Field Sampling Plan 2020 Red and Bonita Mine Bulkhead Test Closure

Bonita Peak Mining District San Juan County, Colorado

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Abbreviations and Acronym List

BPMD	Bonita Peak Mining District
CA	Corrective Action
CDM	Camp, Dresser, McKee
CLP	Contract Laboratory Program
COC	Chain of Custody
DQO	Data Quality Objective
EDCD	Electronic Data Collection Device
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
ESAT	Environmental Services Assistance Team
FSP	Field Sampling Plan
GKM	Gold King Mine
GPS	Global Positioning System
HDPE	High-Density Polyethylene
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
MSI	Mountain Studies Institute
MS/MSD	Matrix Spike/Matrix Spike Duplicate
ORD	Office of Research and Development
PQL	Practical Quantitation Limit
PSQ	Principal Study Question
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
R&B	Red and Bonita Mine
REE	Rare Earth Element
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
TAL	Target Analyte List
TOPO	Task Order Project Officer
USFS	United States Forest Service
USFWS	United Stated Fish and Wildlife Service

1.0 INTRODUCTION

This document serves as the Field Sampling Plan (FSP) for the Red & Bonita Mine bulkhead test closure in the Bonita Peak Mining District Superfund site in San Juan County, Colorado (**Figure 1**). The FSP has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) *Bonita Peak Mining District Site-Wide Quality Assurance Plan* (CDM Smith, 2020). This document has been prepared in accordance with the U.S. Environmental Protection Agency (EPA)*Bonita Peak Mining District Site-Wide Quality Assurance Plan* (CDM Smith, 2020) to guide field sampling events for the Red & Bonita Mine bulkhead test closure. Sampling will be conducted in the 2020 field season at the Bonita Peak Mining District (BPMD) Superfund site located in San Juan County, Colorado. This FSP will be used to guide field work that includes monitoring and sampling of key identified sites in the vicinity of the Red & Bonita Mine during the scheduled bulkhead test closure. Mobilization and watershed sampling activities are scheduled to be performed as the following activities (**Table 5**):

> **Monitoring Phase 1-July**: Prior to bulkhead closure, monitoring will occur at 36 locations including surface water, draining mines, seeps and springs, and wells.
>
> **Monitoring Phase 2-August:** Once bulkhead pressure is raised to 200 feet, monitoring will occur at 14 locations including surface water and draining mines.
>
> **Monitoring Phase 3-September:** Monitoring will continue at 36 locations including surface water, draining mines, seeps and springs, and wells.
>
> **Monitoring Phase 4-Post Test Closure:** A synoptic sampling event will occur at 7 locations including surface water and draining mines.
>
> **Weekly:** Inspection of all 36 sites including weekly equipment checks, instrument cleaning, flume scraping, and, instrumentation downloads. On a weekly basis, data will be reviewed for quality assurance and uploaded to EPA's SharePoint and Survey 123.

Dates may be altered depending on weather conditions, river flow conditions, and accessibility to sample locations.

Laboratory analyses for environmental samples collected during these sampling events will include; total recoverable and dissolved metals, alkalinity, anions, stable isotopes, total rare earth elements (REEs), dissolved REEs, and other parameters as needed. Field collected measurements will include water quality parameters, flow measurements, and pressure transducer data.

The remainder of this FSP includes the Data Quality Objectives (DQO) process as it relates to identifying necessary methods and procedures needed to generate data of known quality and specificity. Further, it describes site-specific field sampling methods that will be implemented during the project. This FSP does not detail all sample chemistry analysis processes, data management, storage, and reporting requirements, or project management activities. These elements are described in detail by CDM Smith (2020) *Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado*.

2.0 PROBLEM DEFINITION

The Animas River originates high in the San Juan Mountains in San Juan County, Colorado. This river and associated tributaries flow through the BPMD Superfund site which consists of historic mines or mining-related features where ongoing releases of metal-laden water and sediments occur. The BPMD mine features are located throughout the Mineral Creek, Cement Creek, and Animas River watersheds near Silverton, Colorado. The Animas River flows from these headwater reaches downriver to and through the City of Durango and eventually into the San Juan River in Farmington, New Mexico.

The Red & Bonita Mine is one of 48 mine or mining-related sites on the National Priority List within the BPMD. The Red & Bonita Mine has a bulkhead that was constructed in 2015 to control the adit drainage. The bulkhead's purpose is to flood the mine workings, reduce output in the surrounding drainage, and thereby reduce the contaminant levels being released back into the local water table.

The EPA will conduct a test closure of the Red & Bonita Bulkhead to evaluate the efficacy of the bulkhead's intended purpose once water is impounded behind it. The test closure will also reveal and changes to the surrounding mining-related features, such as changes in flow, seepage, or increase in secondary adit drainage. Monitoring of nearby mine portal changes in discharge will be critical in determining the connective relationship between the workings. Relative hillside seep monitoring will reveal any changes occurring as a result of impounding the mine pool.

3.0 ROLES AND RESPONSIBILITIES

Planning team members, their affiliations, and their roles are:

Christina Progess, EPA RPM – primary decision-maker

Kerry Guy, EPA OSC – primary decision-maker

James Hou, EPA RPM – primary decision-maker

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4.0 OBJECTIVES

Sampling events described herein will be conducted throughout the 2020 Red & Bonita Bulkhead test closure to evaluate the performance of the bulkhead once water is impounded behind it, as well as evaluate the effect of the bulkhead closure on mining structures in the vicinity for changes in flow from adits or seeps. Data generated from these sampling events will be used in accordance with the provisions outlined in the DQOs discussed in Section 5.0 and include:

Stream Gauges

Maintain pressure transducers, water quality meters, and cameras.

Collect stream flow measurements for calibration and confirmation. Download pressure transducer, water quality, and camera data.

Surface Water

Collect surface water samples from key seeps and springs to be analyzed for total recoverable metals, dissolved metals, alkalinity, anions, stable isotopes, and total and dissolved REEs

Capture flow measurements using flumes and other timed flow methods

Collect water quality parameters including pH, conductivity, and temperature

Record site photographs and other supplemental observations

Groundwater Wells

Maintain pressure transducer or multi-parameter sonde

Ensure that satellite telemetry remains active for the duration of the test

Install bladder pump at NFPZ

collect intermittent water samples

Draining Mines

Collect water samples from draining mines to be analyzed for total recoverable metals, dissolved metals, alkalinity, anions, stable isotopes, and total and dissolved REEs

Capture flow measurements using flumes and pressure transducers

Collect water quality parameters including pH, conductivity, and temperature

Record site photographs and other supplemental observations

Dry Mines

Investigate the status of dry mines and adits to verify the presence or absence of flow. If flow is observed at a previously dry site, then water samples and water quality parameters will be collected and flow will be measured.

Record site photographs and other supplemental observations.

Opportunistic Sampling

Surface water: total recoverable and dissolved metals, hardness, alkalinity, anions, and other parameters as needed.

Sediment: total recoverable metals and other parameters as needed

Pore water: total recoverable and dissolved metals, hardness, alkalinity, anions, and other parameters as needed

Other media as needed: surface water flow measurements using flumes, flow meters, or gaging stations

site photographs and other supplemental observations collected for all sampling locations.

GPS data

5.0 DATA QUALITY OBJECTIVES

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 data of specified quality. The process also ensures that the resources required to generate the data are justified. The following are the seven DQO steps.

Step 1: State the Problem

Mine adit discharges of poor water quality and other mining-related sources contribute metal loadings in Cement Creek and the Upper Animas River watersheds. Data is limited about variability and magnitude of stream discharge at key locations in the BPMD and additional data is required to get an understanding of temporal variations of flow into receiving streams and the Animas River.

The Red & Bonita Bulkhead is one of a system of bulkheads in the BPMD designed to hold back drainage in the mine workings, thereby reducing discharge into the watershed and returning the water table to pre-mining conditions. The Red & Bonita Bulkhead has not been in use and its efficacy is unknown. This bulkhead closure test will reveal the structural integrity of the bulkhead and its effects on other mine workings, seeps, and springs in the district that are connected to the Red & Bonita Mine.

The 2020 Red & Bonita Bulkhead monitoring activities will include a process of sampling and measuring flow of key seeps, springs and draining adits in the BPMD site. The data will be used to support the Red & Bonita Bulkhead test closure study.

Step 2: Identify the Goals of the Study

The purpose of this step is to define the Principal Study Questions (PSQs) that this study will attempt to resolve. The PSQs help determine appropriate data inputs and select potential alternative actions. PSQs can be used to develop decision statements when the potential alternative actions have been determined to resolve the problem. In situations where the outcomes may not lead to specific decisions or the information may be used to gain a greater understanding of existing conditions, estimation statements are more appropriate. Estimation statements are more applicable to the nature of the PSQs being investigated herein. The PSQs and associated estimation statements are as follows:

> *The primary goal of this bulkhead test is to evaluate the performance of the Red & Bonita Bulkhead once water is impounded behind it. Results of this investigation will determine if additional grouting or other work is needed before potentially closing the bulkhead permanently.*
>
> *How does closing of the Red & Bonita Mine tunnel bulkhead impact the spatial distribution, flow rates, and magnitude of mining related contaminant from discharges of key seeps, springs, and draining mine adits?*

Monitoring for changes in water quantity and quality at key locations potentially associated with the groundwater system connected to the Red & Bonita Mine discharge before, during, and after a bulkhead test closure will provide information on the overall impacts to surface waters from this activity.

Step 3: Identify the Information Inputs

The purpose of this step is to identify the data required to answer the PSQs listed above in DQO Step 2. The primary information and decision inputs will be data generated from samples, field instruments, and laboratory analyses, as well as established water quality for comparison.

Field parameters and non-sampling objectives include:

- Inspection of all sites – instrument cleaning, flume scraping, photo documentation, changing characteristics, seepage, changes in discharge.
- Stream stage – pressure transducers at each gaging location will measure and record stage information.
- Stream flow data – timing and magnitude of hydrologic outputs across the study area.
- Water quality field parameters (pH, conductivity, and temperature). Analytical laboratory parameters for routine and opportunistic samples will include:
- Total and dissolved TAL metals and hardness (calculated) data;
- Alkalinity and anions;
- Stable isotopes of seeps and springs and draining mines; and
- Total and dissolved REEs of seeps and springs and select draining adits

Step 4: Define the Boundaries

The objective of this step is to identify the pertinent study sites related to the Red & Bonita Bulkhead test closure. The study area boundary comprises Cement Creek, draining and dry mine adits within the vicinity of Red & Bonita Mine, seeps and springs, and tributaries.

Table 5-1 provides location information for all sampling locations.

Sampling activities will start in July 2020 and end in December 2020.

Step 5: Develop the Analytic Approach

In the context of this investigation, EPA will use the environmental media data to determine the presence or absence of mining-related contamination within the specified areas and determine if additional studies are needed to completely characterize the nature and extent of contamination. Ultimately, results will contribute to evaluation of risks at this site to help inform risk management decisions.

Results will be compared to data from previous sampling efforts to characterize potential seasonal and inter-annual variability in water chemistry and loading from these sources as a result of the Red & Bonita Bulkhead closure. Metals data will be used to calibrate and test the loading tool developed by EPA.

Water quality criteria are applied to either total recoverable metals or dissolved metals fractions; therefore, total recoverable and dissolved metals samples will be collected. Many water quality criteria are normalized with respect to water hardness and to a lesser extent pH and other water quality parameters. As such, water hardness will be calculated from calcium and magnesium dissolved metals results and water quality measurements will be taken at the time chemistry samples are collected. Dissolved organic carbon will be collected to calculate aluminum toxicity.

Water samples from seep and spring locations will also be sampled for analysis of REEs. Sample analysis will be conducted at the R.S. Kerr Environmental Research Center (EPA/Groundwater, Watershed, and Ecosystem Restoration Division, Ada, Oklahoma) using Standard Operating Procedures (SOPs) NRMRL-GWERD-13-0 and NRMRL-GWERD-16-0. The REEs, or lanthanide elements, are a group of 14 elements from Lanthanum (atomic number 57) to Lutetium (atomic number 71). Promethium (atomic number 61) is excluded from the REE list because this element does not occur naturally, having no isotope with a half-life of greater than about 20 days. The REEs are useful tracers of water-rock interactions, water mixing, and reduction/oxidation processes; and they are becoming widely utilized in studies of groundwater processes. The data will be used to evaluate whether or not these tools could be useful to delineate sources of groundwater.

Step 6: Specify Performance or Acceptance Criteria

All analytical methods used to chemically analyze surface water samples should have Method Detection Limits (MDLs) or Practical Quantitation Levels (PQLs) suitable for comparison to chronic water quality standards. The BPMD QAPP summarizes MDLs and PQLs for surface water. Surface water chronic criteria provide the lowest and most conservative screening values in which to evaluate sensitivity of analytical chemistry procedures.

In order to mitigate the potential for false positive or false negative errors associated with field sampling, sample collection processes will be consistent with established and relevant EPA SOPs. This includes implementing a decontamination procedure (which may include the use of disposable sampling equipment), use of field blanks, and collection of field duplicate samples (and subsequent analysis using

Relative Percent Difference [RPD] statistics).

Duplicate field samples will be collected to determine sampling precision and the correlation between samples. According to the EPA *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2017), a control limit of 20% for water for the RPD shall be used for original assessment and duplicate sample values that are greater than five times the contract required quantitation limit or PQL. These requirements are laboratory guidelines which may not apply to all field situations but nonetheless will be assessed. RPD results will be included in the SAR and data validation report. RPD values will be calculated using the following equation:

$$RPD = \frac{100*(\text{Assessment Sample Result} - \text{Duplicate Result})}{0.5*(\text{Assessment Sample Result} + \text{Duplicate Result})}$$

Results from field blank samples will be used to verify that sample containers, filters, preservative, and field practices are contaminant free. Since field blank samples are made with clean, contaminant free water, field blank results shall be free of contamination (detections less than the PQL). Refer to Section 6.0 for field QC sample collection frequency.

For laboratory analysis of samples, Quality Assurance/Quality Control (QA/QC) steps (such as the use of laboratory controls, Matrix Spikes and Matrix Spike Duplicates (MS/MSDs), blanks, etc.) will be consistent with EPA Region 8 ESAT and Contract Laboratory Program (CLP) analysis and reporting requirements (EPA, 2016a). Additionally, analytical results will undergo 10% data validation by a third party.

Step 7: Develop the Plan for Obtaining Data

A judgmental sampling design as described in *Guidance for Choosing a Sampling Design for Environmental Data Collection - QA/G-5S* (EPA, 2002) will be used to assist with identification and verification of the sources of contaminants of potential concern. Sampling locations were identified from historical sampling locations and were refined herein to obtain additional information needed to define the nature and extent of contamination and identify any additional sources of contamination. Ongoing evaluation of data collected for the BPMD remedial investigation will be used to identify data gaps and determine opportunistic sampling events as directed by the EPA RPM.

6.0 MEDIA, SAMPLING LOCATIONS, AND SAMPLE QUANTITIES

For each sample, **Table 5-1** details the location name, location description and coordinates, and field activities that will take place in the 2020 Red & Bonita Bulkhead test closure field sampling season. Locations are shown in **Figure 1**. Sampling locations will be verified to the sub-meter using electronic data collection devises (EDCDs) and/or Trimble GPS handheld devices as needed prior to sample collection.

Field duplicate samples will be collected at a rate of one duplicate per 10 assessment samples. Field blank water samples will be collected at a rate of one blank per 20 assessment samples or one per day of sampling for each team collecting samples. Analysis of blank samples will be used to verify that the sample containers, filters, and preservatives are contaminant free.

If there are deviations from this FSP or applicable SOPs, including the decision to not sample a location because conditions are either unsafe or there are accessibility problems, these changes will be recorded in the site-dedicated field notebook or EDCD.

7.0 FIELD ACTIVITIES METHODS AND PROCEDURES

The following subsections describe sampling methods that will be used to collect surface water samples, stream flow data, and water quality parameters. **Attachment 1** of this FSP provides copies of the applicable SOPs that outline how field activities will be performed (including documentation protocols). **Tables 7-1** and **7-2** provide the sampling checklist and field equipment checklist, respectively.

All field data will be recorded in the field using an EDCD to the greatest extent possible. A field notebook will be used if an EDCD is not available or becomes inoperable. EPA SOPs *Field Data Collection Using GPS and Collector for ArcGIS* and *Survey123 for ArcGIS* (EPA, 2017) will be followed when using and entering data into an EDCD. Photographs will also be taken using the EDCD to document notable observations encountered when sampling.

When feasible, sampling should start from the most downstream and proceed to the most upstream sampling locations to avoid cross-contamination in accordance with EPA SOP *Surface Water Sampling* FLD-01.00 (EPA, 2012).

A variety of data will be collected during these events, some of which are critical to achieve the established DQOs and project objectives, and some of which are primarily for informational purposes or that will be used to supplement critical data.

The following chart specifies each type:

Data Type	**Purpose**
Real-time water quality parameters (pH, temperature, and specific conductance)	Informational
Stream flow measurements	Critical
Pressure transducer data	Critical
Surface water (analyzed for dissolved metals and hardness, total recoverable metals, anions, and alkalinity. Seeps and springs samples also analyzed for stable isotopes, and total and dissolved REEs)	Critical
GPS coordinates	Critical
Rain Gage	Informational
Photolog	Informational
General field observations noted in an electronic data collection device	Informational

The EPA RPM or their designee will be responsible for directing Corrective Actions (CAs) if problems are encountered in the field which would impact the way this FSP or the BPMD QAPP are implemented, or if sampling locations are inaccessible. Any problems encountered and actions taken or deviations from this FSP or the BPMD QAPP will be documented in the EDCD or a site-dedicated field notebook.

7.1 Surface, Seep, and Spring Water Sampling

Surface water sampling activities will include collecting in situ water quality measurements and measuring flow rates in accordance with the protocols outlined in the *Hach FH950 User Manual* (Hach, 2018) and EPA SOP 722 *Field Flow Measurements* (EPA, 2006).

Sampling protocols, sample containers, sample labeling and custody, EDCD entries and overall field management requirements for collecting surface water samples are described in the BPMD QAPP (CDM, 2018 or latest approved version), EPA SOPs *Surface Water Sampling* FLD-01.00 (EPA, 2012), *General Field Sampling Protocols* FLD-12.00 (EPA, 2012), *Sample Custody and Labeling* FLD-11.00 (EPA, 2012), and *Sample Preservation* FLD-03.00 (EPA, 2012) (**Attachment 1**).

The surface water samples will be collected as discrete grab samples from each sampling location. All sample bottles will be filled with water in immediate succession of one another. All sample bottles will be new, certified clean, and not be reused between sampling locations. The following is a list of individual samples bottles and handling requirements that will be used for the different analyses:

- Total recoverable metals: 250 mL High Density Polyethylene (HDPE) bottle (not filtered and HNO3 preserved);
- Dissolved metals: 250 mL HDPE bottle (filtered and HNO3 preserved);
- Alkalinity/anions: 250 mL HDPE bottle (not filtered or preserved);
- Stable isotopes: 40 mL glass vial (not filtered or preserved);
- Total REEs: 125mL HDPE bottle (not filtered and HNO3 preserved);
- Dissolved REEs: 125mL HDPE bottle (filtered and HNO3 preserved);
- Dissolved Organic Carbon: 500 mL brown amber glass (not filtered, H_3PO_4 preserved)

Sampling will progress in a manner that will eliminate the potential for sediment disturbance in the stream bed that could result in cross-contamination of subsequent samples. Surface water samples will be collected by immersing an uncapped sample bottle completely beneath the water surface with the mouth of the sample bottle facing upstream. To fill the bottle, the sample container will be inverted and held at approximately a 45-degree angle with the mouth of the bottle facing upstream.

All sample bottles will be filled with surface water and rinsed three times before taking samples. When collecting dissolved metals samples and dissolved REE samples, the total recoverable metals-specific 250 mL HDPE bottle and the total REE-specific 125 mL HDPE bottle will be tripled rinsed, filled, then transferred to and filtered through a Nalgene filter apparatus. The now empty, total recoverable metals bottle and total REE bottle will be refilled with surface water and capped to make the total recoverable metals sample and total REE sample. When required, samples will be preserved in the field as soon after collection as possible. All water samples will be stored in hard-sided coolers with ice at 4˚C when in the field.

A 60 mL disposable syringe may be used to extract water from seeps, areas of pooling, or in areas where water depth is not deep enough to fully submerge the sample bottles. Water collected in this manner will be transferred to the sample container or filter apparatus until the required volume has been collected. Sample bottles and syringes used for sample collection will be new, disposable, and sampling location dedicated; therefore, decontamination is not required.

Field duplicate surface water samples will be collected at a rate of one duplicate for every 10 samples. Duplicate samples will be taken and processed the same way and at the same time as corresponding assessment samples. Duplicate samples will be collected for each sample analysis being performed.

Field blank samples will be collected by pouring deionized water into the same type of bottles for each analysis. All field blank samples will be field filtered and preserved using the same procedures as assessment samples. Field blank samples will accompany all assessment samples, during field deployment and when in storage at the laboratory.

The pH, conductivity, and temperature measurements will be obtained in the field. These field measurements will be taken at each sampling location using a water quality multi-meter according to the provisions outlined in the manufacturer's instructions. In cases where there is not enough water to submerse the multi-meter probe, the multi-meter sample cup will be filled with water from the sample location and readings will be collected soon thereafter. A note will be made in the EDCD when this technique is used, and temperature will be considered as an estimate.

Stream flow measurements will be collected at each surface water location, seep and spring sampling location, as well as at the gaging stations for calibration purposes, see **Table 5-1.** As a safety precaution, flow measurements will only be collected provided conditions are deemed safe based on observed stream conditions. The Field Task Lead or designee will be informed if conditions are too dangerous to collect stream flow data. Flow will be measured following the protocols outlined in the EPA SOP 722 *Field Flow Measurements* (EPA, 2006) and the *Hach FH950 User Manual* (Hach, 2018). All flow measurements will be recorded on the EDCD or field notebook.

7.2 Stream Gages

To capture instantaneous stream conditions, continuous monitoring stations consisting of a pressure transducer, a game camera and a stage card will be installed and maintained at the locations that were selected (**Table 5-1**). The monitoring station equipment will be installed and maintained starting in April 2020 when acquisition of instrumentation is complete. Stage cards and pressure transducers are attached to steel T-posts. Water quality meters will be deployed once available. Since water quality sondes are particularly susceptible to damage if exposed to air, they should be placed in the deepest part of the channel or placed in a stilling well. Rain gauges will be maintained at each stream gauge location and may be used to determine precipitation duration and magnitude in the event of isolated storm events not captured by the primary BPMD weather stations. A game camera will be positioned on a tree or T-post so the water quality meter and stage card are in the camera's field of view. The game camera will be programmed to take one photograph every hour 24 hours a day. These photographs will be used to gap fill stage heights when pressure transducer information is unavailable and to verify instrumentation results when necessary.

7.3 Groundwater Sampling

Routine monitoring of groundwater levels near the Red & Bonita Mine and static water levels behind bulkhead #3 of the American Tunnel, two wells (NFPZ and ATPZ, respectively) will be monitored weekly during the test (Figure 5-1). The continuously recording pressure transducers will be downloaded weekly during the test and can be viewed in real-time on the In-Situ website. Water quality sampling will occur periodically from the two wells using bladder pumps following the EPA SOP *Groundwater Sampling* FLD-04.00 (EPA, 2012). Two groundwater wells on the Red & Bonita fen will be monitored opportunistically throughout the Red & Bonita Bulkhead Test Closure. Water quality sampling of the Red & Bonita fen wells will occur periodically using flow through cell following the EPA SOP *Groundwater Sampling* FLD-04.00 (EPA, 2012).

