROJECT:_______________________________________ DATE:_________________

FIELD PERSONNEL:_____________________________WEATHER: ____

Time	General Location Description	Location ID	Lithology Description	pH (su)	Conductivity (µS/cm)	Lab Sample Collected?

SURFACE WATER SAMPLING FIELD DATA SHEET

PROJECT:_______________ DATE:__________ LOCATION ID:_______________

FIELD PERSONNEL:_______________ WEATHER: _______________

FIELD MEASUREMENTS:

Time	Flow (Calculate or Estimate)	Temp (^{O}C)	pH (su)	Conductivity (µS/cm)	ORP (mV)	DO (mg/L)	Ferrous Iron	Alkalinity

FLOW MEASUREMENT AND CALCULATION:

FLOW MEASUREMENT METHOD:_______________

STREAM WIDTH (FT):_______________ VELOCITY MEASUREMNT POINT SPACING (FT):_______________

PORTABLE FLUME WATER DEPTH (FT OR IN):_______________

Stream Point #	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Stream Point Distance (ft)										
Stream Point Depth (ft)										
Velocity										

SAMPLES COLLECTED: Type of Sample: _______________

Sample Identification	Time	Size/Number of Container(s)	Preservative

COMMENTS:

____
____
____
____
____

SYNOPTIC WATER LEVEL FIELD DATA SHEET

PROJECT:____ DATE:__________________

FIELD PERSONNEL:______________________________WEATHER: ____

Date	Time	Well ID	Depth to Water	Total Depth	Thickness of any Floating Product	HNu Readings

All readings are from Top of Inner Casing (TIC)

GROUNDWATER PURGING AND SAMPLING FIELD DATA SHEET

PROJECT:______________________________________ DATE:__________ WELL ID:__________________________

FIELD PERSONNEL:____________________________WEATHER: ____

FIELD MEASUREMENTS:

A. Depth to Water (DTW) below top of casing/piezometer: ______________________ Ft. or In.
B. Thickness of Free NAPL, if present: ______________________ Ft. or In.
C. Total Depth of Well (TD) from top of casing/piezometer: ______________________ Ft. or In.
D. Height of Water Column in casing (H = TD – SWL): ______________________ Ft. or In.
E. **Useful approximate Purge Volumes (PV) per foot of water column for common casing sizes:**

	3 Well Vols	5 Well Vols				
2" diameter	= 0.5 gals/ft	0.82 gals/ft	X	feet of water ____________	= _____________	PV (gallons)
4" diameter	= 2.0 gals/ft	3.25 gals/ft	X	feet of water ____________	= _____________	PV (gallons)
6" diameter	= 4.4 gals/ft	7.35 gals/ft	X	feet of water ____________	= _____________	PV (gallons)

PURGING METHOD: _____________________________ DURATION: _______________________________

OBSERVATIONS:

Well Purge Vol	Time	DTW (ft)	Temp (^{O}C)	pH (su)	Conductivity (µS/cm)	ORP (mV)	DO (mg/L)	Turbidity
1st Vol								
2nd Vol								
3rd Vol								
4th Vol								
5th Vol								

*****ESTIMATED TOTAL VOLUME OF WATER PURGED FROM WELL**: ___________________________________
PURGE WATER STORED/DISPOSED OF WHERE/HOW: ____

SAMPLES COLLECTED: Depth to Water at time of sample collection: ____________________________________

Sample Identification	Time	Size/Number of Container(s)	Preservative	Field Ferrous Iron	Field Alkalinity

COMMENTS:

____
____
____

RECHARGE CALCULATION AT TIME OF SAMPLE COLLECTION:

Casing Capacities:
2-inch hole …..…. 0.16 gal/lin ft.
4-inch hole …..…. 0.65 gal/lin ft.
6.5 inch hole …... 1.70 gal/lin ft.
8-inch hole …….. 2.60 gal/lin ft.
10-inch hole …… 4.10 gal/lin ft.

Total Depth of Well: __________________________
Original Water Column: ___________ x 0.80 = -- ( )
Collect Sample when Depth to Water Measures
Less than or equal to: ______________________