7.4 Dry and Draining Mine Adit Discharge Monitoring

Routine site visits to instrumented dry and draining mine adits will occur. Routine monitoring will occur at regularly scheduled intervals at the following locations; Adams Mine (SS127), Pride of Bonita (SS128), Adit 1 between Pride of Bonita and Adams Mines (SS129), Solomon Group (SS130), Adit 268-20, Adit 268-21, Adit 2 between Pride of Bonita and Adams Mine (no ID), Gold King Level 7 (CC06), Blackhawk (CC50), Red & Bonita (CC03C), American Tunnel (CC19), South Mogul (SS105), Mogul (CC01B), and Terry Tunnel (A38). Site activities may include scraping and cleaning of flow devices (flumes), inspection of water containment and conveyance infrastructure, snow removal for portal access, downloading of monitoring instruments, and other activities as directed by the EPA OSC or RPM. All downloaded data will be transferred to EPA SharePoint folders and a site conditions report will be provided to the EPA on a monthly basis. Additional support of field activities at these sites may be provided when requested by the EPA OSC.

7.5 Pore Water Sampling

Opportunistic pore water samples may be collected for performance monitoring of remedial or investigation actions, storm events, or other needs identified at the BPMD. It is anticipated that pore water will be collected for dissolved metals but other analyses may be necessary.

Opportunistic pore water samples will be collected by inserting a PushPoint® sampler into the hyporheic zone and purging until the pore water runs clear in accordance with *Pore Water Sampling* SOP FLD-10.00 (ESAT, 2012). The syringe used to extract the pore water will be rinsed three times prior to sample collection with water from the sample location. The water samples pulled into the syringe will be placed in a 250 mL HDPE bottle with an attached filter apparatus. After approximately 250 mL of water has been collected, the sample will be filtered using a 0.45-micron filter. The PushPoint® pore water samplers will be decontaminated between uses in accordance with *Sampling Equipment Decontamination* SOP FLD-02.00 (EPA, 2012).

7.6 Field Equipment

Specific field equipment necessary for execution of this FSP is included in **Table 7-2**. Access to the Gladstone IWTP offices will be maintained in order to perform O&M of the radio and satellite internet communication networks and for access to the internet phone line. Keys for all mine portal gates and any locked infrastructure will be kept available at the Gladstone IWTP.

7.7 Equipment Decontamination

New, certified clean, and disposable sample collection and processing equipment will be used to collect all samples. As such, equipment will be disposed of between sites and does not require decontamination. If reusable sample collection or processing equipment is used, it will be decontaminated before collecting samples between each sampling location.

Decontamination will follow the requirements and procedures described in EPA SOP *Sample Equipment Decontamination FLD-02.00*. Water quality meter probes will not be decontaminated but should be rinsed with clean water between sampling locations.

Decontamination is not required between assessment and field duplicate samples that are collected at the same sampling location.

Table 7-2 provides a list of materials and equipment that will be needed to decontaminate sampling equipment and will be available in the field in case decontamination is required.

7.8 Inspection and Acceptance of Supplies and Consumables

All supplies for this event will be purchased by the EPA from approved vendors. The week prior to the sampling event, a sampling team member will gather needed supplies and consumables, which will subsequently be verified by another team member. Supplies and consumables will be ordered, inspected upon receipt, accepted, tracked, and inventoried. Acceptance of supplies and consumables will be based on the requirements of the end user.

8.0 SAMPLE ANALYSIS

All water samples will be analyzed for total recoverable metals, dissolved metals, alkalinity, and anions. Seep and spring samples will also be analyzed for stable isotopes, tritium, and total and dissolved REEs. The CDM Smith *2020 Quality Assurance Project Plan* summarizes the laboratory analytical instrumentation and methods to be used for water sample analysis. These methods will be in accordance with Method 200.7 *Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry, Revision 4.4* (EPA, 1994a); Method 200.8 *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Revision 5.4* (EPA, 1994b); and Method 245.1 *Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry* (EPA, 1994c). Alkalinity sample analysis will be in accordance with Method 310.1 *Alkalinity by Titration* (EPA, 1978) and anions sample analysis will be in accordance with Method 300.0 *Determination of Inorganic Anions by Ion Chromatography, Revision 2.1* (EPA, 1993).

Total recoverable metals, dissolved metals, and anions and alkalinity samples will be submitted for analysis to EPA Region 8 ESAT laboratory. Samples will be collected, preserved, labeled, and stored in accordance with EPA SOP *General Field Sampling Protocols FLD-12.00*.

Stable isotope samples will be analyzed using U.S. Geological Survey Methods MS007 and MS020 at the Department of Geosciences at the University of Arizona. Tritium will be analyzed using EPA Method 906.0.

Total and dissolved REEs samples will be analyzed by the Office of Research and Development (ORD) laboratories or through ORD contracts.

Sample and hazardous waste disposal at the EPA Region 8 ESAT laboratory will follow the protocol defined in EPA SOP *Laboratory Waste Management 16-LAB-01.02*.

The maximum holding times vary depending on the target analytes or compound, as follows: 180 days for total recoverable metals, dissolved metals, and REEs; 28 days for anions and mercury; 14 days for alkalinity; and one year for stable isotopes. Tritium does not have a holding time.

9.0 DATA AND INFORMATION PROCESSING, STORAGE, AND USE

The data generated from field activities will be managed in accordance with the *U.S. EPA Region 8 Ecosystems Protection and Remediation Data Management Plan* (EPA, 2016b) and the Data Management Checklist (**Attachment 2**). Specific management processes will be followed for data that will be collected during field activities: field equipment calibration and maintenance entries, field logbook entries, Chain of Custody (COC) forms, electronically entered and logged data (such as GPS locations, flow measurements, etc.), and analytical data.

9.1 Field Equipment Calibration and Maintenance Logs

All field equipment calibration and maintenance activities will be documented in a logbook dedicated to each piece of equipment. Logbook entries will be signed and dated by the individual performing calibration or maintenance, or the individual responsible for coordination (such as the Field Task Lead) if equipment is shipped to a manufacturer for repair or maintenance. Field logbooks will be stored with the appropriate piece of equipment.

9.2 Electronic Data Collection Device or Field Logbook and Datasheet Entries

All field measurements and observations will be recorded in the EDCD or bound notebook by the field personnel at the time they are performed. It is anticipated that all field data will be recorded electronically. However, if the electronic device is unavailable or fails then data will be handwritten in the bound notebook. The personnel doing the recording will initial and date each logbook. Corrections to logbook entries will be made by drawing a single line through the error accompanied by the date and the initials of the person performing the correction, followed by the proper entry. All data that is hand-entered into field notebooks and datasheets will be transferred to electronic spreadsheets (such as Microsoft® Excel) to prepare for uploading to Survey 123. Field personnel will perform a 100% verification of spreadsheet entries against hand- entered field logbook and datasheet entries before uploading to EPA SharePoint.

9.3 Chain of Custody Forms

COC forms will be filled out when samples are collected following the protocol outlined in EPA SOP *Sample Custody and Labeling FLD-11.00*. Information entered on the forms during investigation activities will be entered into Scribe when received at the EPA Region 8 Laboratory as a part of the Scribe upload process (see below). ESAT personnel will verify 100% of all the data entered into Scribe against the COC forms completed in the field. Hard copies of these forms will be sent with the shipped samples and stored at the Region 8 ESAT laboratory until relinquished to EPA in accordance with ESAT contract requirements. An electronic copy of all COC forms will be sent to the ESAT laboratory at the time of sample shipment.

9.4 Electronically Entered or Logged Data

In some cases, data may be recorded in the field directly on electronic field forms or using data loggers (such as GPS instrumentation, multi-probe data loggers, and pressure transducers). In these cases, all electronic data logs will be downloaded directly to a spreadsheet (or alternate electronic media depending on specific instrument software requirements), verified against the electronic form used in the field, and processed into an electronic form that can be uploaded directly to Scribe or EPA SharePoint folders. In cases where information must be manually entered into Scribe, ESAT personnel will perform 100% verification between electronic documents and data logs and data manually entered into Scribe.

9.5 Analytical Data

An analytical chemist will log all the samples that come to the ESAT Laboratory into the Laboratory Information Management System (LIMS) upon receipt at the ESAT Region 8 Laboratory. All analytical results will be uploaded into the LIMS in accordance with EPA SOP *Sample Receipt, Custody, Storage and LIMS Data Entry 16-LAB-05.05*. Peer review of the data package, at a 100% frequency of reported versus raw data, will be performed by the analytical laboratory before a final report is released. The final report will be in a standard CLP format, including all laboratory and instrument QA/QC results. The laboratory Electronic Data Deliverable (EDD) will immediately be uploaded into a Scribe project for permanent electronic storage and archiving after the final report is generated. Hard copies of data reports (including bench sheets) will be stored at the Region 8 ESAT Laboratory, until relinquished to EPA in accordance with ESAT contract requirements.

9.6 Scribe Project Generation

As indicated above, all data generated as a part of field investigation activities will be uploaded into a Scribe project (or updated to a Scribe project) and subsequently published to Scribe.net in accordance with the EPA SOP *Data Management for Field Operations and Analytical Support* 16-DAT-01.01 (EPA, 2018). It is anticipated that more data may be collected in the field that supersedes existing or historical data that has already been published (such as GPS locations, etc.) for a specific sampling site. Therefore, before data are published or updated to Scribe projects, ESAT or MSI personnel will perform a 100% verification of each Scribe project against data collected in the field (hand-entered logbook data, electronic forms and data logs) prior to publishing the project on Scribe.net. Verified Scribe projects should be published within one week of delivery of the analytical EDD when possible. In the event that conditions preclude publication within that time period, the TOPO will be notified, and a new publication date will be established.

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Tables

Table 5-1 Bonita Peak Mining District 2020

Red and Bonita Bulkhead Test Closure Site Monitoring Locations, Monitoring Phases, and Frequency of Visits

Location ID	**Site Type**						**Flow**					**Water Quality Parameters**				***Additional Visual Inspection***	
		Description	**Lat**	**Long**	***Flow***	***Pressure Transducer***	***Staff Gauge***	***Camera***	***Bladder Pump***	***Total Metals***	***Dissolved Metals***	***Alkalinity Anions***	***Total REE***	***Dissolved REE***	***Stable Isotopes***		***Monitoring Phase***
CC01B	DM	Mogul Mine	37.90999	-107.638324	Weekly	Weekly				3	3	3	3	3	3	weekly	1,2,3
CC03D	DM	Red and Bonita Mine	37.897231	-107.6437025	Weekly	Weekly				3	3	3	3	3	3	weekly	1,2,3,4
CC06	DM	Gold King Level 7	37.8945686	-107.638355	Weekly	Weekly				3	3	3	3	3	3	weekly	1,2,3,4
CC19	DM	American Tunnel	37.890981	-107.64844	Weekly	Weekly				3	3	3	3	3	3	weekly	1,2,3
SS105	DM	Mogul South Mine	37.90833	-107.638424	Weekly	Weekly				3	3	3	3	3	3	weekly	1,2,3
Adit 2	DRY	Located between Pride of Bonita and Adams	37.901889	-107.6418401	2					2	2	2	2	2	2	weekly	1,3
Adit 268-20	DRY	Located between Adams and Adit 268-21	37.89990	-107.64263	2					2	2	2	2	2	2	weekly	1,3
Adit 268-21	DRY	Located between R&B and Adams	37.898118	-107.642863	2					2	2	2	2	2	2	weekly	1,3
SS127	DRY	Adams Mine	37.9002184	-107.642346	2					2	2	2	2	2	2	weekly	1,3
SS128	DRY	Pride of Bonita Mine	37.9036359	-107.6411956	2					2	2	2	2	2	2	weekly	1,3
SS129	DRY	73m SW of Pride of Bonita Mine	37.903049	-107.641927	2					2	2	2	2	2	2	weekly	1,3
SS130	DRY	Salomon Group	37.8963525	-107.6396136	2					2	2	2	2	2	2	weekly	1,3
SS060	SS	Cement Creek above North Fork	37.906085	-107.642411	2					2	2	2	2	2	2	weekly	1,3
SS061	SS	Cement Creek above North Fork	37.904061	-107.644002	2					2	2	2	2	2	2	weekly	1,3
SS062	SS	Cement Creek above North Fork	37.897621	-107.645047	2					2	2	2	2	2	2	weekly	1,3
SS067	SS	Cement Creek above North Fork	37.896249	-107.646373	2					2	2	2	2	2	2	weekly	1,3
SS069	SS	Cement Creek above North Fork	37.900564	-107.644423	2					2	2	2	2	2	2	weekly	1,3
SS084	SS	North Fork Cement Creek	37.894308	-107.639741	2					2	2	2	2	2	2	weekly	1,3
SS086	SS	Above AT below N Fork	37.894184	-107.647306	2					2	2	2	2	2	2	weekly	1,3
SS236	SS	Cement Creek above North Fork	37.8974294	-107.6459215	2					2	2	2	2	2	2	weekly	1,3
SS250	SS	Cement Creek above North Fork	37.905767	-107.643516	2					2	2	2	2	2	2	weekly	1,3
SS300	SS	Cement Creek above North Fork	37.9058033	-107.6430992	2					2	2	2	2	2	2	weekly	1,3
SS301	SS	Cement Creek above AT	37.8924438	-107.6483408	2					2	2	2	2	2	2	weekly	1,3
A68	SW	Animas River at Silverton (USGS Gage)	37.811967	-107.65867	3					3	3	3	3	3	3	3	1,2,3
A72	SW	Animas River below Silverton (USGS Gage)	37.790351	-107.667461	3					3	3	3	3	3	3	3	1,2,3,4
CC48	SW	Cement Creek at Silverton (USGS Gage)	37.82001	-107.6631	3					3	3	3	3	3	3	3	1,2,3,4
CCSG-1	SW	Cement Creek below Gladstone at Steel Bridge	37.889437	-107.653634	3	3	3	3		3	3	3	3	3	3	weekly	1,2,3,4
CCSG-3	SW	Cement Creek at Gladstone (at culvert)	37.890753	-107.650028	Weekly	Weekly	Weekly	Weekly		3	3	3	3	3	3	weekly	1,2,3,4
CCSG-5	SW	North Fork Cement Creek near mouth	37.895143	-107.646773	Weekly	Weekly	Weekly	Weekly		3	3	3	3	3	3	weekly	1,2,3,4
CCSG-6	SW	Cement Creek above Red & Bonita (immediately above)	37.898244	-107.645899	Weekly	Weekly	Weekly	Weekly		3	3	3	3	3	3	weekly	1,2,3,4
CCSG-7	SW	Cement Creek below Mogul Gage (below braided portion)	37.908354	-107.64227	Weekly	Weekly	Weekly	Weekly		3	3	3	3	3	3	weekly	1,2,3
M34	SW	Mineral Creek at Silverton (USGS Gage)	37.802794	-107.67274	3					3	3	3	3	3	3	3	1,2,3
ATPZ-2	WELL	ATPZ-2	37.893575	-107.6441667	2	Weekly			installed	2	2	2	2	2	2	weekly	1,3
NFPZ-1	WELL	NFPZ	37.8938889	-107.6380556	2	Weekly			pending	2	2	2	2	2	2	weekly	1,3
R&B fen -3	WELL	R&B fen below R&B mine	37.897191	-107.645658	2					2	2	2	2	2	2	weekly	1,3
R&B fen -2	WELL	R&B fen below R&B mine	37.897009	--107.645331	2					2	2	2	2	2	2	weekly	1,3

Table 7-1 Sampling Checklist

Task			Completed
1.	Make sure the necessary paperwork is in place for a field event: Approved LSR, FSP, and QAPP.		
2.	Coordinate sampling dates and times with members of the field team and talk with chemists involved in the project to see if your plans work for them. Coordinate sample delivery with outside laboratories.		
3.	Fill out the necessary paperwork: comp time forms and TAs if travel will be more than 50 miles from the laboratory. Be sure to have reservations made for airlines and hotels if necessary.		
4.	Make necessary arrangements with people outside of the Region VIII laboratory that are involved with the project. Arrange meeting times and places, vehicle needs, sampling teams, additional equipment needs, etc.		
5.	Inform any volunteers outside of the EPA laboratory group what will be involved with sampling - physical stressors, equipment to bring, lunch, water, etc.		
6.	Calibrate meters needed for fieldwork well before leaving. Make sure:		
	a.	pH probes are filled.	
	b.	DO membranes are intact.	
	c.	Spare batteries, calibration logs, and pens are available for each meter.	
	d.	Replace pH and conductivity calibration standards with fresh solution.	
	e.	Condition new probes and replace damaged ones as needed. Buy new equipment from a scientific vendor if necessary.	
7.	Lay out needed sampling equipment in the field room (see attached list).		
8.	Check vehicles: fill with gas, top off windshield wiper fluid, equip with cell phones, radios and chargers.		
9.	Charge batteries for needed sampling equipment one or two nights before leaving: digital camera, hydrolab, GPS units, walkie-talkies, etc.		
10.	Pack vehicles the night before leaving. In the event of hot or cold weather, leave meters and deionized water in the field room and pack the day you leave.		

Table 7-2 Field Equipment Checklist

Water Sample Containers:
- ☑ 250 mL HDPE bottles
- ☑ 250 mL Nalgene filter bottles
  - ☑ vacuum pumps
  - ☑ filter stands
- ☑ 500 mL HDPE bottles
- ☑ 125 mL HDPE bottles
- ☑ Syringe
- ☑ 0.45 µm acrodisc
- ☑ glass vial

Preservative:
- ☑ Nitric acid
- ☑ CaCO3 acid waste container
- ☑ Ice
- ☑ Cooler

Meters:
- ☑ Hach FH950
  - ☑ Tape measure
  - ☑ Batteries
  - ☑ Rebar
- ☑ Flumes
  - ☑ Bubble level
  - ☑ Shovel
- ☑ Water quality meters
  - ☑ Calibration logbook
  - ☑ Cage and calibration cup
  - ☑ pH buffers
  - ☑ Conductivity standard
  - ☑ DI water
  - ☑ Tap water
- ☑ GPS unit w/charger

Stream Gage
- ☑ Pressure Transucer
- ☑ Camera
- ☑ Stage Card
- ☑ T-posts
- ☑ Rain Gauge

Sediment Sampling:
- ☑ Teflon scoops
- ☑ 4 oz glass jar

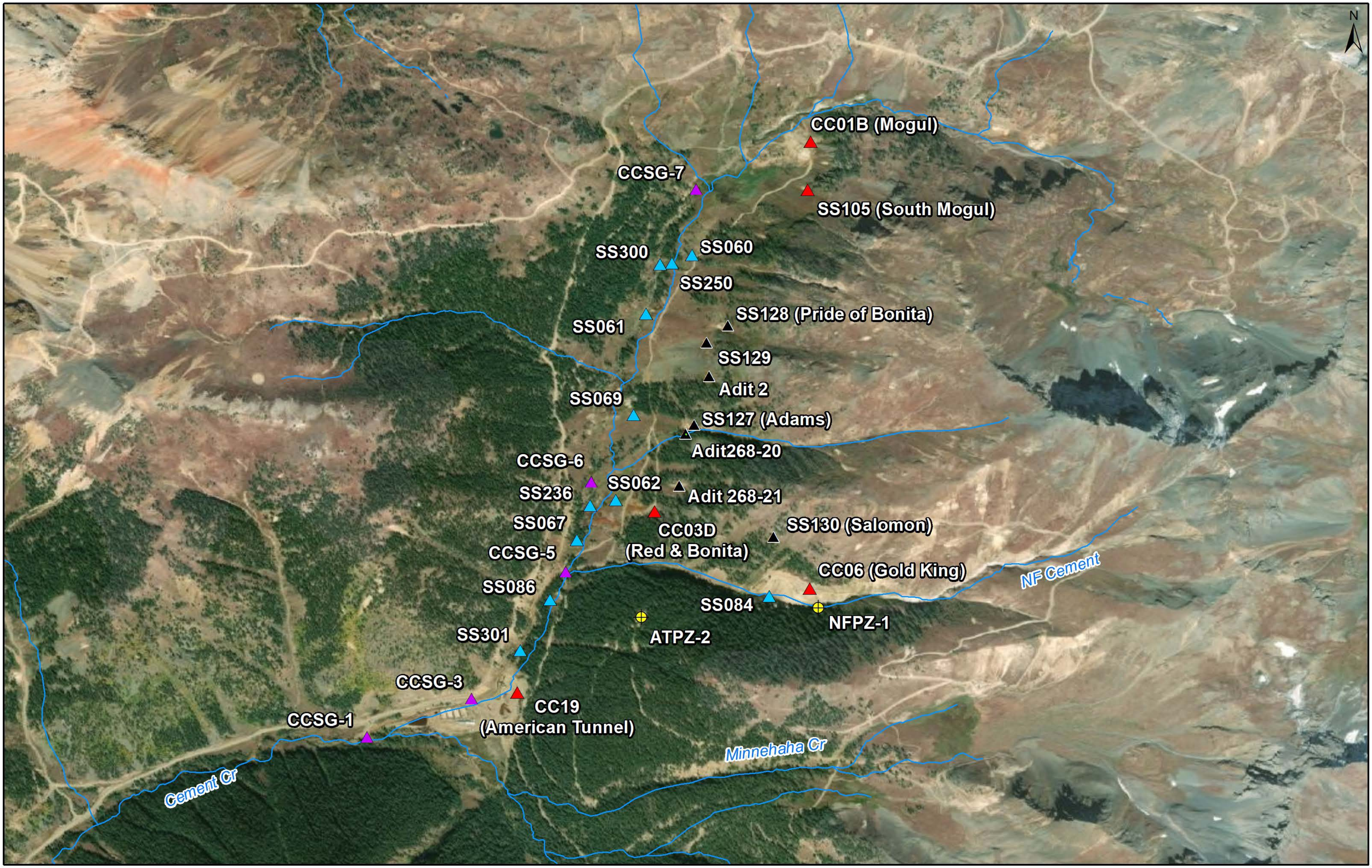
Pore Water Sampling:
- ☑ PushPoint sampler
- ☑ Tubing
- ☑ Syringe
- ☑ 250 mL HDPE bottles
- ☑ 250 mL Nalgene filter bottles
  - ☑ vacuum pumps
  - ☑ filter stands

Paperwork:
- ☑ QAPP
- ☑ FSP
- ☑ HASP
- ☑ Tables
- ☑ Maps
- ☑ Chains and lables
- ☑ Electronic Data Collection Device w/charger
- ☑ Field Notebooks
- ☑ Cameras
- ☑ Pens
- ☑ Sharpies

Miscellaneous:
- ☑ Nitrile Gloves
- ☑ E-Pure H2O
- ☑ pH test strips
- ☑ Safety glasses
- ☑ Trash bags
- ☑ Paper towels
- ☑ Sealable plastic bags
- ☑ Tape
- ☑ Spare car keys
- ☑ Batteries
- ☑ Scissors
- ☑ Screw driver
- ☑ Packing materials for shipping

Field Gear
- ☑ Waders
- ☑ Wading boots
- ☑ Backpacks
- ☑ Hiking boots
- ☑ Hat
- ☑ Rain Coat
- ☑ Layered clothing
- ☑ Gloves
- ☑ Snowshoes
- ☑ Sunscreen
- ☑ Bug spray
- ☑ Sun glasses
- ☑ Food and water
- ☑ Chapstick

Figures



Red and Bonita Test Closure Monitoring Locations

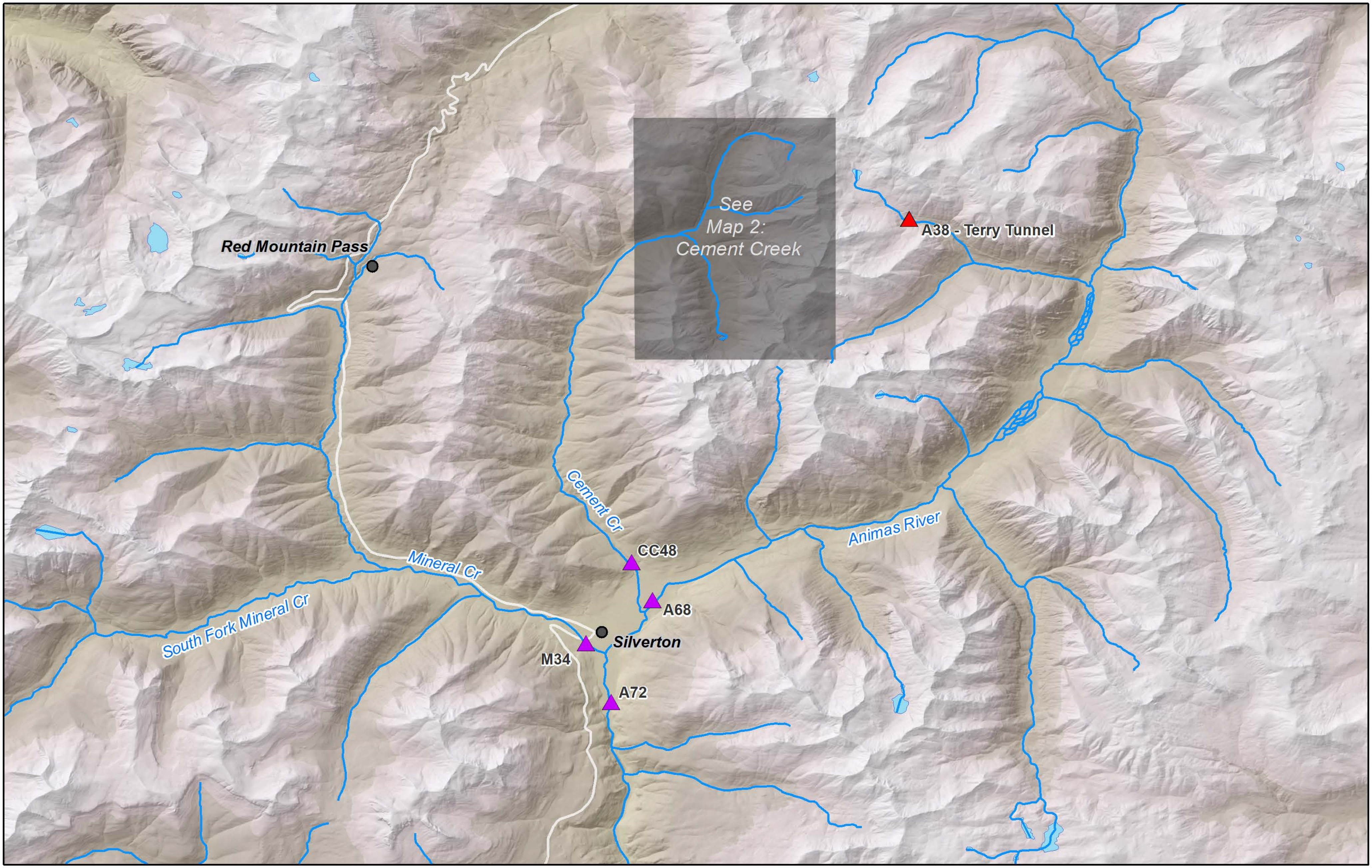
Map 2: Cement Creek

Mountain Studies Institute
RESEARCH & EDUCATION IN THE SAN JUAN MOUNTAINS, COLORADO
mountainstudies.org

Red and Bonita Test Closure Monitoring Locations

- ▲ Draining Mine
- ▲ Dry Mine
- ▲ Seep/Spring Source
- ▲ Surface Water
- ⊕ Well

0 0.125 0.25 0.5 0.75 1 Miles



Red and Bonita Test Closure Monitoring Locaitons

Map 1: BPMD

Mountain Studies Institute
RESEARCH & EDUCATION IN THE SAN JUAN MOUNTAINS, COLORADO
mountainstudies.org

Red and Bonita Test Closure Monitoring Locations

▲ Draining Mine

▲ Surface Water

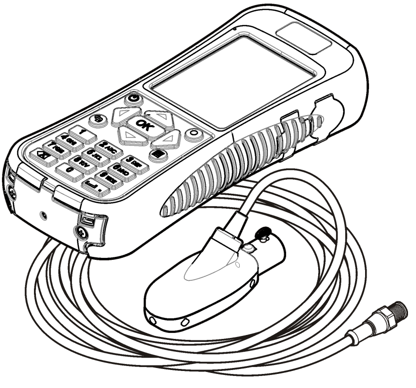
Attachment 1
Standard Operating Procedures

DOC026.53.80210

FH950

04/2018, Edition 5

User Manual



Specifications

Specifications are subject to change without notice.

Sensor specifications

Specification	Details
Velocity measurement	
Method	Electromagnetic
Range	0 to 6.09 m/s (0 to 20 ft/s)
Minimum water depth	3.18 cm (1.25 in.)
Accuracy	±2% of reading ±0.015 m/s (±0.05 ft/s) 0 to 3.04 m/s (0 to 10 ft/s); ± 4% of reading from 3.04 to 4.87 m/s (10 to 16 ft/s)
Resolution	0.01 value < 100; 0.1 value < 1000; 1.0 value ≥ 1000
Zero stability	±0.015 m/s (±0.05 ft/s)
Material	ABS, glass filled
Enclosure rating	IP68
Dimensions (L x W x H)	11.9 x 4.3 x 6.3 cm (4.7 x 1.7 x 2.5 in.)
Cable material	Polyurethane jacketed
Cable lengths	1.5, 6.1, 12.2 and 30.5 m (5, 20, 40 and 100 ft)
Depth measurement	
Method	Diaphragm type: absolute pressure with single point calibration
Accuracy (static)	The larger of ± 2% of reading or ± 0.015 m (± 0.504 inches). Steady state temperature and static non-flowing water.
Range	3.05 m (0-10 ft)
Resolution	0.01 value < 100; 0.1 value < 1000; 1.0 value ≥ 1000

Portable meter specifications

Specification	Details
Pollution degree	2
Protection class	II
Charging temperature	0 to 40 ºC (32 to 104 ºF)
Operating temperature	–20 to 55 ºC (-4 to 131 ºF)
Storage temperature	–20 to 60 ºC (-4 to 140 ºF)
Enclosure rating	IP67
Battery life gauge	Five-segment bar graph
Battery type	Rechargeable lithium ion, 3.6 V, 5.0 Ah, 18 Wh
Battery life	18 hours heavy typical day use[1]; 20 ºC (68 ºF)

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[1] Defined as 30 minutes of set up, six 1-hour periods of continuous use with an active sensor and the display at maximum brightness and 30 minutes of sleep mode between use periods, data download and power off.

Specification	Details
Battery charger	External power adapter, energy efficiency VI, 100–240 VAC, 50–60 Hz, 0.5 A input; 12 VDC, 1.25 A output
Dimensions (L x W x H)	21.8 x 9.3 x 5.3 cm (8.6 x 3.7 x 2.1 in.)
USB connector	Type Mini-B, 5-pin, rated to IP67 when capped
Material	Polycarbonate with a thermoplastic elastomer (TPE) overmold

User interface specifications

Specification	Details
Graphics display	Color, LCD 3.5" QVGA transflective (readable in direct sunlight)
Measurement resolution	0.01 value < 100; 0.1 value < 1000; 1.0 value ≥ 1000
Keypad	Alpha-numeric
Operating modes	Real time, profiling
Profile types	Stream, conduit
Conduit shapes	Circular, rectangular, trapezoidal, 2/3 egg, inverted 2/3 egg
Stream entries	Fixed, non-fixed stations
Noise rejection	User-selectable, 50 Hz or 60 Hz
Units of measure	Velocity: ft/s, m/s, cm/s, mm/s
	Flow: ft^3/sec, million gal/day, gal/day, gal/min, m^3/s, m^3/min, m^3/hour, m^3/day, liters/s, liters/min
	Depth: in., ft, m, cm, mm
Stream flow calculation	Mean-section or mid-section method
Diagnostics	Self test, keypad, display, event log
Conduit profiling methods	0.9 x Vmax, 0.2/0.4/0.8, velocity and level integrator, 2D
Stream profiling methods	1, 2, 3, 5 and 6 point (velocity method - USGS and ISO)
File types	Real-time, profiling, event log
Languages	English, French, Spanish, German, Italian, Dutch, Danish, Swedish, Chinese, Polish, Japanese, Korean, Portuguese, Slovak, Russian, Hungarian, Bulgarian, Romanian, Czech, Turkish, Finnish, Greek

General specifications

Specification	Details
Profiles	Data storage for up to 10 profiles with 32 stations per profile
Maximum number of real-time files	Three each with up to 75 readings captured by the user.
Firmware	The sensor and portable meter are field upgradeable via USB

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer’s website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	This symbol indicates the presence of devices sensitive to Electro-static Discharge (ESD) and indicates that care must be taken to prevent damage with the equipment.
	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECS-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

The portable velocity system is used in the field, laboratory and municipalities. Turbulent, noisy and low flows can be measured with this system.

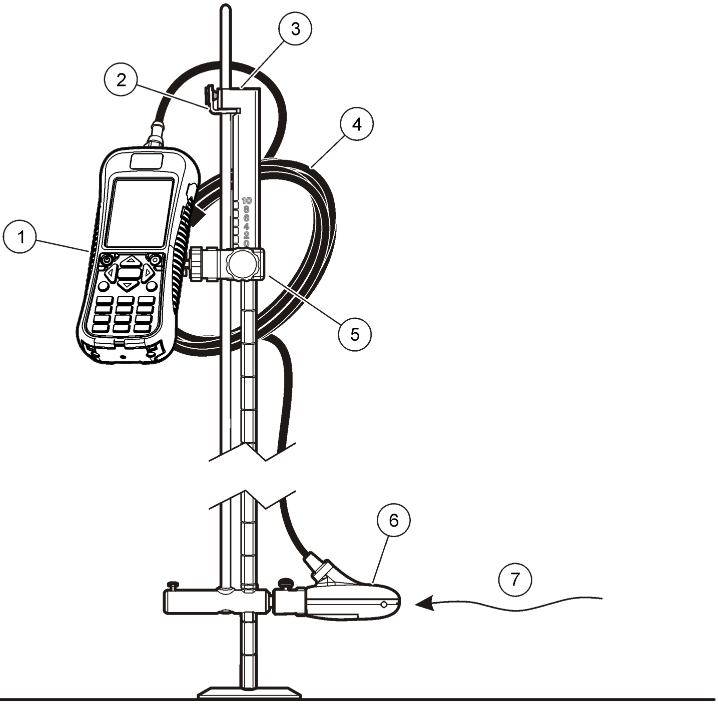
The meter and sensor get velocity information in conduits and streams. These measurements are important for calibration in municipal wastewater industries, as well as for environmental-impact evaluations.

Two types of sensor are available: velocity-only and velocity plus depth. This manual covers both types of sensors. If information applies to a specified type of sensor, this fact is noted in the text.

System overview

An overview of an assembled system is shown in Figure 1. Refer to the documentation supplied with the individual components or accessories for more information.

Figure 1 Assembled components



1 Portable meter	**5** Adjustable mount for portable meter
2 Sensor height lock/release device	**6** Sensor assembly
3 Top setting wading rod (accessory)	**7** Flow direction
4 Sensor cable	

Sensor overview

Figure 2 shows the main sensor components. Instructions for how to attach the sensor on a standard or top-setting wading rod are supplied with the accessory.

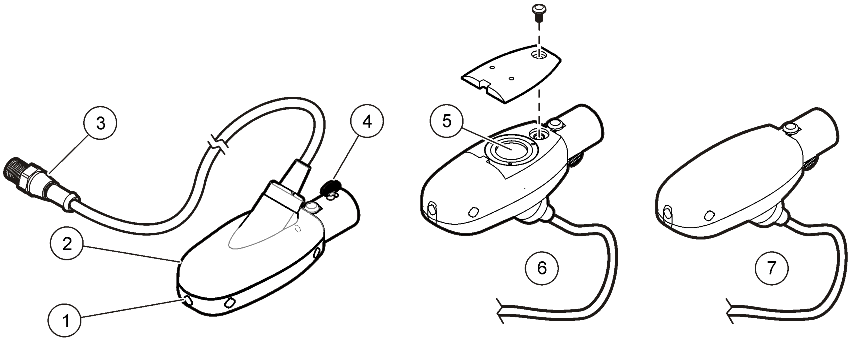


Figure 2 Sensor components

1	Sensor electrodes	**5**	Pressure cell (sensors with depth option)
2	Sensor body	**6**	Sensor with depth option
3	Sensor connection plug	**7**	Sensor without depth option
4	Sensor attachment thumb screw		

Meter overview

Figure 3 shows the features of the meter.

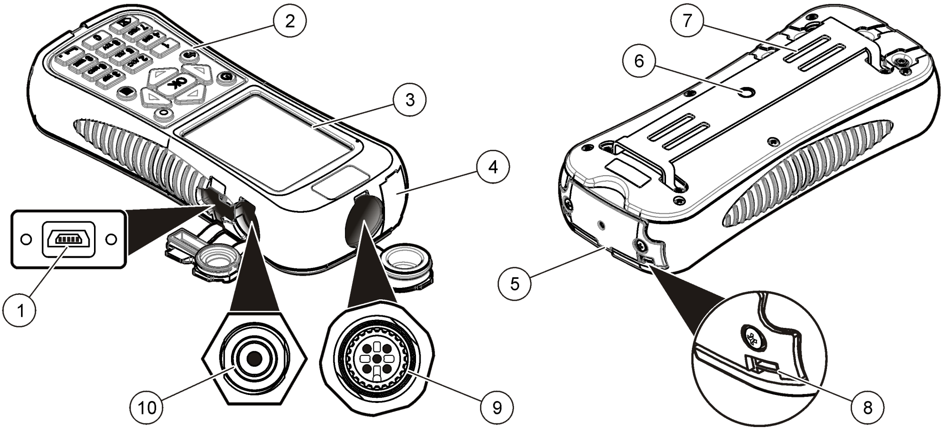


Figure 3 Meter components

1	USB connection port[2]	**6**	Threaded hole for adjustable meter mount
2	Keypad	**7**	Slots for velcro or strap attachment
3	Meter display	**8**	Slot for neck strap attachment threads (2x)
4	Expansion port (not used)	**9**	Sensor connection port
5	Battery compartment cover	**10**	Battery charger connector

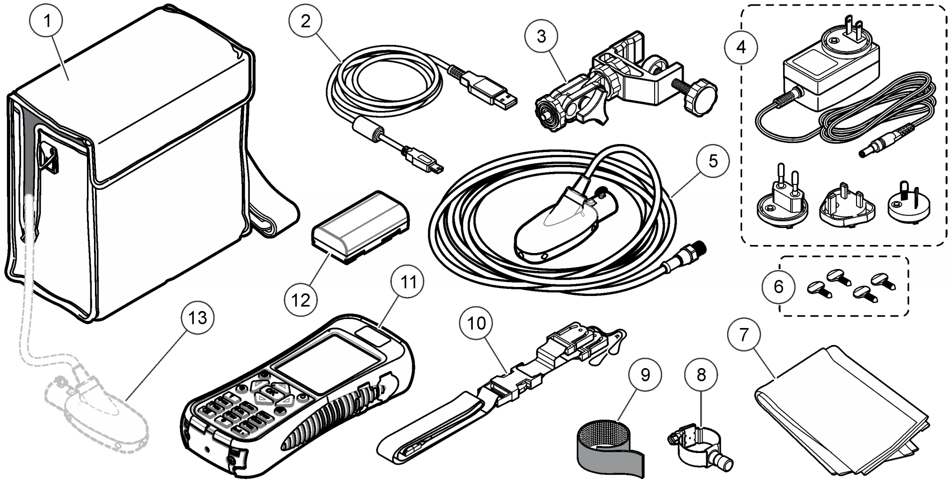
---

[2] Do not use the USB connection to charge the battery.

Product components

When purchasing a complete system, refer to Figure 4 to make sure that all components have been received. If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 4 System components



1 Carrying case (with slot for sensor cable)	**8** Universal sensor mount
2 USB cable with mini-USB connector, 1 m (3 ft)	**9** Velcro strap
3 Adjustable portable meter mount	**10** Lanyard
4 Battery charger, 100–240 VAC	**11** Portable meter
5 Sensor	**12** Lithium battery pack
6 Extra thumb screws (4x)	**13** Sensor as connected to meter inside case
7 Cloth to dry the sensor	

Installation

Installation with optional accessories

Mount the meter on an optional wading rod for use in low-stage stream environments where the stream can be waded. Optional accessories let the user take measurements from a bridge or cable over a stream. A torpedo shaped weight attached below the sensor keeps the sensor in place when under water. For more information, refer to the documentation supplied with the accessory.

Install the sensor on the universal sensor mount

Use the universal sensor mount to attach the sensor to poles 1 inch or less in diameter. For correct operation and accurate readings, the front of the sensor must be pointed upstream with the electrodes in full contact with the flow.

***Note:** Keep the sensor electrodes free from nonconductive substances such as oil and grease. To remove sensor contamination, refer to* Clean the sensor *on page 28.*

1. The front part of the sensor is round and contains three electrodes. The sensor has a mounting hole in back and a thumbscrew on top. Put the mounting shaft of the universal mount in the

mounting hole at the back of the sensor. Make sure that the mounting shaft is completely engaged with the mounting hole and the thumbscrew is engaged with the groove.

2. Hand tighten the thumbscrew.
3. Move a pole 1 inch or less in diameter through the clamp of the universal sensor mount. Tighten the clamp.
   Note: *Instructions for how to mount the sensor on a standard or top setting wading rod are supplied with the accessory.*

Lithium battery safety

⚠ WARNING

Fire and explosion hazard. Lithium batteries may get hot, explode or ignite and cause serious injury if exposed to abuse conditions.

- Do not use the battery if there is visible damage.
- Do not use the battery after strong shock or vibration occurs.
- Do not expose the battery to fire.
- Keep the battery at temperatures less than 60 °C (140 °F).
- Keep the battery dry and away from water.
- Prevent contact between the positive and negative battery terminals.
- Do not let unauthorized persons touch the battery.
- Discard the battery in accordance with local, regional and national regulations.
- Do not use or store the instrument in direct sunlight, near a heat source or in high temperature environments such as a closed vehicle in direct sunlight.

Install the battery

⚠ WARNING

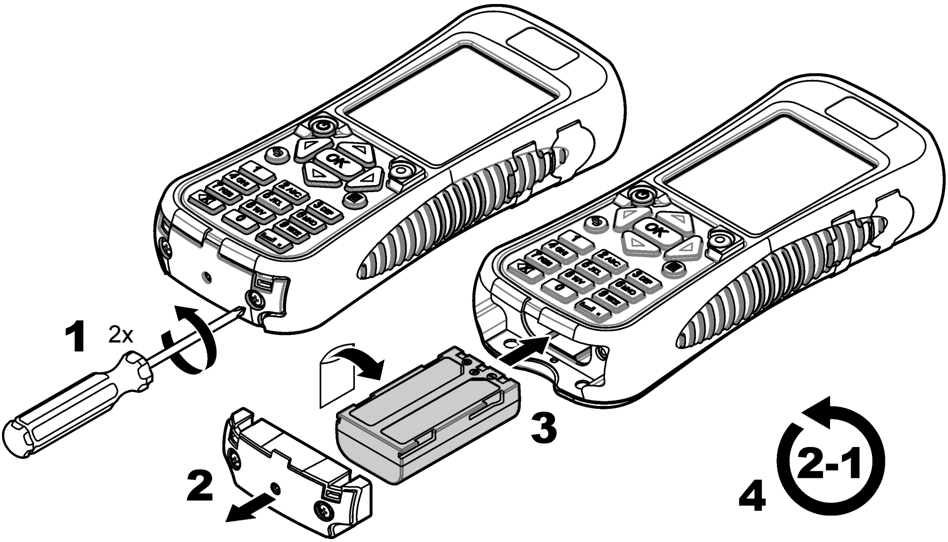
Fire and explosion hazard. This equipment contains a high energy lithium battery which can ignite and cause fire or explosion, even without power. To maintain the safety provided by the instrument enclosure, the instrument enclosure covers must be installed and secured with the supplied hardware.

⚠ WARNING

Explosion and fire hazard. Battery substitution is not permitted. Use only batteries that are supplied by the instrument manufacturer.

Install the supplied lithium battery as shown in Figure 5.

Figure 5 Install the battery



Charge the battery

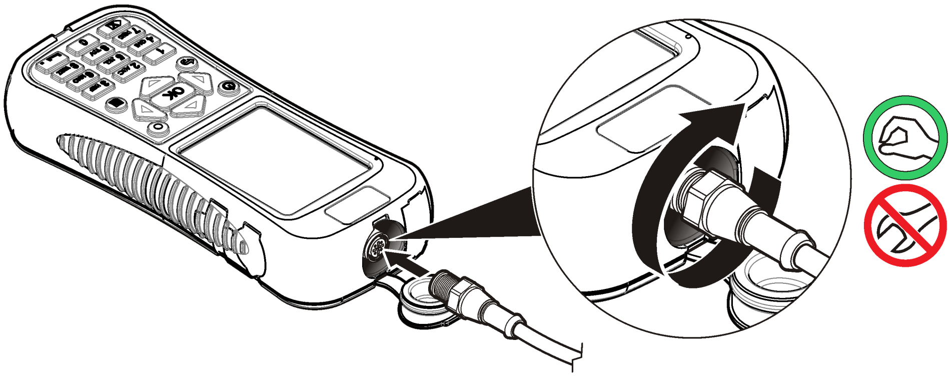
Note: *Battery charger substitution is not permitted. Use only the charger specified in the list of parts and accessories for the instrument. Refer to* Replacement parts and accessories *on page 30.*

Before initial use, fully charge the instrument battery with the supplied battery charger. A discharged battery is fully charged in approximately 8 hours.

A full battery charge will supply power to the system for approximately 10–11 hours with constant use. When the level of battery charge drops to 3.4 V or less, the display shows a warning and the meter automatically powers off. The battery must be charged before the unit becomes functional again.

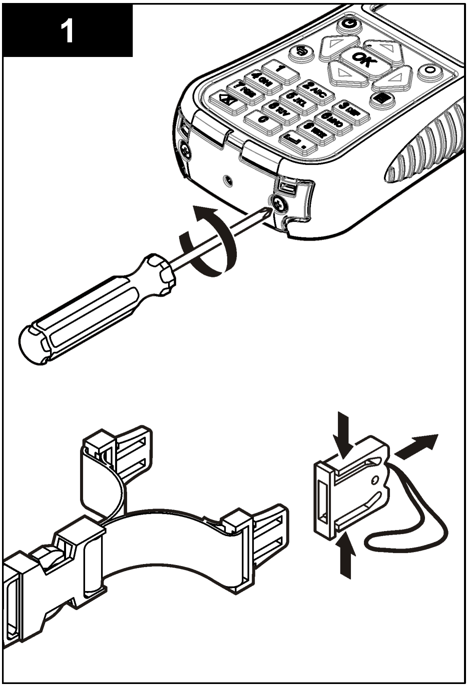
1. Make sure that the correct type of plug for the geographic location is installed on the battery charger.
2. Connect the battery charger to an electrical outlet with earth ground.
3. Connect the battery charger to the battery charger connector on the instrument. Refer to Meter overview on page 8. The battery level shows on the display.
   A blue light shows around the charge port while the battery charges. When the charge process is complete, the blue light goes off.
   Note: *The meter is not operational while the battery charges. The battery does not charge through the USB cable connection.*

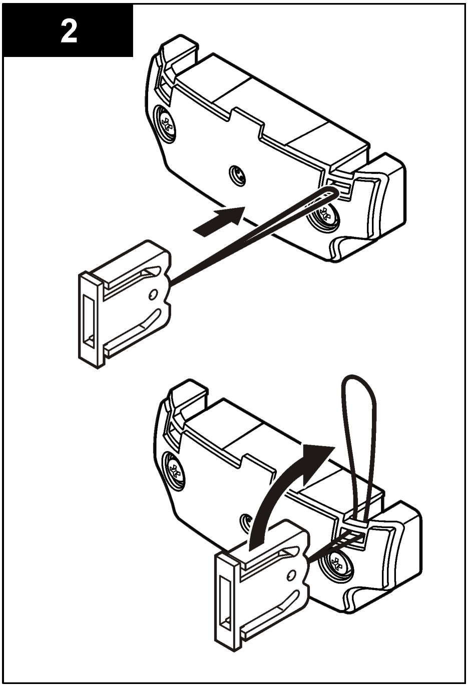
Connect the sensor to the meter

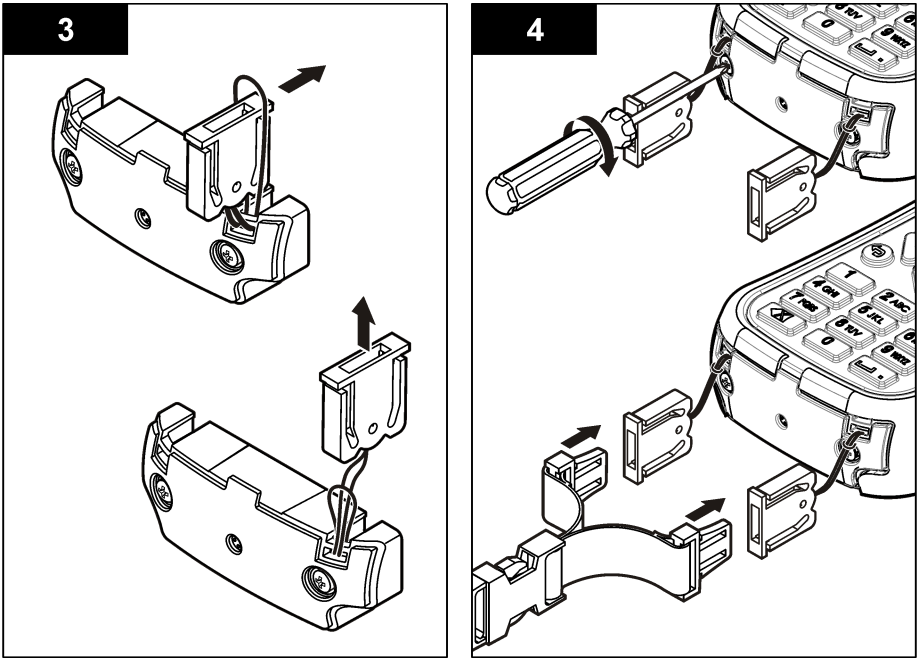


Attach the lanyard

Attach the lanyard to wear the meter safely around the neck.



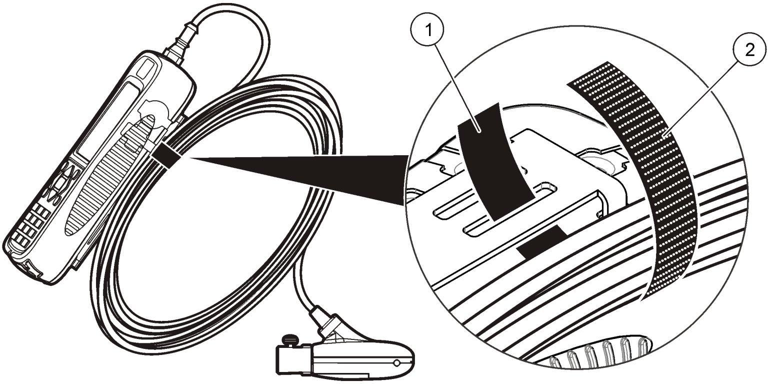




Attach the velcro strap

Use the velcro strap to hold the extra cable. Refer to Figure 6.

Figure 6 Attach the velcro strap



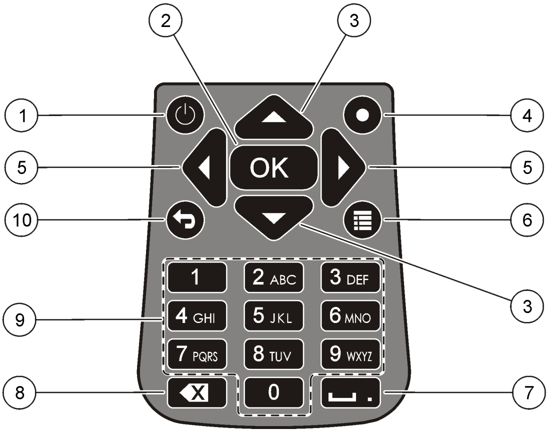
1 Loop side	**2** Hook side

User interface and navigation

Keypad and key functions

Figure 7 shows the meter keypad. Table 1 gives the functions of each key or key type.

Figure 7 Keypad



1 Power On/Off	**6** Main Menu
2 OK	**7** Underscore or decimal
3 Up and Down arrows	**8** Backspace
4 Quick Jump	**9** Alpha-numeric
5 Right and Left arrows	**10** Previous menu

Table 1 Key description

Key	**Description**
Power On/Off	Energizes and de-energizes the meter.
OK	Confirms an entry or highlighted menu option.
Up and Down arrows	Moves up or down in the display. If the cursor is at the top or bottom of the display, the cursor wraps to the bottom or top when the UP or DOWN arrow is pushed.
Quick Jump	In normal operation, this key jumps to the Select conduit shape screen. If the auto-zero feature is disabled, hold this key for five seconds to do a manual zero of the depth sensor. In Real-Time mode, the Quick Jump key toggles between the digital and graph views.
Right and Left arrows	Moves to the right or left in the display.
Main Menu	Moves to the Main Menu from any submenu or screen.
Underscore or decimal	Puts in an underscore or decimal character. In numeric-only fields, this key automatically puts a decimal point in the cursor position.
Backspace	Moves the cursor back one space.
Alpha-numeric	Puts in the key alpha or numeric value. Values are put in the order shown on the key. After 2 seconds, the value shown in the display is stored and the cursor advances.
Previous menu	Moves to the previous screen.

Status bar

A status bar is shown in the top of the display. Descriptions of the information in the status bar are given in Table 2.

Table 2 Status bar indicators

Indicator	Description
Time and Date	Shows the current time and date.
USB	Shows when a USB cable is connected. If a USB cable is connected and this indicator does not show in the status bar, the USB cable is not fully engaged. Make sure that the USB cable is pushed in completely and makes full contact with the connection port.
Conductivity	If the sensor is out of the water and non-conductive, a blue ring appears next to the battery icon. If the sensor is in the water and conductive, the indicator is a solid blue circle.
Battery	A five-bar graph shows the level of charge in the battery.
File access	Shows while the meter gets access to a file.
Auto zero depth indicator	If the depth sensor was zeroed in the last 30 minutes, a solid green circle shows next to the Conductivity indicator. If the depth sensor was not zeroed in the last 30 minutes, this indicator flashes red.

Navigation and Main Menu

Push **OK** to confirm a selected menu option or a value shown in the display. Select More and push **OK** to see additional screens and options if available. Push the Main Menu button to go to the Main Menu from a submenu.

***Note:** Some operations cannot be completed unless a sensor is connected to the meter. If these operations are tried when there is no sensor connected, the display shows an error message. Connect a sensor and try the operation again.*

1. **Real time**—Select this option to get real-time velocity and depth information. (A sensor with depth capability is necessary to read depth). An example of a Real Time screen for sensors with velocity only is shown in Figure 8. Real time screens for sensors with both velocity and depth is shown in Figure 9. The format of the information and options shown depends on the type of sensor used. In Real Time mode, the Quick Jump key toggles between digital and graphic views of Real Time information. The velocity is updated in FPA filter mode according to fixed period averaging time. In RC filter mode, the velocity is updated continuously on the screen every 250 ms.

Option	Description
Capture	Stores the depth and velocity information shown in memory. The information is saved until power is cycled, the memory is saved to a non-volatile real-time file, or the user exits from real-time mode.
Save	Saves captured measurements in the volatile memory to a non-volatile real-time file. A message will show if the number of files is greater than the maximum possible. Files are stored in tab delimited (.tsv) format.
Done or OK	Exits the real-time mode and returns to the Main Menu. If there is unsaved data in volatile memory, a confirmation message asks the user to confirm the exit without saving the data.
Clear	Clears captured measurements from the volatile memory buffer. The user can choose from Clear Last, Clear All or Cancel options.

Option	Description
Setup	Allows the user to modify the main filter parameters and enable and program the Maximum Depth sensor positioning feature. The Maximum depth feature allows a user to enter system parameters for depth measurement in Real Time mode. The user can choose to enter a maximum depth value taken directly with a ruler measurement (manual), or taken indirectly with the depth measurement (automatic). Both methods enable the Maximum Depth sensor positioning feature. In automatic mode setup, the user directly enters the distance from the bottom of the channel to the bottom of the sensor mount (offset). The setup interface will continuously show the current depth value returned by the sensor plus the offset. The meter stores this value as the Maximum Depth when the OK button is pushed. In all other cases, the depth values shown do not include the offset. The Maximum depth feature requires a sensor with velocity plus depth.
Files or View	Shows a summary of each real-time file stored in non-volatile memory. Files can be individually viewed and deleted.

Figure 8 Real time screen

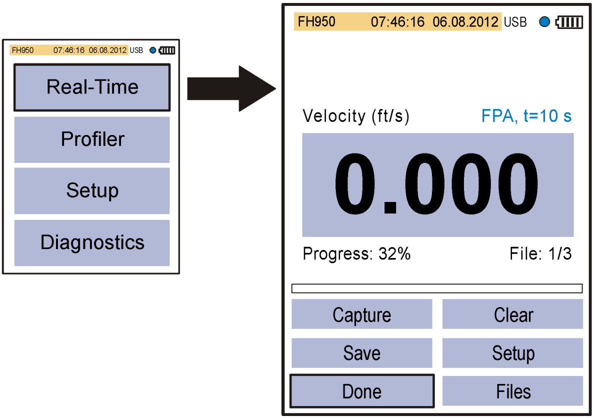
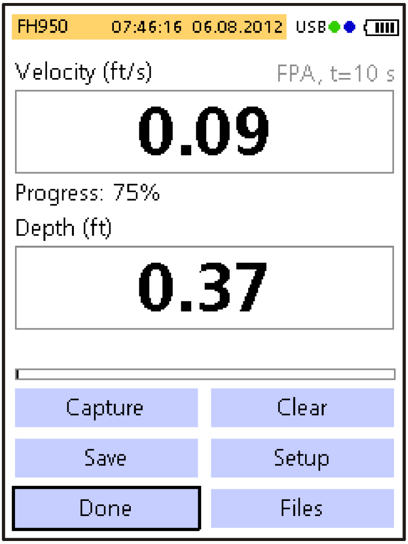


Figure 9 Real time screen for sensor with depth



Velocity (ft/s) FPA, t=10 s

0.09

Progress: 75%

Depth (ft)

0.37

2. **Profiler—** Select this option to do stream or conduit velocity measurements. The meter shows prompts when user input is necessary. The meter saves up to 10 profiles with up to 32 stations per profile. This number can be greater if data acquisition time is less than the maximum. A percentage of the remaining memory is given in 1% resolution. Refer to the Appendix on page 32 for more information about profiles.

Option	Description
Stream	This option is used to set up a profile for a stream or flowing channel. Do velocity measurements to calculate total discharge based on ISO 748 or USGS standards for Mid-section or Mean-section methods.
Conduit	This option is used to set up a profile for a conduit.
Files	This option is used to view or delete stored files. Files can be deleted all at once or individually.
Setup	This option is used to set up or change the settings for filter parameters and the Maximum Depth feature.

3. **Set up**—Select this option to change general system settings and preferences.

Option	Description
Velocity calibration	Calibrates the sensor. Adds a field offset to the factory calibration. Refer to the Appendix on page 32 for more information.

Option	Description
Filter parameters	Applies a data acquisition filter (Main filter or Pre-filter). The user can select the filter parameters. **Main filter** • Fixed Period Averaging (FPA)—Fixed Period Averaging averages data over a user selectable fixed period of time (1 to 480 seconds). The default is 10 seconds. If the FPA value is 5, the velocity value shown in the display is updated once every 5 seconds. • RCA time constant—The RC filter helps smooth out turbulence through the use of a selected time constant in the filter algorithm. This mode is useful when searching for a maximum velocity, for example in the common 0.9 x Vmax profile method. High RC filter time constants give higher degrees of smoothing. The time constant can be set from 2 to 20 seconds, with a default value of 6. At 1 time constant, the filter settles to approximately 60% of the final value. At 5 time constants, the filter settles to 99.9% of the final value. Thus, if the RC value is set to 2, the final value shows after 10 seconds. **Pre-filter** • Median filter—The filtering process is done in the sensor. The feature can be disabled. However, the recommended (default) value is 5. Enable the feature to enter or change this value.
Wet/dry threshold	Sets the sensor submersion threshold for wet and dry conditions. The default value is 20%. Refer to Wet/Dry threshold on page 34 for more information.
Auto zero depth	Sets the Auto Zero feature to On or Off. If set to On, the instrument does an air calibration when the sensor is removed from the water and is in the air. To do the air calibration, the instrument automatically zeroes the sensor. If set to Off, the user can manually zero the sensor. To do this, remove the sensor from the flow, then push and hold the Quick Jump key for five seconds. When the sensor has been in the flow for 30 minutes, the green circle in the upper right corner goes from green to red. This is a prompt to the user to remove and zero the sensor again.
EMI	Sets the local line frequency for ambient noise rejection to 50 Hz or 60 Hz (default).
Clock	Sets the date and time of the portable meter in 24-hour format. Daylight savings time is not supported.
USB	Sets the USB mode. • Mass Storage (default)—This mode operates like a memory stick or hard drive. Files are read-only. • CDC—This mode is used to update firmware.
Language	Selects the language used in the menus.
Units	Sets the units for velocity, flow and depth measurements. Options are Metric or English (default).
Beeper	On (default) or Off. If set to On, the meter makes an audible tone when the sensor is at the correct depth for applicable profile methods. The meter also makes an audible tone when an inactive button is pushed in any menu. This feature is available only with the optional depth sensor.
Flow calculation	Selects the method of flow calculation for open water segment (stream profiles only). Options are Mean-section or Mid-section. Refer to the Appendix on page 32 for more information.

Option	Description
Station entry	• Fixed—The operator puts in the width of the stream and the number of stations for measurements. The meter divides the cross-section into evenly spaced distances between the station verticals. • Non-fixed (default)—The operator selects the spacing between station verticals. This is the more commonly used option as it lets the operator include obstructions and other restrictions in the cross section.
Restore defaults	Sets all meter options to the factory default values.

4. **Diagnostics—** Select this option to troubleshoot problems with the meter or an attached sensor. For more information about the Diagnostics options, refer to Diagnostics on page 29.

Startup and self-test

⚠ DANGER

Chemical or biological hazards. If this instrument is used to monitor a treatment process and/or chemical feed system for which there are regulatory limits and monitoring requirements related to public health, public safety, food or beverage manufacture or processing, it is the responsibility of the user of this instrument to know and abide by any applicable regulation and to have sufficient and appropriate mechanisms in place for compliance with applicable regulations in the event of malfunction of the instrument.

⚠ WARNING

Fire and explosion hazards. Do not use or store the instrument in direct sunlight, near a heat source or in high temperature environments such as a closed vehicle in direct sunlight. Failure to take this precaution can make the battery overheat and cause a fire or explosion.

The battery must be installed in the meter and charged before use. For more information about battery installation and replacement, refer to Install the battery on page 10. For information on how to charge the battery, refer to Charge the battery on page 11.

***Note:** The meter is not operational while the battery charges.*

1. Push the meter power button until an audible beep is heard.
   The meter does a self test and the display shows the results. If the meter fails the self-test, the display shows FAIL next to the failed parameter. If the sensor fails, attach a different sensor if available.
2. When the self test is complete, push **OK** to go to the Main Menu.
3. To de-energize the meter, push the power button again. In the Confirmation screen, select Yes and push **OK**.
   If the portable meter becomes unresponsive, push and hold the power button for more than 3 seconds to force the power off. Do not force off the power in normal operation or when the file access icon is visible.

Sleep mode

The meter backlight goes dim after 30 seconds of no activity and goes into sleep mode after 60 seconds of no activity. These actions do not occur if the meter is in real-time mode or while the meter is measuring. After 30 minutes in sleep mode, the meter power goes off.

To cancel the sleep mode, push any key. The display brightness goes back to the normal level and all keys go back to their normal functions.

Operation

Stream profiles

Stations and station spacing

For a well-chosen cross-section, division into 25 to 30 partial sections is typically sufficient. If the cross-section is very smooth and the velocity distribution very consistent, it is possible to decrease the number of stations.

Make the distance between the partial stations so that no individual station contains more than 10% of the discharge. The ideal measurement is one in which each partial station contains 5% or less (≤ 5%) of the total discharge, but this is rarely possible when 25 stations are used. Partial stations should not have equal widths across the entire cross-section unless the discharge is well-distributed.

Distances between stations are generally smaller where water depth and flow velocities change significantly. Places where depth and velocities frequently change significantly include bank areas, vertical or steep slopes, ledges in divided cross-sections and transitions from the main stream bed to the foreland. Stations should also be located at points of significant changes in the stream bed profile.

The measurement cross-section must be set at right angles to the direction of flow. Cross-sections must not contain still areas, counter currents or eddies. Do not put the sensor in deep pools, below large inflows, or near ship moorings, ferries or sluices.

Use Table 3 as a guide for the number of stations necessary for an acceptable measurement. The information is based on EN - ISO 748 standards.

Table 3 Number of stations in relation to the waterway width

Feet	Meters	Number of stations
< 1.6	< 0.5	5 to 6
> 1.6 and < 3.3	> 0.5 and < 1	6 to 7
> 3.3 and < 9.8	> 1 and < 3	7 to 12
> 9.8 and < 16.4	> 3 and < 5	13 to 16
> 16.4	≥ 5	≥ 22

Measure velocity

Measurement quality is dependent on the correct selection of a measurement cross-section. Select a section of stream with the following characteristics:

- The flow directions at each measurement point across the stream are parallel to the bank and perpendicular to the cross-section.
- The streambed is stable and free of large rocks, weeds and protruding obstructions such as piers that cause turbulence.

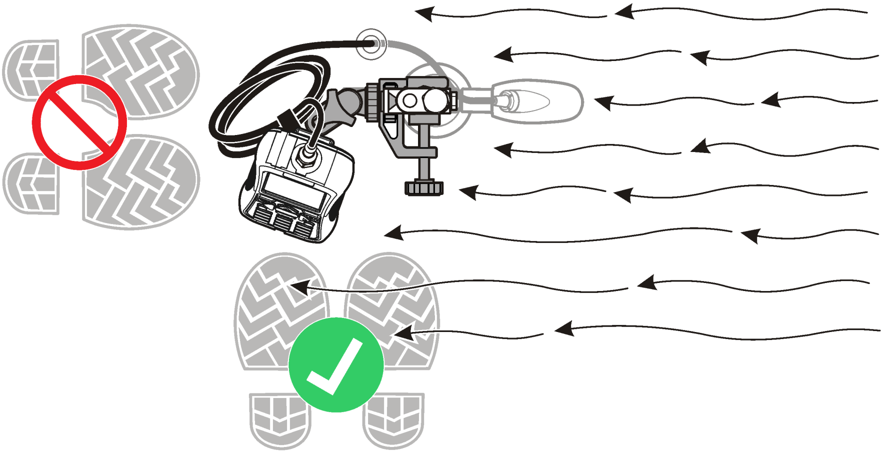
It is often not possible to completely satisfy all of these conditions. Use the criteria to select the best possible section and then select a cross-section.

The general procedure to take velocity measurements in river and stream profiles is described below. Make the first measurement in a stream profile at the top or bottom. Make each subsequent measurement below the last one.

- In fixed mode, divide the channel into stations of equal width.
- Conduct a velocity measurement at each station. The portable meter shows and stores the depth and measured velocity information.
- When the stream profile is completed, the meter automatically calculates the total flow.

For accurate measurement results, stand to the side of the instrument. Refer to Figure 10.

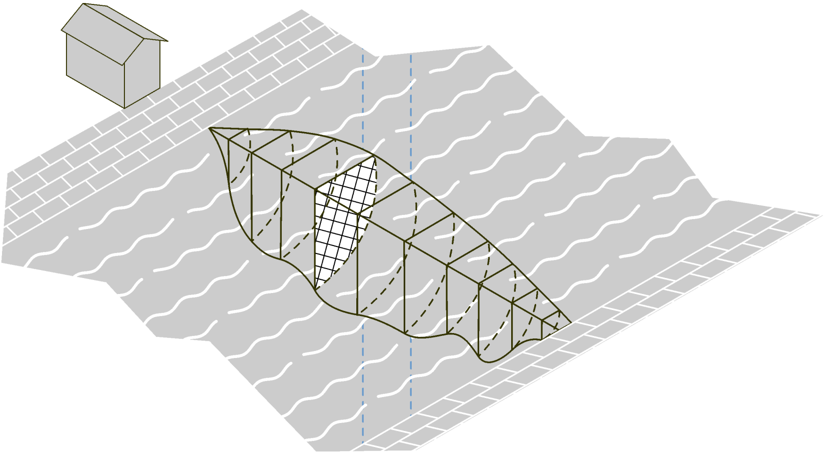
Figure 10 Position of user in the flow



Measure velocities in a cross-section

A typical stream cross-section is shown in Figure 11.

Figure 11 Example of a typical cross section



To measure velocities in a cross-section:

1. In the Main Menu, select Profiler.
2. Enter the Operator name. A list of options will show.

Option	Description
Stream	Used for measurements in a stream profile.
Conduit	Used for measurements in a conduit profile.

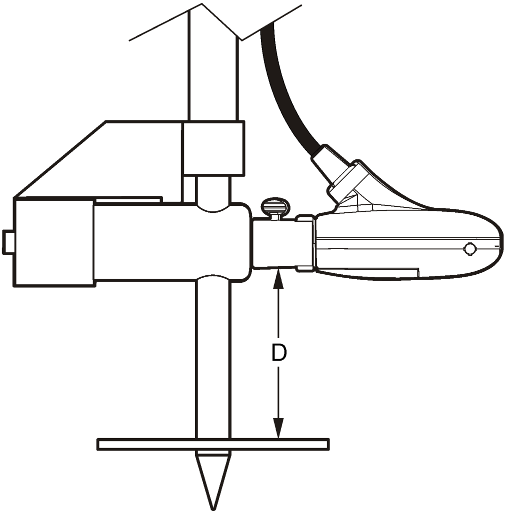
Option	Description
Files	Used to view or delete files.
Setup	Used to set up filter parameters and the Maximum depth feature.

3. Select Setup > Maximum depth. Select Manual or Automatic.

Option	Description
Manual	In this mode, the instrument prompts the user to manually enter the maximum depth of each vertical. This value is normally obtained from a wading rod.
Automatic	In this mode (available only on sensors with the depth option), the instrument uses the pressure transducer to measure the maximum depth at each vertical.

   a. If Automatic is selected, enter the distance from the bottom of the channel to the bottom of the sensor mount.
   b. Put the sensor at the lowest position on the wading rod.
   c. Enter the minimum depth (measured from the bottom) that the sensor can read. Refer to Figure 12.

Figure 12 Minimum depth



4. Select Top or Bottom for the measurement reference then push **OK**.
5. If necessary, change or update the filter parameters in Profiler Setup.
6. In the Profiler menu, select Stream.
7. Enter a name for the stream profile. Make profile names alpha-numeric with a maximum of 11 characters. Push **OK** to save the profile name or select Clear to delete all current stream profile data.
8. Enter the stage reference. This is typically an elevation value from an immovable object such as a survey marker or bridge, etc.

9. In the Station menu, select Edge/Obstruction. Select one of the options.

Option	Description
Left	Select this option if the station is at the left edge of the water or an obstruction (i.e, sandbar, pylon or large boulder).
Right	Use this option if the station is at the right edge of water or an obstruction (i.e., sandbar, pylon or large boulder).
Open water	Use this option to configure the edge as an open water environment (default).

10. Select Distance to Vertical and enter the information.
11. Select Set Depth and enter the information. If at an edge, the meter automatically sets this value to 0.00.
    a. If Manual mode was selected in the Profiler setup, enter the total depth of water at this vertical position.
    b. If Automatic mode was selected in the Profiler setup, push **OK** to set the maximum flow depth at the value shown.
12. If Left or Right was selected in Step 9, enter an edge factor for the vertical. Select a factor from the list or User-defined. For User-defined values, enter a roughness factor between 0.50 (very rough) and 1.00 (smooth). The roughness factor is relevant only for right angled cross sections. It is used as a factor in the calculation of the discharge proportion of edge areas. For example:
    - Smooth edge with no vegetation (e.g., concrete, steel, cement)— 0.8 to 0.9
    - Brick sides with vegetation— 0.7
    - Rough walls with heavy vegetation—0.6 to 0.5
13. Select Measure Velocity. Select the number of points on the vertical to collect.
14. Select a measurement point from the list. Obey the instrument prompts and adjust the sensor to the correct depth. If the sensor has a depth option, adjust the sensor depth until the depth box is green. This means the sensor is in at the correct position.
    ***Note:** Red indicates more adjustment is necessary. Yellow indicates the depth is close to the correct depth.*
15. Select Capture to start the measurement process.
16. If necessary, the setup can be changed and the measurement can be repeated. When the measurement is complete, push **OK** to store the data.
17. Repeat steps 13–16 for the other measurement points on the vertical.
18. When all measurements for the station are complete, select Main or Verify. results. Push **OK** to return to the list of measurement points.

Option	Description
Main	Returns to the station menu.
Verify	Shows the average velocity reading for the station based on the measurement method.

19. Select Next to go to the next station.
20. Repeat steps 10–19 for the remaining stations.
21. When all measurements for all stations in the profile are complete, select Channel Summary to view the results.
    ***Note:** A warning flag will show if the discharge in one or more segments is > 5% of the total discharge.*

Insert or delete a station

Prev, **Next**, **Ins** and **Del** options show at the bottom of the display in the Station screen. **Prev** and **Next** are used to navigate to a previous or subsequent station. **Ins** and **Del** are used to insert or delete a station.

For example, after measurements have been done at 10 stations, a user may wish to insert a new station between stations 3 and 4. The steps below describe how to do this. These steps can be applied in similar situations.

1. Select **Prev** and push **OK** until the display shows the information for Station 3.
2. Select **Ins** and push **OK**.
   The instrument adds a new station named Station 4. Subsequent stations are automatically given new sequential numbers.
3. To delete the current station (when in non-fixed mode), select **Del** and push **OK**.

Conduit profiles

It is possible to use all of the methods for conduit profiles in this section in sites with a typical profile shape and sufficient depth to measure 3-point velocities. The 0.9 x Vmax method can also be used when the depth is not sufficient for multi-point profiles.

Note: *In typical conduit profiles, the first measurement is made at the bottom. Subsequent measurements are made above the one made before. A different procedure may be necessary for some profiles.*

1. In the Main Menu, select Profiler.
2. Enter the operator name.
3. In the list of options, select Conduit.
4. Enter a name for the new Conduit profile.
5. Select the conduit shape.
   Note: *The input screens that show next depend on the shape selected.*
6. Enter values at the screen prompts.
   When the necessary values have been entered, the display shows the Select Method menu.
7. Select a profile method and do the steps for the method.

Option	Description
0.9 x Vmax	The meter calculates flow based on 90% of the fastest velocity. This is the recommended method when the depth is less than 12.7 cm (5 in.) or when the velocity is not stable.
0.2/0.4/0.8	The meter calculates the flow value based on velocity measurements taken at 0.2, 0.4 and 0.8 x the depth. One and two-point versions of this method are also possible.
Vel./Lev. Integ.	The meter integrates 10 separate velocity and level measurements to calculate the flow level.
2D	The sensor collects information while constantly moved through the flow in a specified pattern. The meter calculates the flow value when the user selects Save. This method is recommended for flows where a difference of 30% or more exists between the right and left side velocities.

0.9 x Vmax measurement method

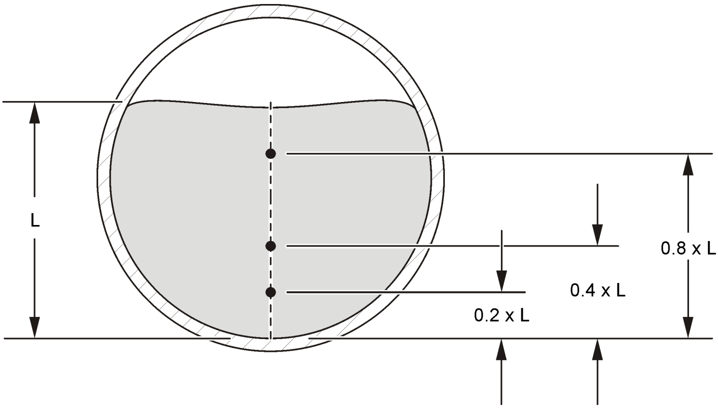
The meter uses the maximum velocity measurement in the conduit and multiplies this value by 0.9 to calculate the total flow.
Note: *The RC filter mode with a value of 2 to 4 seconds is recommended for this method.*

1. In the Select Method menu, select 0.9 x Vmax.
2. With the sensor in the flow, select Measure Velocity to get a velocity measurement.
   The measured values are shown on the graph.
3. Move the sensor until a point of maximum velocity is found, then push **OK**.
   The meter calculates and shows the flow, maximum and average velocity values.
4. Select Save.
   The information is saved to a data file.

0.2/0.4/0.8 method

Do measurements at one, two or three points to calculate an average velocity. Each point represents a percentage of the maximum depth as measured on the center line as shown in Figure 13.

Figure 13 2-4-8 profile



1. In the Select Method menu, select **0.2/0.4/0.8**.
2. Select one of the options.

Option	Description
One point	One-point measurement at 0.4 x maximum depth
Two point	Two-point measurement at 0.2 and 0.8 x maximum depth
Three point	Three-point measurement at 0.2, 0.4 and 0.8 x maximum depth

3. For the selected option, select a measurement point. The meter shows the sensor adjustment information.
4. If necessary, adjust the sensor as necessary.
5. Select Capture.
   The meter gets information from the sensor and shows the velocity value in numerical and graphical form.
6. If necessary, select Setup to change the Y-axis range or the data filter parameters.
7. Push **OK**.
8. Do steps 3–7 for all of the other measurement points then push **OK** to return to the list of measurement points.
9. Select Flow.
10. Select Save to save the information to a data file.

Velocity/Level Integration measurement method

Measurements are done at 10 different depths. The results from all segments are integrated to calculate the flow value.

- Select Prev or Next to go to another measurement.
- Select Main to return to the Select Method menu.

1. In the Select method menu, select Vel./Lev. Integ.
   The display shows the first measurement screen.
2. Select Measure Velocity.
   The sensor depth information is shown.
3. If necessary, adjust the sensor depth as shown.
4. Select Capture.

The handheld unit gets information from the sensor and shows the average velocity value in numeric and graphical form.

5. If necessary, select Setup to change the Y-axis range in FPA filtering mode, the X and Y-axis range when in RC filtering mode or the data filter parameters.
6. Push **OK** to confirm the information.
7. Select Next. The next measurement screen in the series appears.
8. Do steps 2–7 for the other measurement depths.
9. Select one of the options at the bottom of the screen.

Option	Description
Save	Calculates the current flow value and saves this information to a data file.
Units	Changes the unit type (English or Metric).

2D measurement method

Velocity is measured while the sensor is moved through the flow as shown in Figure 14.

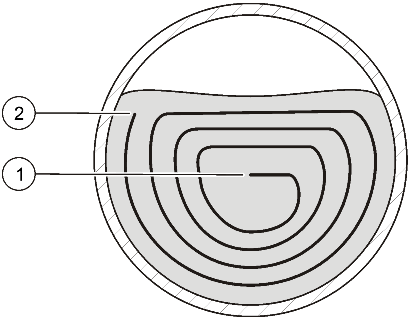
Select Cancel at any time to cancel the measurement and return to the Select Method menu.

Note: *The RC filter mode with a value of 2 to 4 seconds is recommended for this method.*

1. In the Select method menu, select 2D.
   The sensor depth information is shown.
2. If necessary, adjust the sensor depth.
3. Select Capture. While the sensor collects data, move the sensor through the entire cross-section in the pattern shown in Figure 14.
4. If necessary, select Setup to change the Y-axis range in FPA filtering mode, the X and Y-axis range when in RC filtering mode or the data filter parameters.
5. Push **OK**.
6. Select one of the options shown at the bottom of the screen.

Option	Description
Save	Calculates the current flow value and saves this information to a data file.
Units	Changes the unit type (English or Metric).

Figure 14 Path of the sensor in the flow



1 Start	**2** Finish

Download data

The meter directory is Read Only. In Windows, the meter operates as a mass storage device or removable hard drive.

1. Set the meter to USB Mass Storage mode.
2. To edit the data in a file, drag and drop the file to a laptop or PC. File names are limited to eight characters.
3. Data files are kept in the tab separated variable (.TSV) format. To see files in Microsoft® Excel, double or right-click a file and open the file with Excel.
   Real time files are stored in a directory called RT. Stream and conduit profile files are stored in a directory called P.

Delete data files

1. To delete all files from USB memory:
   a. Go to Main Menu > Diagnostics > Delete Files.
   b. In the confirmation window, select Yes.
   c. Push **OK** once to delete the files, then one more time to return to the previous screen.
2. To delete Real Time files:
   a. Go to Main Menu > Real-Time > Files.
   b. Select Delete All or use the UP or DOWN arrow to select a file in the list.
   c. Push **OK** once to delete the files, then one more time to return to the previous screen.
3. To delete Profiler files:
   a. Go to Main Menu > Profiler > Files.
   b. Select Delete All or use the UP or DOWN arrow to select a file in the list.
   c. Push **OK** once to delete the files, then one more time to return to the previous screen.

Maintenance

Download the PVM utility

The PVM utility is used to update the firmware in the portable meter. The PVM Utility is available at http://www.hach.com or http://www.hachflow.com. Do the steps listed for the selected URL.

1. Go to http://www.hach.com.
2. Search for FH950.
3. Select the product.
4. Click the Downloads tab.
5. Click the download link.
6. Click PVMSetup.msi.
7. Select Save or Run.

1. Go to http://www.hachflow.com.
2. Click Data Management.
3. Click Software Download Center.
4. Click the FH950 link.
5. Click PVMSetup.msi.
6. Select Save or Run.

Update the firmware

Note: *All data files in mass storage are lost when the firmware is updated. To download data, refer to* Download data *on page 27.*

The PVM Utility is necessary for this procedure. To download the PVM Utility, refer to Download the PVM utility on page 27.

This is the general procedure to update firmware for the meter and sensor. To update the sensor firmware, the sensor must be connected to the meter.

1. Double-click the PVM Utility desktop icon.
2. Push the power button on the meter. When the meter self-test is complete, push **OK**.
3. In the Main Menu, select Setup, then push **OK**.
4. Select USB>CDC, then push **OK**.
5. Connect the USB cable to the portable meter and the PC.
6. In the PVM Utility window, select Connect.
7. In the drop-down menu, select the PVM (COM X) port, where COM X is the virtual port number assigned to the PVM by Windows. Push **OK**.
8. In the left-side panel, select Firmware Update, then select the Meter or Sensor tab.
9. Select the correct firmware version, then click Start.
   The firmware download starts. A "Firmware update successful" message shows when the download is complete. For meter updates, the instrument display turns off until the instrument completes the update. Then, the instrument automatically resets and powers up again after a few minutes. Do not try to make the instrument power on or off before the update process is complete.
10. In the Main Menu, select Diagnostics > About. Make sure that the firmware versions for both the Handheld Boot and the Handheld Application are correct.

Clean the sensor

⚠ WARNING

Chemical exposure hazard. Obey laboratory safety procedures and wear all of the personal protective equipment appropriate to the chemicals that are handled. Refer to the current safety data sheets (MSDS/SDS) for safety protocols.

Clean the sensor when unexpected increases or decreases in flow or level trends occur and after use in sandy or muddy waterways.

For heavy contamination, soak the sensor in clear water for a few minutes to help make the contamination easy to remove.

Disconnect the sensor from the meter before it is cleaned. Use only solutions listed as acceptable in Table 4 to clean the sensor. For sensors with a pressure cell (i.e., velocity plus depth sensors), make sure the holes for the pressure cell chambers are washed out and clear of contamination. Rinse the sensor with clean water before re-attaching the sensor to the assembly.

Table 4 Acceptable and unacceptable cleaning solutions

Acceptable	Do not use
Dish detergent and water	Concentrated bleach
Window cleaner	Kerosene
Isopropyl alcohol	Gasoline
	Aromatic hydrocarbons

Clean the meter

1. Push the power button to de-energize the meter.
2. Use a clean, moist cloth to clean the meter exterior. Mix the water with a mild detergent if necessary.
3. Dry the meter exterior with a clean cloth. Let the meter dry in air completely before it is energized again.
   Note: *Do not use paper-based cloths to clean the display. This type of cloth can cause damage to the display screen.*

Replace the battery

⚠ WARNING

Fire and explosion hazard. This equipment contains a high energy lithium battery which can ignite and cause fire or explosion, even without power. To maintain the safety provided by the instrument enclosure, the instrument enclosure covers must be installed and secured with the supplied hardware.

⚠ WARNING

Explosion and fire hazard. Battery substitution is not permitted. Use only batteries that are supplied by the instrument manufacturer.

Replace the battery when the battery does not hold power when charged.

Note: *If the instrument must be returned to the factory for repair or maintenance, remove the battery and put the battery in a protective cover before shipment.*

1. Set the power to off.
2. Remove the battery. Refer to Install the battery on page 10.
3. Discard the battery in accordance with local, regional and national regulations.
4. Install a new battery in the same location and with the same orientation. Refer to Install the battery on page 10.
   Use only batteries that are supplied by the instrument manufacturer.
5. Install the battery cover. Make sure that the cover is secure to keep the enclosure rating.
6. Charge the battery if necessary. Refer to Charge the battery on page 11.

Troubleshooting

Diagnostics

In the Main Menu, select Diagnostics to see information about the meter and do the diagnostic tests in Table 5.

Table 5 Meter diagnostics

Option	Description
About	Shows information about the meter and the sensor. Includes the serial number and the firmware version.
Delete files	Deletes all files from memory to make space for new measurements. Make sure that the data is downloaded to a PC before this option is selected. The system automatically reformats the memory after file deletion.
Sensor	Shows diagnostic information about the sensor.

Table 5 Meter diagnostics (continued)

Option	Description
Self test	Makes the meter do a diagnostic self test.
Key pad test	Does a test of any button to make sure that the button is functional.
Display test	Does a test on the display to make sure that the display is functional.
Event log	Lets the user see, delete or export the event log. Export the event log to make the contents available as an accessible file through USB mass storage. This option is used primarily by factory service.

Troubleshoot errors

The meter and sensor contain no user-serviceable parts. For the errors and messages listed, try the corrective action.

If the problem does not go away or a problem occurs that is not in the list, contact the manufacturer.

Message or problem	Solution
Sensor is not connected	Connect a sensor and try the action again.
Value is out of range	Change the measurement parameters or put in a different value, then try the action again.
Sensor data is known to be not correct or not accurate	Clean the sensor and test.
Sensor is not recognized	Check the sensor connection. Make sure that the lock nut on the connection port is tight (finger-tighten only).
Display is dim or is not visible	Push a key on the keypad.
Data is not available or access to the data is not possible	Make sure that the USB option (Main Menu) is set to Mass Storage.
Meter is unresponsive	Push and hold the power button for at least 3 seconds. This de-energizes the meter. Energize the meter again. ***Note:*** *Do not use this method to power off while in normal operation or if the file access icon is visible in the display.*

Replacement parts and accessories

⚠ WARNING

Personal injury hazard. Use of non-approved parts may cause personal injury, damage to the instrument or equipment malfunction. The replacement parts in this section are approved by the manufacturer.

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Replacement parts

Table 6 Velocity only sensor

Description	Item no.
Sensor with 1.5 m (5 ft) cable	EM950.0005
Sensor with 6.1 m (20 ft) cable	EM950.0020
Sensor with 12.2 m (40 ft) cable	EM950.0040
Sensor with 30.5 m (100 ft) cable	EM950.0100

Table 7 Velocity with depth sensor

Description	Item no.
Sensor with 1.5 m (5 ft) cable	EM950.1005
Sensor with 6.1 m (20 ft) cable	EM950.1020
Sensor with 12.2 m (40 ft) cable	EM950.1040
Sensor with 30.5 m (100 ft) cable	EM950.1100

Table 8 Handheld meter

Description	Item no.
English/Metric	FH950.1

Accessories

Table 9 Wading rods

Description	Item no.
Standard wading rod kit, English	75002
Standard wading rod kit, Metric (includes the bullet items below)	75002M
• Bottom section for wading rod, English/Metric	43000M/43001M
• Intermediate section for wading rod, English/Metric	43010M/43011M
• Base plate for wading rod, English/Metric	43015M
• Double-end hanger for wading rod, English/Metric	43020M
Top set wading rod kit, English	75013
Top set wading rod kit, Metric	75013M

Table 10 General accessories

Description	Item no.
Absorbent wipe	9073500
Adjustable meter mount	9071700
Battery charger	8760200
Carrying case	9073400
Lanyard, double ended loop	9072700
Lithium battery pack	9073600
Suspension cable kit (includes bulleted items below)[3]	75003
• Sensor mount	42033

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[3] Cable is ordered separately by the foot.

Table 10 General accessories (continued)

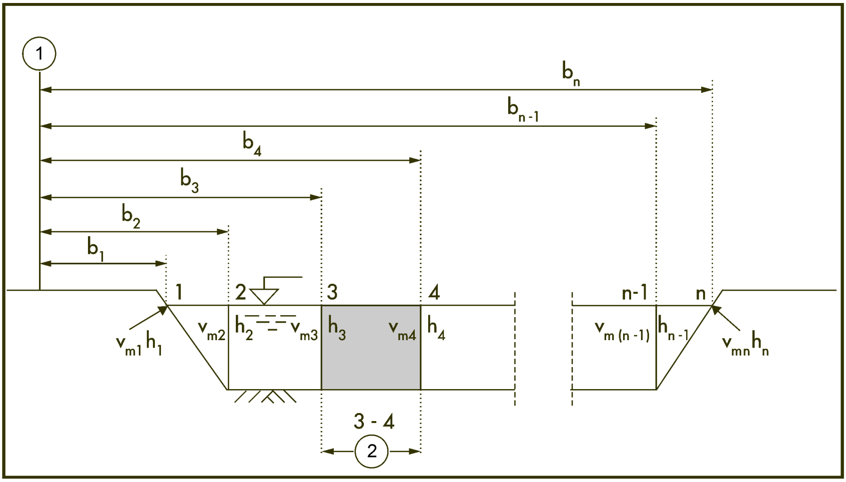
Description	Item no.
- Link connector	43025
- Weight hanger	43030XX01
- Weight pin	43035M
- 6.8 kg (15 lb) lead weight	43040
Thumb screw kit (includes four thumb screws)	9073200
Universal sensor mount	75015
USB cable	9070800

Appendix

Mean-section and Mid-section methods

The user can select the Mean-section or the Mid-section method for flow calculations. The Mean-section method divides the cross-section into individual flow segments. Pairs of adjacent verticals are the limits of the segments. The two edges of the cross-section are given values of 0 for the velocity and depth. The total flow is the sum of the partial flows of all segments. Figure 15 shows the definitions and the equation for the Mean-section method.

Figure 15 Mean-section method



$$q_{3-4} = \left(\frac{V_{m3} + V_{m4}}{2}\right) \times \left(\frac{h_3 + h_4}{2}\right) \times (b_4 - b_3)$$

Where:

V = velocity at vertical

b = distance to vertical from bank

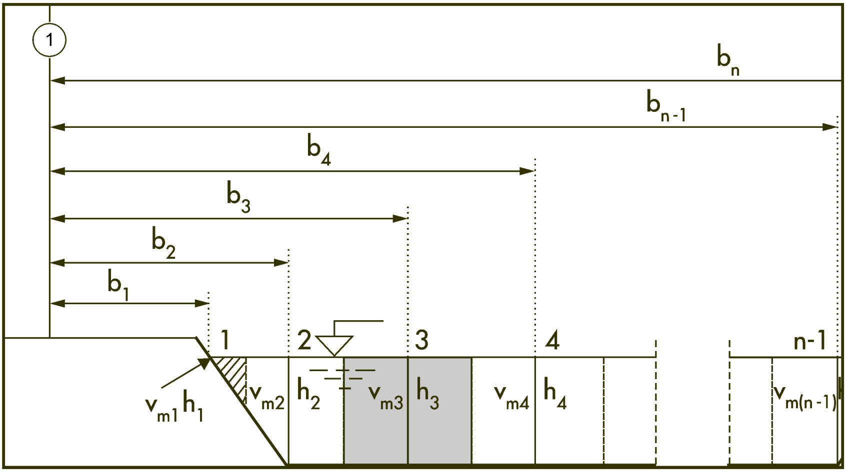
h = depth at vertical

q = flow at vertical

The Mid-section method also divides the cross-section into individual flow segments. With the Mid-section method, the segments are not between verticals but are defined by half of the distance to neighbor verticals in each case. For this reason, the first and last verticals should be as near to the edges as possible (i.e., left edge of water (LEW) and right edge of water (REW)). Boundary conditions dictate the proximity of the first and last vertical to the edge of water.

Experience shows that the Mid-section method gives more exact results compared to the Mean-section method so it is the default setting. Figure 16 shows the definitions and equation for the Mid-section method.

Figure 16 Mid-section method



$$q_3 = V_{m3} \times \left(\frac{(b_3 - b_2) + (b_4 - b_3)}{2} \right) \times h_3$$

Where:

m = station number

n = total number of stations

V = velocity at vertical

b = distance to vertical from bank

h = depth at vertical

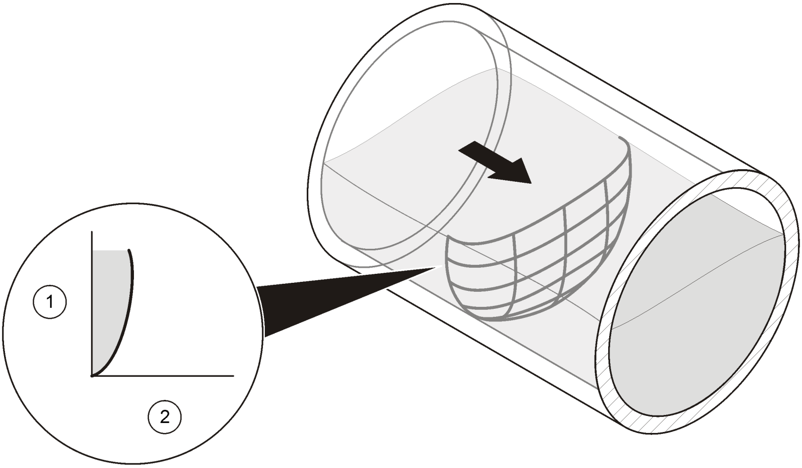
q = flow at vertical

Profiles and measurements

Profiles can be set up for streams or conduits. Figure 17 shows an example of a typical profile shape in a conduit. In a typical profile, velocity is less near a wall or edge than at the center and decreases near the surface. Multiple velocity measurements in the profile are averaged to calculate the total flow. Measurements for conduit profiles are made from the bottom up. Measurements for stream profiles are made from the top down or bottom up.

In the Main Menu, select Profiler. The meter prompts for the operator name, the type of profile (stream or conduit) and the profile name. Do the instructions for the selected profile type.

Figure 17 Typical profile



1 Depth	**2** Velocity

Site selection

A site with the typical profile shape gives the most accurate results. Visual inspection is typically sufficient to identify problem sites. Use the information in these guidelines to help select the best site.

These guidelines apply to conduit and stream profiles.

- The channel should have as much straight run as possible. If the length of the straight run is limited, the length upstream from the profile should be two times the downstream length.
- The channel should be free of flow disturbances. The site must not have protruding pipe joints, sudden changes in diameter, contributing side-streams, outgoing side-streams or obstructions. Remove all rocks, sediment or other debris from the bottom of the pipe.
- The flow should not have visible swirls, eddies, vortices, back-flow or dead zones.
- Do not select areas immediately downstream from sharp bends or obstructions.
- Do not select areas with converging or diverging flow (approaches to a flume) or vertical drops.
- Do not select areas immediately downstream from sluice gates or places where the channel spills into a body of stationary water.

Do a velocity calibration

Use this feature to remove a velocity offset if necessary. The velocity offset stays active until the meter power is switched off.

1. Collect a bucket of water from the water in the profile area. The bucket must be non-metallic and at least 20.32 cm (8 in.). The water depth must be at least 15.24 cm (6 in.).
2. Put the sensor in the center of the bucket so that it does not touch the sidewall or the bottom of the bucket.
3. Let the water become still.
4. Let the velocity reading stabilize.
5. Select Zero Velocity.

Wet/Dry threshold

The wet/dry threshold is the trigger point for the meter to know when the sensor is in or out of the water. This information is important because if the meter does not know that the sensor is under the surface of the water, the meter sets the velocity value to zero. For a profile or real-time reading, the meter prompts the user to submerge the sensor in the water.

If the specific conductivity of the water being measured is very low, adjust the threshold value for the best performance. Go to Setup Menu>Wet/Dry Threshold.

For troubleshooting, the present reading is used as a guide to set a custom threshold. Get a reading in the water (wet) and then out of the water (dry). The threshold value must be between the wet and dry value. For example, if the actual wet value is 17 and the actual dry value is 2, put in a threshold value half way between 2 and 17. The default value is 20.

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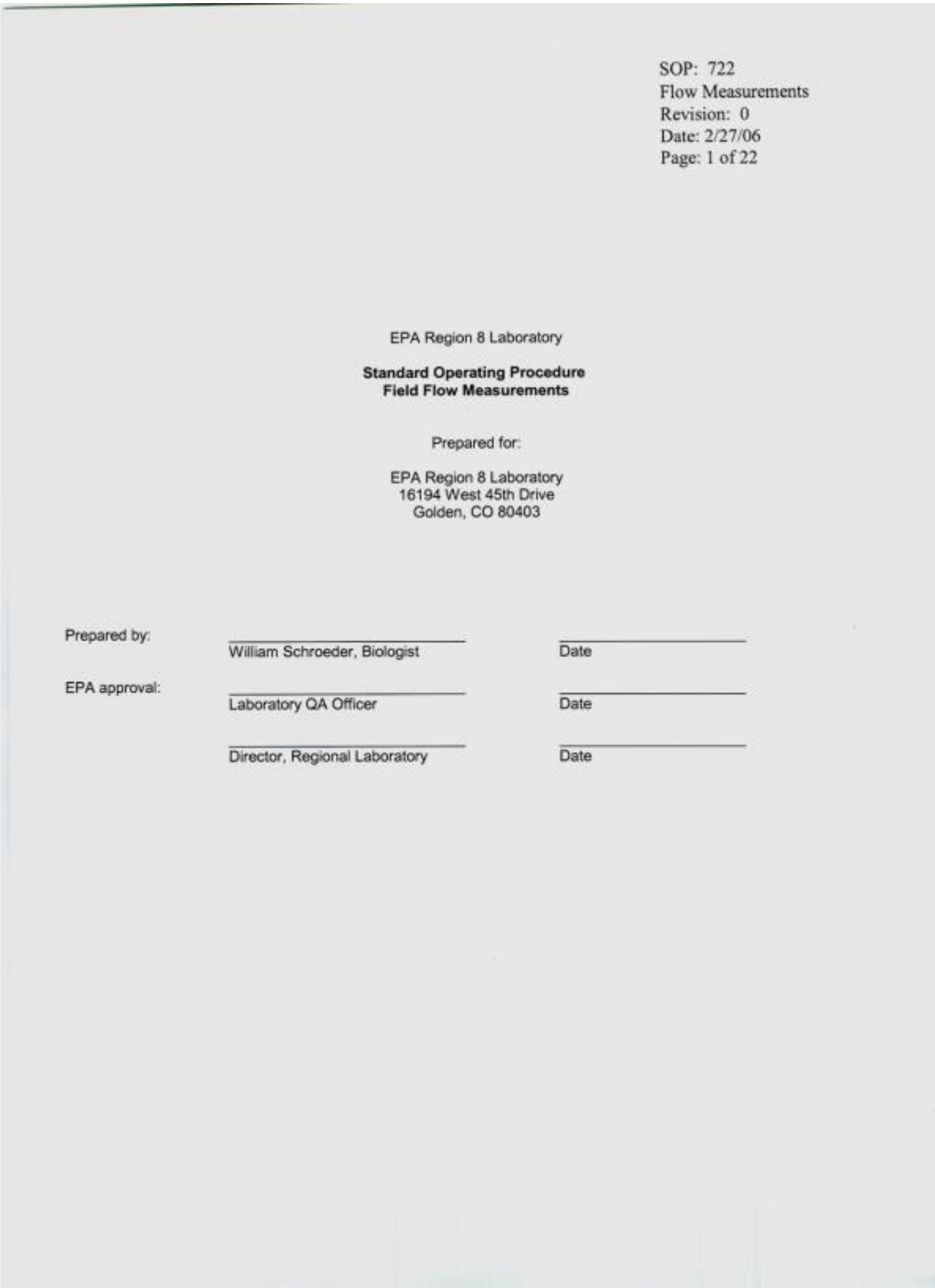
SOP 722 Flow Measurements



EPA Region 8 Laboratory

Standard Operating Procedure
Field Flow Measurements

Prepared for:

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EPA approval:	Laboratory QA Officer	Date
	Director, Regional Laboratory	Date

Table of Contents

1.0 Scope and Application

This document describes three basic techniques for measuring streamflow during a water quality sampling event. The first technique, referred to as the velocity-area procedure, measures stream discharge using a current meter attached to a wading rod. The second procedure measures discharge using a cutthroat flume. The third technique, known as the timed filling procedure, utilizes a bucket and stopwatch for discharge measurements. It is important to note that flow procedures can be modified in the field due to characteristics of the sampling location and the data quality objectives for the sampling event. This document serves as a basic flow measurement standard operating procedure (SOP) for the EPA Region 8 Laboratory and does not describe all types of flow measurement procedures that a hydrologist can use in the field.

Mention of trade names or commercial products in this document does not constitute endorsement or recommendation for use. Because the EPA Region 8 Laboratory uses the Marsh-McBirney Flo-mate model 2000 flowmeter, specific instructions for the calibration and use of this instrument will be described in this document. Hydrographers should consult their instrument's instruction manual when using a flowmeter from a different manufacturer.

2.0 Summary of Method

Choose a method to measure flow.
Choose an area to measure flow.
Setup the flow measuring device (flowmeter, flume, etc.).
Record data.
Calculate flow.

3.0 Definitions and Attachments

Cross section	a plane that extends perpendicular to flow, from one stream bank to the other, and is used for depth and velocity measurements (also called a reach)
Discharge	The amount of water flowing past a point over a given amount of time (also referred to as flow)
Eddies	Areas where water moves in the opposite direction to the main flow current, typically in a circular pattern and characterized by waves or whirlpools
EPA	Environmental Protection Agency
Flow increment	the interval at which depth and velocity readings will be taken across the stream (also referred to as a width increment)
Gauge	A device used for measurement
Hydrographer	the person who takes streamflow measurements in the field
Laminer flow	The regular, continuous, and smooth movement of water
Measurement verticals	points in the stream where depth and velocity measurements are taken
Tag line	a line or tape measure that marks the stream cross section and is used to position the wading rod for depth and velocity measurements
Timed filling procedure	a procedure that uses a bucket and stopwatch to measure streamflow
Velocity-area procedure	a procedure that uses a velocity sensor and depth gauge to measure streamflow (also referred to as the flowmeter procedure)

Wading rod	the device to which the flow sensor is attached, is used to measure water depth, and positions the sensor at two-tenths, six-tenths, and eight-tenths depth

4.0 Cautions

Always obtain permission when measuring flows on private property. Keep all equipment in good working order and perform maintenance procedures as necessary.

5.0 Interferences

Several parameters can affect the accuracy of flow measurements. Interferences will be discussed separately for each flow measurement technique below.

5.1 Velocity-area (Flowmeter) Procedure

Stream discharge is equal to the product of the mean current velocity and vertical cross sectional area of flowing water (EPA 2003). Because the velocity-area procedure uses a flow sensor attached to a wading rod, anything that is likely to interfere with the performance of the sensor will have an effect on final discharge calculations. Hydrographers should assure that all batteries are fully charged when operating the flowmeter. Care should be taken to keep the sensor clear of all types of stream debris. Sediment, algae, macrophytes, wood, or rocks immediately in front of the sensor may result in inaccurate velocity measurements. Because the flowmeter uses an electromagnetic sensor to measure velocity in a conductive liquid (water), interference with the electromagnetic signal will affect meter performance. The presence of airspace (bubbles, rapids, etc.) around the sensor will cause a "Con Lost" error message to display on the screen, indicating that the sensor is out of the water and preventing the meter from taking readings . Naturally occurring geologic features, such as magnetite in the streambed, will also disrupt the meter's electromagnetic signal and will interfere with its performance. The accuracy of streamflow measurements can be increased by choosing a stream cross section that is free of obstructions.

5.2 Flume Procedure

The accuracy of streamflow measurements using a flume is highly dependent upon where the hydrographer chooses to place the flume. Flumes should always be placed in areas where water is flowing and not pooled. Flumes must always be level before readings are taken. Failure to do so will prevent water from properly flowing through the device and will result in an inaccurate depth measurement and subsequent discharge calculation. Hydrographers should also remove rocks or level uneven substrate immediately upstream of the flume so water does not undulate in the vicinity of the depth gauge and produce an inaccurate depth reading. All water at the flow measurement location must flow through the flume. Water that is pooled and not flowing properly through the device will result in an inaccurate discharge measurement. Hydrographers must adequately dam the flume using all available materials and check to be sure that leaks are not present. Flumes used to measure flow must also be the proper size. Discharge measurements taken with flumes that are too large or small for the flowing volume of water are likely to be inaccurate.

5.3 Timed Filling Procedure

When using the timed filling procedure, stream discharge is determined directly by measuring the time it takes to fill a container of known volume. Any physical barrier (rocks, logs, roots, etc.) that prevents the consolidation of water into the container will interfere with the accuracy of the final discharge calculation. Hydrographers should always remove any barriers that exist before readings are taken. In the event that barriers can not be removed, a new location should be selected for the timed filling procedure.

6.0 Health and Safety

Measuring streamflow often requires walking on uneven and slippery substrate in the presence of rapidly flowing water. Hydrographers should exercise extreme caution when attempting to measure flow and should make decisions not to do so when conditions are too dangerous. Personnel should always wear the appropriate level of personal protective equipment (PPE) that is suited for the job. Flow procedures should be halted immediately if lightning is observed in the immediate vicinity.

7.0 Personnel Qualifications

Personnel should thoroughly read and understand this standard operating procedure before attempting flow measurements in the field. Personnel who do not have considerable experience measuring flow should always work with more experienced hydrographers until they gain the experience necessary to perform these measurements on their own.

8.0 Equipment and Supplies

8.1 Velocity-area (flowmeter) procedure

Tape measure
Tape measure securing device (pipes, rebar, stakes, sticks, rocks, etc.)
Flowmeter with charged batteries
Wading rod
Clipboard
Write in the rain flow forms
Pencils / Pens
Calculator

8.2 Flume procedure

Flume (of the appropriate size for the sampling location with water depth gages)
Shovel
Bubble level
Material in the surrounding location to dam the flume (dirt, rocks, etc.)
Clipboard
Write in the rain flow forms
Pencils / Pens
Calculator

8.3 Timed filling procedure

Device of the appropriate size to measure water volume (bucket, flask, etc.)
Stopwatch
Clipboard
Write in the rain flow forms
Pencils / Pens
Calculator

9.0 Reagents and Standards

Reagents and standards are not used for flow measurements.

10.0 Sample Collection, Preservation, and Storage

This section is not applicable to flow measurement procedures.

11.0 Procedures

11.1 Determine the Appropriate Flow Procedure

When arriving at a sampling location, a hydrographer will need to determine which flow technique is best to use. The velocity-area procedure can measure discharges of any size, from small to large. The portable flume and timed filling procedures typically measure smaller discharges that are easily consolidated. A hydrographer may be able to choose between all three flow methods when discharges are less than 2 cubic feet per second (cfs). Several variables will need to be considered in order to choose the best flow technique, including: discharge size, width, depth, velocity, obstructions, ease of flow consolidation, levelness of the measurement location, and bottom substrate. A hydrographer may perform the velocity-area procedure when the discharge is spread out over a wider area and is not easily consolidated into a flume. Likewise, he or she may use the timed filling procedure when flow arises from a pipe or culvert or when the ground is too sloped to level a flume. If site conditions still warrant the use of all three techniques, the hydrographer should always use the flume method because it is the most accurate for smaller discharges.

11.2 Determine the Appropriate Measurement Location

Choosing a great location to collect measurements is the most important step in obtaining high quality flow data. It can also save the hydrographer a considerable amount of time and effort in the field. Personnel must always be mindful of safety issues and should consider other locations if conditions are too dangerous. Below is summery of things to consider when choosing a location for each flow technique.

11.2.1 Site considerations for the velocity-area procedure

Because the velocity-area procedure involves the collection of depth and velocity measurements at several points across the stream, hydrographers should choose a measurement area that is easy to wade across. Areas containing surging water or riffles should be avoided because they limit the accuracy of the flow sensor. Hydrographers should setup a cross section where flow is as consistent as possible across the entire reach. Stay away from uneven substrate where water rapidly changes in depth and velocity. Make sure that flow moves in a positive direction across the entire reach. Avoid backwater areas where flow is likely to go upstream (negative), especially at the banks. Choose a cross section where water flows directly perpendicular to the cross section. The accuracy of velocity measurements is decreased when water intersects the sensor at an angle other than 90 degrees. Undercut banks should also be avoided because it is very difficult to take depth and velocity measurements in these areas. Stay far enough downstream from obstacles such as rocks, logs, tree limbs, sand bars, and bridge posts so flow measurements are not obstructed.

Once the flow location has been chosen, survey the area to be sure that all of the streamflow will be captured. It is often easy to overlook side channels when vegetation is thick at the banks. In cases where side channels can not be avoided, measure the flow at both the stream location and the side channel and add these two values together in the final discharge calculation. Remove any obstructions in the cross section or upstream before starting flow measurements.

11.2.2 Site considerations for the flume procedure

Similar to the flowmeter technique, choosing a good location to take measurements is very important when installing a flume. The hydrographer should look for areas where water is actively flowing and can easily be consolidated into the flume. Avoid places where water is pooled or widely dispersed. Because flumes must be level when taking measurements, steer away from slopes or steep gradients. Hydrographers can always modify the discharge channel with a shovel in order to make it suitable for installation of the flume. Choose a location where material is available to easily dam the flume. Materials of a small particle size, such as dirt or clay, typically work the best.

11.2.3 Site considerations for the timed filling procedure

When searching for a location to take flow measurements with the timed filling procedure, look for areas where water can easily be collected into the bucket. Waterfalls or discharges from the end of a culverts are the best to measure with this procedure. Avoid areas where obstructions hinder the consolidation of all water into the bucket. The hydrographer can always modify the discharge channel with a shovel to facilitate this process.

11.3 Velocity-Area Procedure

Once the flow location has been determined for the velocity-area procedure, it is time to setup the cross section for collection of depth and velocity measurements. Stretch a tape measure across the stream, perpendicular to the flow, from one bank to the other. The tape, also known as a tag line, can be secured at water's edge using a pipe, stake, or piece of rebar so the stream wetted width can be accurately measured. Secure the other end in the same fashion. Use rocks, tree limbs, etc. to secure the tape in the event that stakes are not available. Make sure that the tag line is pulled taut so it doesn't droop into the stream water. Remove rocks and other obstructions to improve the cross-section before taking measurements. Because removing obstacles from one part of a cross-section affects adjacent water velocities, hydrographers should not modify the cross-section once readings commence. Be sure to check for eddies, negative flow, or other onerous flow patterns under the tag line before taking measurements. Modify the substrate as necessary.

Record the sampling station, facility/site description, sampling crew, date/time, stream width, meter type, and measurement units on the top of the stream discharge form. See Figure 1 for an example of a stream discharge form. Be sure to always use the same measurement units when taking flow. When measuring depth in feet, record the tag line position and width in feet and the flow velocity in feet per second so that discharge can easily be calculated into cubic feet per second (cfs). Use a tag line that measures distance in feet and tenths of feet rather than feet and inches to avoid having to convert inches into tenths of feet for the discharge calculation. If discharge needs to be reported in cubic meters per second, record depth, width, and tag line position in meters and velocity in meters per second. The EPA Region 8 Laboratory will always report streamflow in cubic feet per second unless otherwise requested.

Choose an appropriate flow increment, the interval at which depth and velocity readings will be taken across the stream (ie. 1 ft, 2 ft, etc.). Choose an increment that is small enough to obtain between 20 and 30 measurement verticals within the stream width; 25 is preferred for quality control (QC) purposes. The best way to do this is to divide the total stream wetted width by 25 and round down to a convenient number. A stream that is 53 feet wide, for example, would require a 2-foot flow increment (53/25 = 2.12, round down to 2). It is important to note that flow increments do not have to remain consistent across the stream and can be changed when discharge changes across the tag line. Hydrographers should remember to always take more depth and velocity readings in areas of greater discharge. For this reason, a hydrographer may start taking measurements using a two-foot flow increment but may decide to reduce the flow increment to one foot in an area where water becomes deep and fast. Likewise, he or she may decide to increase the flow increment to three or four feet when water becomes shallow and slow. Figure 2 illustrates this principle.

Attach the velocity sensor to the calibrated wading rod. Be sure to adequately tighten the mounting screw so that the sensor does not spin on the housing. Mount it so that the three electrodes are parallel to the base of the wading rod and the cable exits from the top. It is always a good idea to attach the sensor to the wading rod before entering the stream so the mounting screw can be easily retrieved if accidentally dropped.

Determine where to start taking flow measurements across the tag line. In the event that there is a significant amount of discharge along the edge of the stream, take the first depth and velocity reading in the water at the bank edge (zero feet on the tag line). If there is not a significant amount of flow at the bank edge or if bank conditions prevent the hydrographer from submersing the sensor or obtaining an accurate measurement, the first reading should be taken out of the water on top of the bank at zero feet on the tag line. In this case, the depth and velocity for the first flow increment would be zero. Figure 2 illustrates this point.

When taking measurements, stand downstream of the tag line, place the wading rod in the water, and measure the depth using the increments on the rod. Each single mark represents 0.1 foot, each double mark represents 0.5 foot, and each triple mark represents 1 foot (see Figure 3). Measuring depth can become a difficult task in areas of high velocity because water will wave and climb up the wading rod. When this happens, stand at arm's length to the side and downstream of the rod, observe the water surface, and determine which line on the wading rod best represents the average depth at the measurement vertical. Be sure that body position does not affect the depth reading. Record the tag line position in the first column of the flow form, the distance to the opposite bank in the second column, and the depth in the fourth column.

After determining the depth, position the sensor. In cases where the water is 2.0 feet deep or less, the velocity reading will need to be taken at a position 60% of the way down from the surface and 40% up from the stream bottom. To set the sensor in this position, also known as six-tenths (0.6) depth, line up the foot scale on the sliding rod with the tenth scale at the top of the depth gauge rod (see Figure 3). If, for example, the total depth is 1.7 feet, align the "1" on the foot scale with the "7" on the tenth scale. The sensor is now at six-tenths depth and velocity measurements can be taken.

In cases where water depth is greater than 2.0 feet, USGS recommends that velocity readings be taken at two positions along the vertical profile at two-tenths depth (0.2) and eight-tenths depth (0.8) and averaged for the final discharge calculation (see Figure 2). (Rantz and others 1982) Because the sliding rod and depth gauge rods are both calibrated for taking measurements at six-tenths depth, a hydrographer will need to perform two simple calculations in order to properly position the sensor at these two positions. To set the sensor at two-tenths depth, multiply the total depth by two and use this new value to position the sensor using the foot scale and tenth scale. To set the sensor at eight-tenths depth, divide the total depth by two and use this number to position the sensor. Let's say, for example, that a hydrographer measures a depth of 2.6 feet at one vertical. Because this water depth is greater than 2.0 feet, he/she knows that velocity measurements will need to be taken at both two-tenths depth and eight-tenths depth and averaged for the discharge calculation. Because $2.6 * 2 = 5.2$ and $2.6 \div 2 = 1.3$, the hydrographer will use the values of 5.2 feet and 1.3 feet to position the sensor for the two velocity readings.

Once the sensor has been properly positioned, face it upstream directly into the streamflow. Grasp the sensor cable with the hand that is holding the wading rod to prevent it from dipping into the stream current and causing the probe to spin on the housing. Turn the meter on and allow it to equilibrate before recording velocity. Readings will tend to change rapidly at the start of the measurement cycle but should stabilize as individual velocity readings are averaged. Usually one 30 second cycle is sufficient to obtain a stable velocity reading. Depending on the data quality objectives for the sampling event, the measurement cycle can be increased or decreased by pushing the up or down arrow keys. In cases where flow is not laminar and eddies cause the velocity reading to change erratically at the end of the first cycle, it will be necessary to run the meter for one or two additional cycles before recording the velocity. Record the velocity measurement in the fifth column on the flow form. In the event that velocity measurements are taken at both two-tenths and eight-tenths depth, be sure to also calculate and record the average of the two values on form.

Move to the next flow vertical, measure the depth, reposition the sensor, and determine the velocity as described earlier. Be sure to always reset the meter by pushing the "on" button before measuring velocity at a new vertical. Repeat this process until depth and velocity measurements are obtained across the entire reach of the stream and are transcribed to the flow form. Figure 6 shows an example of a stream discharge form that has been filled out properly.

Measuring streamflow typically requires two people; one to collect depth and velocity measurements and another to record the data. For quality control purposes, data transcribers should always calculate the streamflow before taking down the tag line and leaving the sampling location. Streamflow is calculated by summing the discharges of all measurement verticals to obtain total discharge. Discharge at each vertical is determined by multiplying the vertical's cross sectional area with its observed velocity. Hence, vertical discharge = width * depth * velocity. Because depth and velocity were measured by the hydrographer in the previous steps, the data transcriber must now determine the width of each vertical in order to calculate discharge.

The width of the measurement vertical can be determined by using one of two different techniques. Using the first technique, known as the midsection method, width is determined by the distance extending halfway from the previous measurement vertical to halfway to the next vertical. Depth and velocity measurements at the vertical occur midsection or in the middle of the resulting subsection. (See Figure 4.) The second technique is called the endsection method. In this case, depth and velocity measurements at the measurement vertical occur at the far end of the rectangular subsection and width is determined by the distance from the previous observation interval to the observation vertical. See Figure 5 for a visual representation of the endsection method.

When comparing Figures 4 and 5, several differences can be noted between the midsection and endsection methods. Notice the first measurement vertical at the left bank edge. When using the midsection technique (Figure 4), width of this vertical extends to the right from the bank edge to midway to the next vertical. Width does not extend to the left because this area is out of the water and there is no flow. When using the endsection technique (Figure 5) as previously described, width of the bank vertical extends to the left from the bank to the previous vertical. Because this area is entirely out of water, width is considered to be zero and discharge is zero even though depth and velocity measurements at the bank edge are greater than zero. Notice also how width calculations vary between the two techniques when the increment used to take depth and velocity measurements suddenly changes in the stream cross section. Compare the widths of subsections 5 and 13 between Figures 4 and 5.

After determining the width of each measurement vertical and recording the width values in the third column of the stream discharge form, the data transcriber should next calculate the final streamflow. Multiply width of the measurement vertical (column 3 on the stream discharge form shown in Figure 1) by its depth (column 4) by its velocity (column 5) to obtain discharge at the vertical. Write this value in column 6. Sum up all of the values in column 6 to obtain total discharge and write this value in the space provided at the bottom of the form.

Because width calculations can vary between the midsection and endsection techniques, the final discharge calculations will also vary between the two methods. Differences will occur when the measurement interval changes in the stream cross section or when readings are taken at bank edge. Typically the difference in discharge calculations between the two techniques is minimal. For purposes of this document, the EPA Region 8 Laboratory will use the midsection technique when taking flow measurements with the velocity-area procedure. In the event that volunteers or other governmental personnel assist the Region 8 Laboratory with streamflow measurements and calculate discharge in the field using the endsection technique, EPA personnel will recalculate discharge using the midsection technique before reporting the data to project managers.

For quality control purposes, the calculated discharge at any one measurement vertical must not account for more than 10% of the total discharge. This QC measure, known as the 10% rule, assures that the hydrographer has taken enough depth and velocity measurements across the stream in order to accurately characterize its flow. After calculating total discharge, the data transcriber should next look for violations of the 10% rule. The easiest way to do this is to multiply total discharge by 0.1 and compare this value to those found in column 6 of the stream discharge form. Any value in column 6 that exceeds this calculated value is in violation of the 10% rule. When an exceedance is discovered, the hydrographer should return to the vertical where the exceedance occurs and take additional measurement verticals on either side. It is best to place the additional verticals at half the distance (midway) to the adjacent verticals. Record depth and velocity measurements of the new verticals on the discharge form and be sure to adjust the corresponding width calculations. Figure 6 shows an example of a stream discharge form where a violation in the 10% rule has occurred. When in the field, a hydrographer can take steps to prevent violation of the 10% rule. Always remember to decrease the flow increment and take more depth and velocity measurements in areas where water is deep and flowing rapidly.

Once an acceptable discharge value has been obtained without violations in the 10% rule, turn off the flowmeter, remove the flow sensor from the wading rod, and take down the tag line. Move on to the next sampling location.

11.3.1 Troubleshooting

When a hydrographer properly sets up a stream cross-section for measurements with a flow meter, few problems are likely to occur. In some cases, however, unusual flow patterns underneath the tag line can not always be observed prior to taking measurements. A hydrographer may discover that velocity suddenly turns negative at a measurement vertical, indicating that flow is moving upstream. When this occurs, look for obstacles upstream that are likely to be the source of the problem. Because circumstances will vary at each sampling location, several remedies can be considered. The best option is to move the tag line to a different location and retake the flow measurements, especially when the obstruction can not be removed. When time is a constraint and there is little negative flow, consider removing the obstruction, if possible. When doing so, be sure to observe how the flow pattern changes at the previously measured verticals and retake depth and velocity measurements at the affected verticals as necessary. In some cases, negative flow can not be avoided at a sampling location. When this occurs, rotate the flow sensor 180 degrees and face it directly into the negative flow so that an accurate velocity can be determined. Record the negative velocity on the discharge form and determine the negative discharge at the measurement vertical.

Problems can also occur when measuring flow on a stream with silty or mucky substrate. Soft substrate often causes the wading rod to sink while velocity measurements are taken. When this happens, the flow sensor is no longer positioned at the required depth and could result in an inaccurate velocity measurement. To avoid this problem, hold the wading rod on top of the substrate and sustain its weight to prevent it from sinking while taking measurements.

When using a Marsh-McBirney flowmeter, a "con lost" message will display on the screen when the sensor is taken out of the water. This error message may occur when attempting flow measurements in rapids where airspace is likely to disrupt the sensor's electromagnetic field. Velocity readings in white water are very inaccurate and should never be attempted. If possible, select a better cross-section with more laminar flow for measurements. A "con lost" message may also appear when the sensor is in the water, indicating that something is interfering with the velocity measurement. When this occurs, first check for obstructions. Remove any debris (algae, macrophytes, trash, etc.) that may have drifted in front of the sensor. If there are no obstructions, check for an oil or grease coating on the sensor. Clean if necessary with soap and water and do not use hydrocarbon solvents. If the problem still persists, clean the electrodes with a very fine grit (600) sandpaper. (Marsh-McBirney 1990)

Because flowmeters use an electromagnetic signal to determine water velocity, anything that is likely to interfere with this signal will disrupt measurements. Natural geologic features that produce their own electromagnetic field, such a magnetite for example, can hinder the performance of the flowmeter. Noisy readings, negative readings, and even "con lost" errors may result. To solve the problem, perform the measurements in a new location away from the electromagnetic interference.

11.4 Flume Procedure

Once a suitable flume location has been determined, select an appropriate sized flume for measurements. Choose a flume with a throat size that can handle the flowing volume of water but is not so large that flow decreases in velocity or pools as it passes through the throat. If flow is dispersed over a wide area, select a flume with wingwalls to assist with flow consolidation. Next, prepare the installation site. Remove any rocks, vegetation or other debris from the area that could obstruct flume installation or the flow measurement processes. Because flumes must remain level for an accurate discharge reading, remove any obstacles that tip the flume to one side or the other. Do not dig too much while removing substrate; a deep hole may disrupt the flow and could affect the quality of the measurement.

Place a bubble level on top of the flume and install the device. Use a circular bubble level so it can be leveled in all directions. If a circular bubble level is unavailable, a bar-type level can also be used and rotated in all directions. Place the flume into the flow so water passes directly into the short end, through the throat, and out the longer back end. Position it so that flow is even and water does not bank against one side or the other. When using a flume with wingwalls, extend the wingwalls as much as possible so they do not interfere with the flow of water. Check the water depth gauge in the front to be sure that the flume is not upsidedown. Dam the flume by shoveling dirt and debris around it and the wingwalls. This process may require the assistance from a volunteer to hold the flume level while the surrounding area is disturbed. Be sure to seal the front edge so that water does not pass under the device. Check for leaks and fix as necessary. Remove any obstructions upstream that cause water to wave near the depth gauge.

Once the flume has been installed, measure the upstream water depth, H_a, using the gauge on the front and compare this value to the water depth at the downstream gauge, H_b. In order to assure an accurate flow measurement, water depth at H_a must be at least twice the depth at H_b. If H_a is not at least twice H_b, water is not flowing fast enough through the device. To correct this problem, install a flume with a smaller throat width or move it to a shallower location where water is flowing more rapidly. In cases where pooled slow-moving water is unavoidable, the hydrographer can narrow the flow channel and decrease water depth by shoveling material into the channel. Consolidating flow in this manner will cause water velocity to increase, making an acceptable flume measurement more likely. Figure 7 depicts a flume that has been setup in the appropriate manner.

Once acceptable flume readings have been obtained, fill out the header information on the top of a stream discharge form including the sampling station, facility/site description, sampling crew, and date/time. Record the water depths at H_a and H_b and the flume's throat width in the spaces provided on the form. Calculate the flow in gpm and cfs using the appropriate formulas for the flume's throat width and transcribe these values to the bottom of each column. Remove the flume from the stream and clean it as necessary. Use the shovel to restore the measurement location to pre-flume conditions.

11.4.1 Troubleshooting

The most difficult task when measuring flow with a flume is getting water to flow properly through the device so that H_a is at least twice H_b. As discussed in section 11.4, a hydrographer can choose a different location, use a smaller flume, or modify the stream channel in order to solve the problem. If these techniques do not work, consider using the two other methods to measure the flow.

11.5 Timed Filling Procedure

Once an appropriate location has been determined for the timed filling procedure, modify the location as needed to assure that all flow can be consolidated into the sampling device (bucket, flask, etc.) for the measurement period. Remove rocks or other obstacles that prevent flow from being captured. Fill out the header information on the top of a stream discharge form including the sampling station, facility/site description, sampling crew, and date/time. Place the sampling device into the flow and measure the time it takes to fill the device to a reasonable level using a stopwatch. Record the volume of water that is collected and the elapsed time in the timed filling section of the discharge form. Be sure to also mark the units of volume and units of time on the form. Perform at least five measurement trials. In the event that a significant difference in volume collected per unit time is noted between trials, more trials may be necessary to obtain an accurate measurement. Sum the total volume collected and total time observed across all trials and record in the appropriate spaces on the discharge form. Divide total volume by total time to obtain an average discharge reading and transcribe it to the form. Proceed to the next sampling location.

11.5.1 Troubleshooting

Problems will arise with the timed filling procedure when the sampling device (bucket, flask, etc.) is not the appropriate size for the flowing volume of water. It would be very difficult, for example, to use a 5 gallon bucket to measure a 300 gpm discharge surging from the end of a culvert. Likewise, a 5 gallon bucket could be too large for a mere trickle of water. If the sampling device is not the appropriate size for the volume of water, choose a different size or consider using one of the two other methods to measure the flow.

12.0 Data Analysis and Calculations

Sections 11.3 thru 11.5 describe all data analysis and calculation procedures that need to be performed in the field. Formulas used to calculate discharge using a flume are shown on the stream discharge form in Figure 1. Report discharge in cubic feet per second (cfs) unless otherwise requested by project managers. In the event that discharge needs to be reported in gallons per minute (gpm), use the following formula to convert units from cfs to gpm:

$$\text{gpm} = \text{cfs} * 448.8$$

Recalculate discharge upon return to the office using a spreadsheet to fix any transcription or rounding errors that may have occurred in the field. Figure 8 displays how a spreadsheet can be designed for final discharge calculations for all three flow techniques.

13.0 Computer Hardware and Software

As discussed in section 12.0, use spreadsheet software to calculate final discharge measurements before presenting the data to project managers. Choose between a number of different programs offered by various manufacturers, including: Lotus 123, Microsoft Excel, or Corel Quattro Pro.

14.0 Quality Control

When measuring flow in the field, hydrographers may encounter a flow device that is permanently installed near their sampling location. Devices may include Parshall flumes, cutthroat flumes, weirs, USGS staff gages, or real-time USGS streamflow gages. Hydrographers may choose to compare the streamflow data they collect in the field to the streamflow data measured by these devices for quality control (qc) purposes. Always contact the owner of the flow device to be sure that it has been properly serviced, calibrated, and maintained for accurate measurements. Flow data from real-time USGS streamflow gages can be accessed on the internet at http://waterdata.usgs.gov/nwis/rt/. Simply select the state in which the gage is located and then select the gage from the corresponding state map. Because real-time flow data is only available for a limited time, be sure to visit the website shortly after returning from the field event.

When encountering a USGS staff gage, contact the USGS to determine the accuracy of the device (whether or not is has been properly maintained) and to obtain a flow-rating curve. Be sure to record the gage measurement in the space provided near the bottom of the discharge form. In the event that USGS has not properly maintained the device, the measurement can not be used for qc purposes. When encountering a flume, record the throat width, the upstream height (H_a), and the downstream height (H_b), if available, on the discharge form. Also note the type of flume on the discharge form and consult the owner for the appropriate discharge formula. If necessary, consult the Bureau of Reclamation Water Measurement Manual for additional assistance. (US Department of Interior Bureau of Reclamation 1974)

Because streamflow constantly changes, the EPA Region 8 Laboratory does not recommend that hydrographers take duplicate flow measurements for qc purposes, especially during periods of high runoff. When duplicate flow measurements are required for the sampling event, take the measurements at the exact same time and do so in a manner where they do not interfere with each other.

Enter all flow data into a spreadsheet after the field event for final calculation of discharge. This step will fix any rounding or transcription errors that may have occurred in the field when using the calculator. The EPA Region 8 Laboratory will store flow data in the Laboratory Information Management System (LIMS) and will peer review it before presentation to project managers. Additional qc procedures for the three flow techniques are described below.

14.1 Velocity-Area Procedure

Hydrographers should consult their flowmeter's instruction manual for specific requirements regarding instrument calibration. Marsh-McBirney, the manufacturer of the EPA Region 8 flowmeters, recommends that hydrographers perform a zero adjust calibration procedure at least once per year. The zero adjust procedure calibrates the sensor to zero velocity. To perform this procedure, first clean the sensor with soap and water to remove any oil or grease coatings that may cause noisy readings or conductivity lost errors. After cleaning, place the sensor in a 5 gallon bucket of water at least three inches away from the sides and bottom of the bucket. To assure that the water is not moving, wait ten to fifteen minutes after positioning the sensor. Press the STO and RCL keys at the same time to initiate the zero adjust sequence. When the number "3" displays on the screen, decrement the value to zero by pressing the "↓" key. The number "32" will display next and will automatically decrement itself to zero and the unit will turn off. The meter is now calibrated to zero velocity. Document performance of the zero adjust procedure in the meter's calibration logbook.

Marsh-McBirney flowmeters can also be calibrated by the manufacturer to a known velocity. If velocity readings appear unusual after performing the zero adjust procedure, return the unit to the following address for calibration:

Marsh-McBirney, Inc.
4539 Metropolitan Ct.
Frederick, MD 21704-8364
(800) 368-2723

Upon receipt of the unit, Marsh-McBirney will run a sensor performance check by placing the probe in water that is moving at a known velocity. If the sensor fails the performance check, Marsh-McBirney will perform a factory calibration for a certain fee. The instruction manual makes no recommendations as to how often a factory calibration should be performed. The EPA Region 8 Laboratory will return flowmeters to Marsh-McBirney for performance checks and factory calibration when problems are noted with the zero adjust procedure or when performance has been compromised.

As noted in section 11.3, hydrographers should always calculate streamflow prior to taking down the tag line and proceeding to the next sampling location. In the event that an exceedance in the 10% rule is discovered at a measurement vertical, the hydrographer should return to the vertical where the exceedance occurs and take additional measurement verticals on either side. Additional quality control procedures are noted in section 11.3.1.

14.2 Flume and Timed Filling Procedures

Quality control procedures for flumes are described in sections 11.4 and 11.4.1. Quality control for the timed filling method is described in sections 11.5 and 11.5.1. It is important to note that instrument calibration is not required when measuring flow using these two procedures.

15.0 Data and Records Management

A copy of the field form used for discharge measurements is stored on the EPA Region 8 Laboratory's G drive at G:\Forms\DischargeForm.wpd. Hardcopies of all discharge forms that are filled out in the field will be stored with their corresponding field data package at the Region 8 Laboratory. Final discharge measurements will be hand entered into the EPA Region 8 Laboratory Information Management System (LIMS) for storage and presentation to project managers.

16.0 Pollution Prevention

Because of recent outbreaks of invasive species, hydrographers must take adequate precautions to prevent the spread of these species to other watersheds. Before performing fieldwork, hydrographers should familiarize themselves with locations where invasive species have been documented. In the event that work is to be performed in these locations, hydrographers must take adequate care to clean and disinfect their waders before leaving a sampling location. It is also highly recommended that hydrographers perform these steps after sampling in areas not known to have invasive species. Commercial products such as bleach or Formula 409 can be used to clean and disinfect waders and boots. These products are known to be effective in preventing the spread of *Didymosphenia geminata*, the New Zeland Mudsnail, and whirling disease, among others.

17.0 Waste Management

All batteries used in flowmeters will be recycled to minimize waste. No other waste is produced while measuring streamflow.

18.0 References

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Figure 1: Stream Discharge Form

Sampling Station: ______________________ Sampling Crew: ______________________

Facility/Site: ______________________ Date/Time: ______________________

☐ **Velocity-Area**					
Distance Units ☐ ft ☐ m ☐ cm		Depth Units ☐ ft ☐ m ☐ cm		Velocity Units ☐ ft/s ☐ m/s	
Total Stream Width:			Meter Type:		
Tape Measure Reading	Distance to Opposite Bank	Width (A)	Depth (B)	Velocity (C)	Discharge (A*B*C)
		Total Discharge:			

☐ **Timed Filling**			
Volume Units ☐ l ☐ qt ☐ gal		Time Units ☐ sec ☐ min	
Trial	Volume	Time	Notes
1			
2			
3			
4			
5			
	Total Volume:	Total Time:	Total Discharge (Vol/Time):

☐ **Flumes**		
Throat Width (Inches): ☐ 1 ☐ 2 ☐ 4 ☐ 8		
h_a = Upstream gauge height in feet =		
h_b = Downstream gauge height in feet =		
Throat Width	Flow Rate	
	CFS	GPM
1 Inch	$0.50\ h_a^2$	$225\ h_a^2$
2 Inch	$1.02\ h_a^2$	$458\ h_a^2$
4 Inch	$2.08\ h_a^2$	$932\ h_a^2$
8 Inch	$4.22\ h_a^2$	$1900\ h_a^2$
Total Flow (cfs & gpm)		

☐ **USGS Staff Gauge**
Staff Gauge Reading:

Notes/Comments

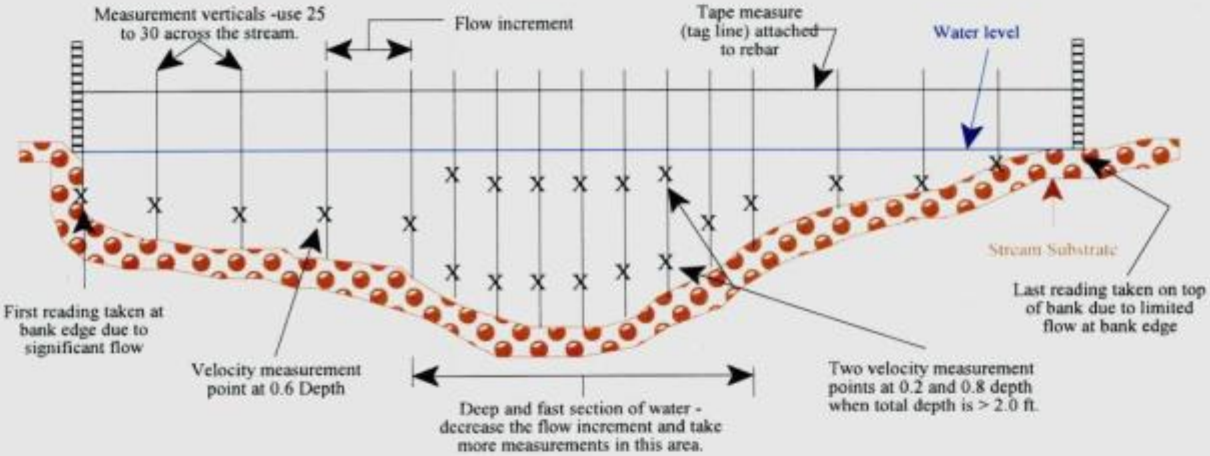


Figure 2: Stream cross section showing measurement verticals and velocity measurement points.

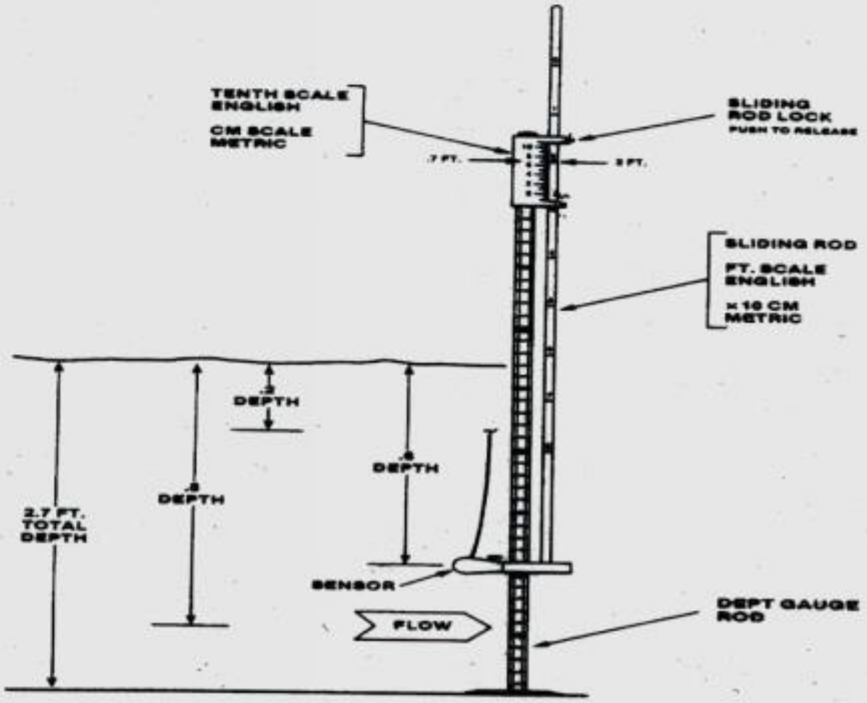


Figure 3: Top setting flow wading rod with a Marsh McBirney flow sensor.

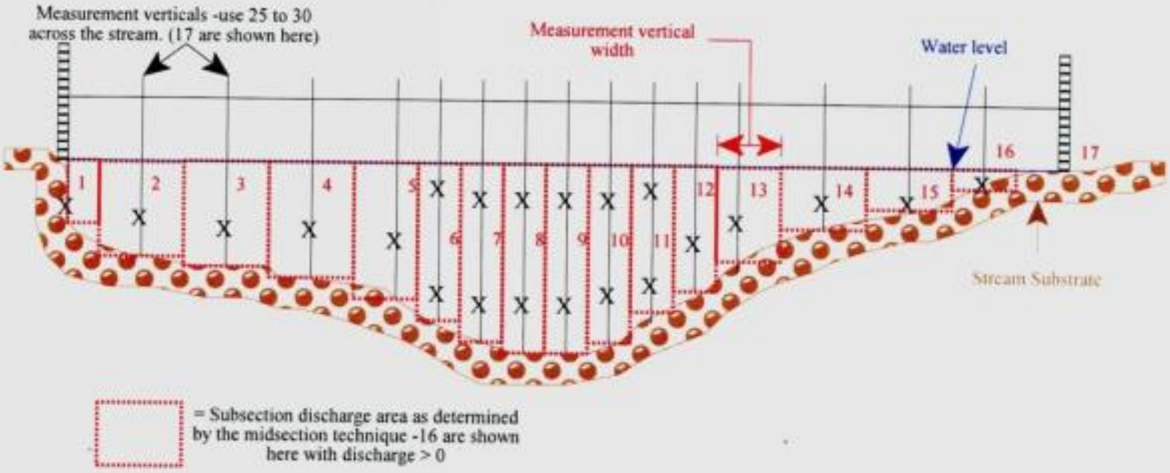


Figure 4: Streamflow measurements using the midsection technique

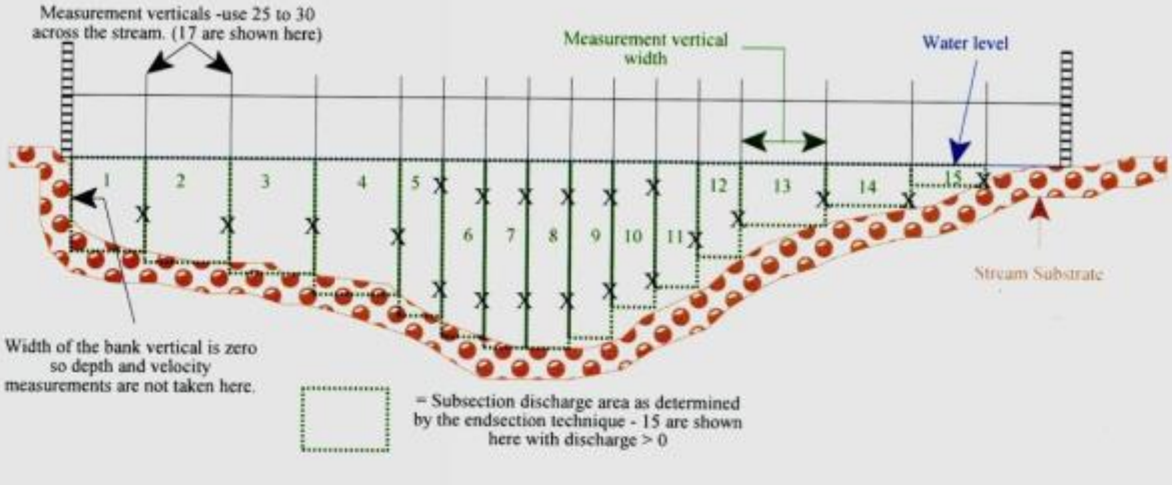
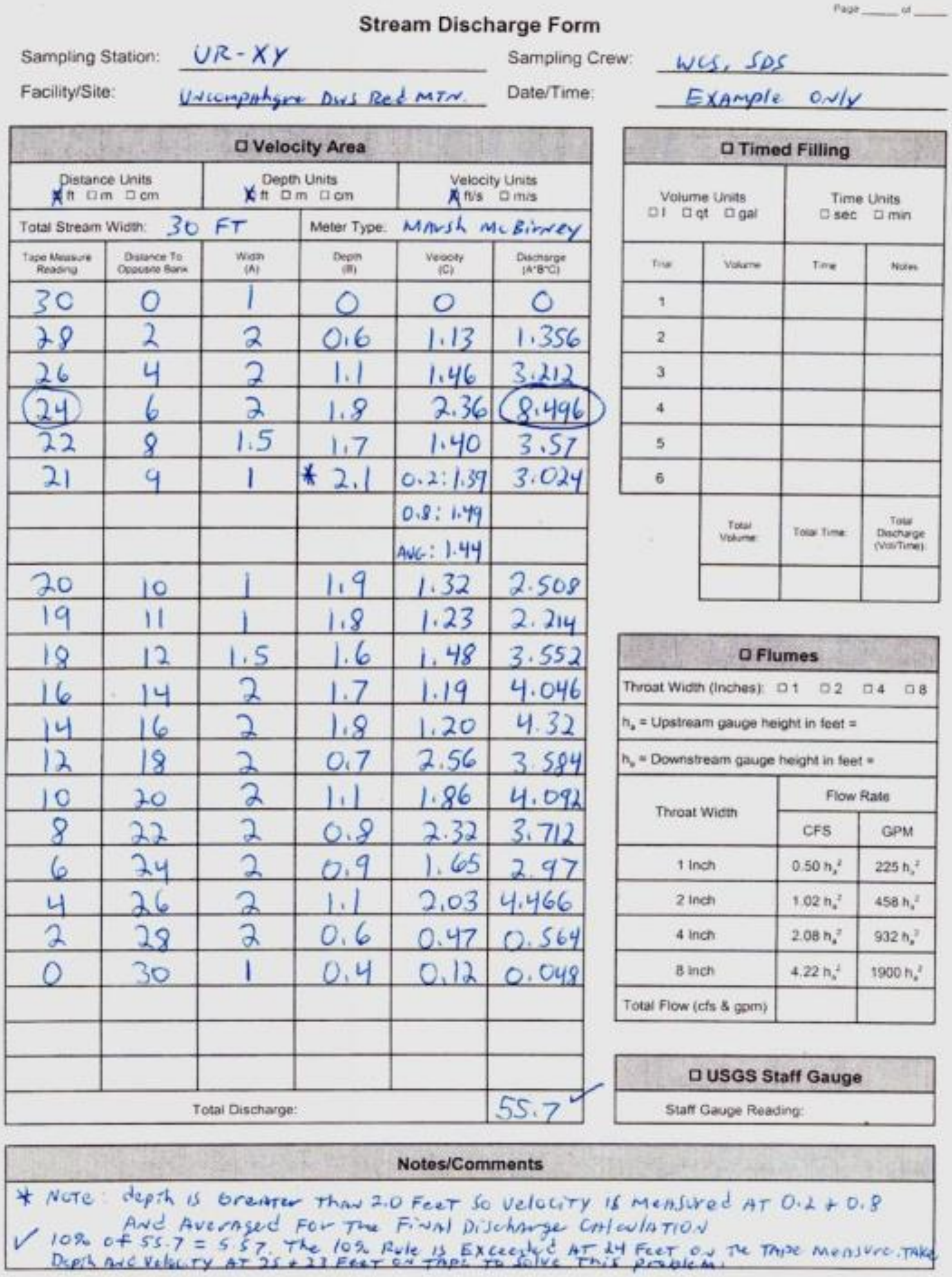


Figure 5: Streamflow measurements using the endsection technique.

Figure 6: Example of a stream discharge form with a violation of the 10% rule



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Stream Discharge Form

Sampling Station: UR-XY
Sampling Crew: WCS, SDS
Facility/Site: Uncompahgre Dws Red MTN.
Date/Time: Example Only

☐ Velocity Area

Distance Units: ☒ ft ☐ m ☐ cm
Depth Units: ☒ ft ☐ m ☐ cm
Velocity Units: ☒ ft/s ☐ m/s

Total Stream Width: 30 FT
Meter Type: Marsh McBirney

Tape Measure Reading	Distance To Opposite Bank	Width (A)	Depth (B)	Velocity (C)	Discharge (A*B*C)
30	0	1	0	0	0
28	2	2	0.6	1.13	1.356
26	4	2	1.1	1.46	3.212
24	6	2	1.8	2.36	8.496
22	8	1.5	1.7	1.40	3.57
21	9	1	* 2.1	0.2: 1.39	3.024
				0.8: 1.49	
				AVG: 1.44	
20	10	1	1.9	1.32	2.508
19	11	1	1.8	1.23	2.214
18	12	1.5	1.6	1.48	3.552
16	14	2	1.7	1.19	4.046
14	16	2	1.8	1.20	4.32
12	18	2	0.7	2.56	3.584
10	20	2	1.1	1.86	4.092
8	22	2	0.8	2.32	3.712
6	24	2	0.9	1.65	2.97
4	26	2	1.1	2.03	4.466
2	28	2	0.6	0.47	0.564
0	30	1	0.4	0.12	0.048
Total Discharge:					55.7 ✓

☐ Timed Filling

Volume Units: ☐ l ☐ qt ☐ gal
Time Units: ☐ sec ☐ min

Trial	Volume	Time	Notes
1			
2			
3			
4			
5			
6			
	Total Volume	Total Time	Total Discharge (Vol/Time)

☐ Flumes

Throat Width (Inches): ☐ 1 ☐ 2 ☐ 4 ☐ 8
h_a = Upstream gauge height in feet =
h_b = Downstream gauge height in feet =

Throat Width	Flow Rate	
	CFS	GPM
1 Inch	$0.50 h_a^2$	$225 h_a^2$
2 Inch	$1.02 h_a^2$	$458 h_a^2$
4 Inch	$2.08 h_a^2$	$932 h_a^2$
8 Inch	$4.22 h_a^2$	$1900 h_a^2$
Total Flow (cfs & gpm)		

☐ USGS Staff Gauge

Staff Gauge Reading:

Notes/Comments

* NOTE: depth is Greater than 2.0 Feet so Velocity is Measured AT 0.2 + 0.8 And Averaged For The Final Discharge Calculation
✓ 10% of 55.7 = 5.57. The 10% Rule is Exceeded AT 24 Feet on The Tape Measure. Take Depth And Velocity AT 25 + 23 Feet on Tape To Solve This problem.

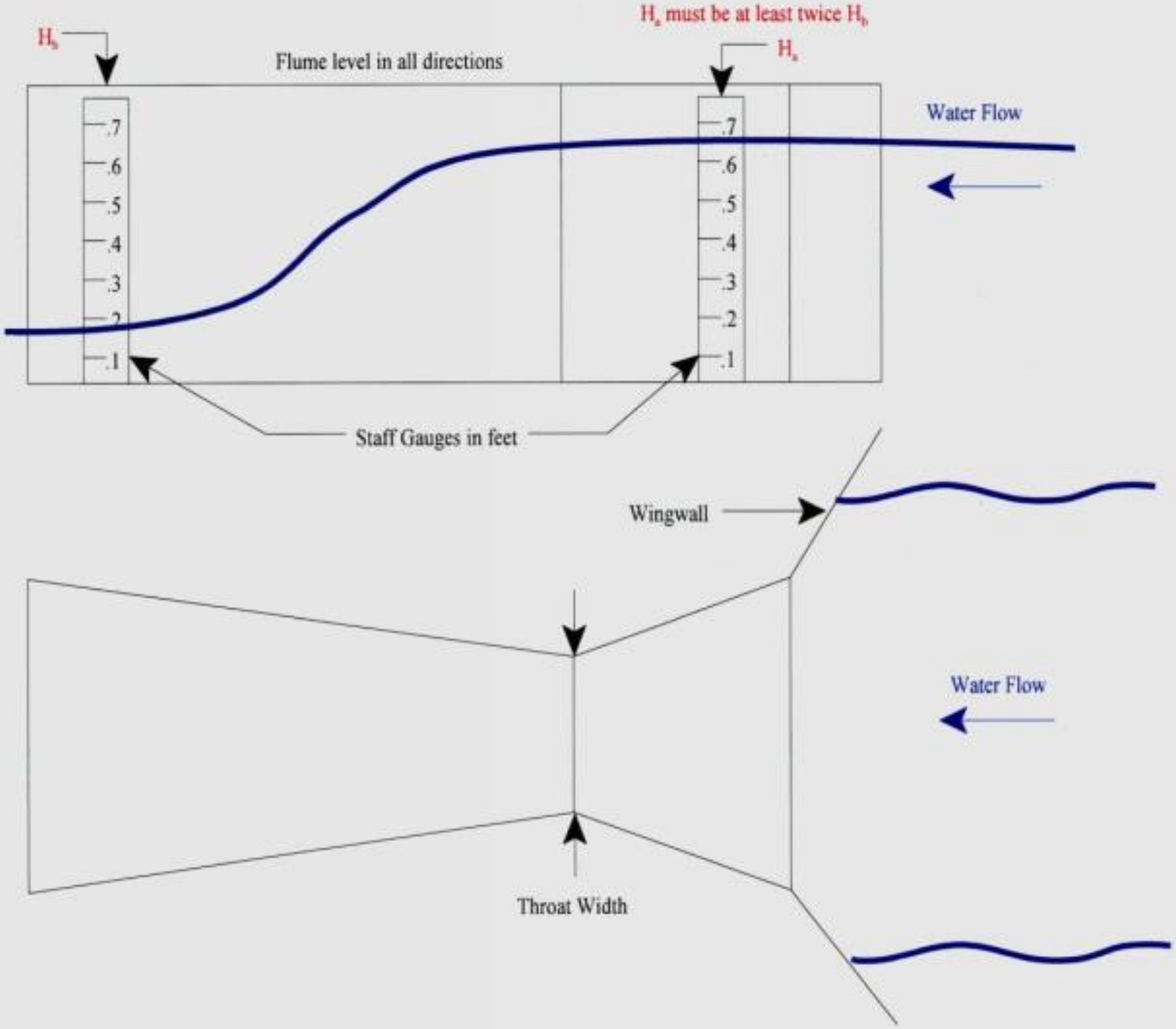

Figure 7: Diagram of proper flume installation

Figure 8: Flow Calculation Spreadsheet

Velocity-area Procedure:

		^{A} Width (ft):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
		^{B}Depth (ft):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Station ID:		^{C} Velocity (ft/sec):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Date & Time:		^{A*B*C}Discharge (cfs):	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Width (ft):	0	^{A} Width (ft):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
		^{B}Depth (ft):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total Flow (cfs):	0	^{C} Velocity (ft/sec):	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
		^{A*B*C}Discharge (cfs):	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Timed filling Procedure:

Station ID:		Volume (quarts):	----	----	----	----	----	----							
Date & Time:		Time (seconds):	----	----	----	----	----	----	Average =	0	qts/sec	=	0	gpm
Total Flow (cfs):	0													
Total Flow (gpm):	0	quarts/second:	0	0	0	0	0	0				=	0	cfs

Flume Procedure:

Station ID:
Date & Time:
Total Flow (cfs):
Total Flow (gpm):

Throat Width:	H_a	cfs	gpm	H_b
1 Inch:	----	0	0	----
2 Inch:	----	0	0	----
4 Inch:	----	0	0	----
8 Inch:	----	0	0	----

Supplemental Procedures for Discharge Measurements at Seeps and Springs

Hydrological measurements for water quantity (discharge) will follow SOP 722. This appendix provides supplemental procedures in greater detail to be followed for various conditions encountered. Five potential methods to measure springs flow, ranging from standard streamflow cross-section velocity measurement, to the use of portable flumes or weirs, to simple capture, to the measurement of wetted patch area (when flow is unmeasurable). Table 1 lists the various instruments recommended for the range of discharges which occur in springs. Three additional methods are listed in the procedures (float velocity, static head change, and visual estimation), but these methods will generally be avoided, unless all other instruments are unable to measure discharge. Replicated flow measurements are needed to develop a trustworthy mean value and ascertain uncertainty around the measurement. It is recommend that at least three measurements be made and the average calculated.

Table 1: Measurement requirements for variable discharge ranges.

Discharge magnitude	Discharge (gpm)	Discharge (metric)	Instrument(s)
Unmeasurable	Not enough to measure	Not enough to measure	Depression
First	< 0.12	< 10 mL/s	Depression, Volumetric
Second	0.12 to 1.0	10 to 100 mL/s	Weir, Volumetric
Third	1.0 to 10	0.1 to 1 L/s	Weir, Flume
Fourth	10 to 100	1 to 10 L/s	Weir, Flume
Fifth	100 to 500	10 to 100 L/s	Flume
Sixth	> 500	> 0.1 m^3/s	Current meter

Flow

Overview: Measure the quantity of water discharging from the spring. If the discharge of the spring is low (unmeasurable or first magnitude), the discharge measurement may take dozens of minutes and should be initiated early in the site visit. Second to fifth magnitude discharges are relatively quicker and easier to measure. The name, serial number (if available), and accuracy of the instrument used to measure discharge should be recorded as well as any other important observations. Important observations may include the markers of any recent high discharges, such as high water marks, oriented vegetation or debris on or above the channel or floodplain. The following sections describe eight specific techniques to measure small discharges based on recommended techniques from the U. S. Geological Survey (Buchanan and Somers, 1984).

1. Volumetric measurements procedure

Volumetric measurements are typically used in first and second magnitude discharge springs (Table 1), where there is a pour off or other features that allow flow to be easily captured in a volumetric container. A temporary earthen dam is constructed using earth and non-permeable materials. Water is diverted through the temporary earthen dam with a temporary pipe or constructed channel. Flow is allowed to stabilize prior to measurement. A volumetric container is used to catch discharge from the pipe. The time to fill the container is recorded. Flow is recorded 3 to 5 times over a 3 to 5-minute interval, as appropriate. The mean value is calculated (mL/s) and recorded. Accuracy of the instrument is dependent upon the accuracy of the volumetric container. A suite of varying size of containers that are appropriate for first to second magnitude discharge springs should be taken to the field site. When not used for volumetric measurements, the containers can be used to help pack various other field gear used for the rapid assessment.

2. Portable weir plate procedure

Typically, weirs are used to measure discharge in spring channels which have low to moderate magnitude values of discharge. The weir pushed into a channel of loose material. The weir has a “V” notch, or other regular geometric shape through which all discharge in the channel must be focused. The weir should have a scale on the weir which directly reads discharge. The weir should have a solid plate below the notch which is driven into the loose material of the stream bed material. Weirs do not work in bedrock channels or channels with bed material coarser than fine gravel without a significant amount of channel modification. To use a weir in a bedrock channel or channel material coarser than gravel, the channel must be significantly modified for weir emplacement.

Once placed in the channel, the weir is leveled using a bubble level. The top of the weir plate is made horizontal and the plate must be plumb. Flow through the weir is allowed to stabilize prior to measurement. Gage height is recorded 3 to 5 times over a 3 to 5 minute interval, as appropriate. The mean is calculated from the three replicates and recorded. The volumetric discharge (m^3/s or l/s) is calculated using a standard equation specific to the weir plate being used. The accuracy of the weir is dependent on the size of the notch in the weir and the resolution of the scale of the weir.

3. Portable Parshall Cutthroat Flume procedure (Flume)

Typically, flumes are used in third to sixth magnitude discharge springs (Table 1). Flumes work best in low gradient channels with fine-grained bed material. The wing walls of the flume are pointed upstream in the channel in such a fashion as to focus as much flow as possible through the regular profile of the opening of the flume. The flume requires free fall of water out the downstream end of the flume. The flume is set in a channel of loose material. A bubble level is used to make sure the flume is level. The floor of the upstream section is leveled both longitudinally and transversely. Flow is allowed to stabilize prior to measurement. Gage height is recorded 3 - 5 times over a 3-minute interval. A standard rating curve for the flume is used to translate gage height to discharge. The mean value for discharge (m^3/s or l/s) is calculated and recorded. Accuracy of the instrument is dependent on the scale on the flume. On some occasions, it may not be possible to capture 100 % of the discharge in the flume. If less than 100 % of the discharge is captured by the flume, the percent of flow captured by the flume should be estimated by for each of the 3 to 5 measurements and recorded. A correction to the discharge measurement should be made to account for the percent of discharge not captured by the flume.

4. Current meter procedure

Current meters are used for measuring flow in wadable spring streams, wide channels, or high discharge channels where flow cannot be routed into a weir or a flume. Measurement locations are selected in a straight reach where the streambed is free of large rocks, weeds, and protruding obstructions that create turbulence, and with a flat streambed profile to eliminate vertical components of velocity. In the making of a discharge measurement, the cross section of the channel is divided into 20 to 30 partial sections, and the area and mean velocity of each section is measured separately. A partial section is a rectangle whose depth is equal to the measured depth at the location and whose width is equal to the sum of half the distances of the adjacent verticals. At each vertical, the following observations are recorded on the data sheet, (1) the distance to a reference point on the bank along the tag line, (2) the depth of flow, (3) the velocity as indicated by the current meter. The velocity should be measured at a depth which is 0.6 of the depth from the surface of water in the channel. The discharge of each partial section is calculated as the product of mean velocity times depth at the vertical times the sum of half the distances to adjacent verticals. The sum of the discharges of each partial section is the total discharge. Measurements are made by wading the stream with the current meter along the tag line. The person wading the channel should stand downstream of the velocity meter. Because of the safety involved in wading a channel, the person wading should not wade in too deep of water or should not use hip waders in swift water without the use of a safety rope or other appropriate safety gear. A life jacket will be worn during high flow conditions.

5. Float velocity procedure

Two cross sections are selected and marked with flagging along a reach of straight channel. The distance between the two sections is measured with the measuring tape. The width and depth of each channel cross section is measured with the tape measure and recorded. Cross section locations are separated to allow for a travel time of >20 seconds float time (if possible). A float, i.e., wooden disk(s), is placed in the stream channel and allowed to reach stream velocity before the upstream cross section is crossed. The position of the float relative to the channel sides is noted. The float is timed between the two cross sections. The position of the float is noted as it crossed the downstream cross section. This procedure is repeated 3 to 5 times, as the float is placed at different locations across the channel at the upstream cross-section. The velocity of the float is equal to the distance between the cross sections divided by the travel time. The mean value of surface horizontal velocity (m/s) is calculated. To convert mean surface velocity to mean vertical velocity a coefficient of 0.85 is multiplied by the mean surface velocity. Discharge (m^3/s) is calculated by multiplying the value of mean velocity by the average area of the section of the stream channel measured. This is a method of last choice compared to the more accurate velocity measurement techniques listed above.

6. The depression/sump procedure

This method is typically used for unmeasurable to first magnitude springs with little to no surface expression of flow. This method is used for relative comparison value of discharge. A depression is constructed in the seep area. The volume of depression is calculated using volumetric calibration or calculation. The volumetric containers used for the volumetric measurement may be used to estimate the volume of the depression. The depression is evacuated, and the time required to fill depression is recorded. This procedure is repeated 3 to 5 times and the mean value is recorded as the measurement.

7. The static head change procedure

This method may be used for a relative comparison value for change in elevation of standing pools. A metric staff gage is placed in the standing pool and relative gage elevation recorded, or efforts are made to locate and record an existing fixed point in or near standing pool and record vertical distance to pool surface. At a later date, the changes in the static head on the staff gage or fixed point are recorded. This measurement technique is of last choice compared to the more accurate methods listed in the protocol and should only be used if necessary.

8. Visual estimate procedure

Site conditions, such as dense vegetation cover, steep or flat slope, diffuse discharge into a marshy area, and dangerous access sometimes do not allow for a direct measurement of discharge by the techniques listed above. Although visual estimation is imprecise, it may be the only method possible for some springs. Photographs should be taken to record the surface area wetted or covered by water and observations recorded on the datasheet. Also, it should be noted if another method could be recommended for future site visits to measure discharge.

Surface Water Sampling

APPROVED:

ESAT Region 8 QA Coordinator

06/06/12
Date

ESAT Region 8 Team Manager

6/6/12
Date

EPA Task Order Project Officer

7/10/12
Date

ESAT Region 8 Task Lead

6/8/12
Date

DCN: EP8-7-7061

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to guide field personnel on general surface water sampling procedures. Not all situations are accounted for; therefore site reconnaissance is a key factor in determining sampling techniques that may be utilized. Always consult the site-specific Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP) before deployment to a surface water sampling event.

2.0 SCOPE AND APPLICABILITY

This SOP is applicable to the collection of representative liquid samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments utilizing direct method sampling procedures. This method may be varied or changed as required, dependent upon site conditions, equipment limitations or other procedural limitations. These are the preferred methodologies and should be implemented as closely as possible. Any deviations from these procedures should be discussed with site managers in order to confirm that data objectives are being met. All procedures employed should be documented and associated with the final report. Mention of trade names or commercial products does not constitute TechLaw, Inc. endorsement or recommendation for use.

This SOP is to be used in conjunction with other relevant and applicable documents which may include:

- Water Quality Measurement Procedures
- Sample Preservation Procedures
- Sediment Sampling Procedures
- Pore Water Sampling Procedures
- Field Sampling Procedures

The following documentation should be included to assist in preparing for and conducting surface water sampling activities:

- Health and Safety Plan (HASP)
- Sampling and Analysis Plan (SAP)
- Quality Assurance Project Plan (QAPP)
- Any other site-specific planning documents

3.0 SUMMARY OF METHOD

This SOP is intended to provide guidance on collection of surface water. Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of aqueous liquids from the above mentioned sources is generally accomplished through use of the direct method technique (filling sample containers directly from the source) and transfer devices (collecting the sample with a container and then transferring to another container). This allows for the collection of representative samples of surface water from streams, creeks, rivers, lakes, ponds, and other impoundments. Note that for certain types of sampling, transfer devices are not appropriate. Volatile Organic Analysis and Semi-Volatile Organic Analysis samples should always be sampled directly if possible. Also, proper decontamination or conditioning of transfer devices must occur in order to avoid cross-contamination.

4.0 ACRONYMS AND DEFINITIONS

°C	Degrees Celsius
COC	Chain of Custody
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
EDI	Equal Discharge Increment
EWI	Equal Width Increment
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene
mL	Milliliter
OSHA	Occupational Health and Safety Administration
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
VCF	Ventrical at Centroid of Flow

Equal Discharge Increment (EDI): A surface water sampling strategy that requires isokintetic water sampling from locations in a moving body of water that have the same discharge rate.

Equal Width Increment (EWI): A surface water sampling strategy that requires isokinetic water sampling from established equidistant intervals in a moving body of water.

Global Positioning System (GPS): A geospatial referencing tool that is used for mapping and identification.

Sampling and Analysis Plan (SAP): A site-specific document that details events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

Ventrical at Centroid of Flow (VCF): A sampling strategy similar to EDI sampling where only one location along a transect is used to collected the isokinetic water sample.

5.0 HEALTH AND SAFETY

When working with potentially hazardous materials or in hazardous situations, personnel must understand and comply with the site-specific SAP/QAPP and HASP before the sampling event begins. More specifically, when sampling streams or surface impoundments containing known or suspected hazardous substances, adequate personal protective equipment such as nitrile gloves, safety glasses, and waders are necessary to prevent contact with contaminants during sampling. When entering a stream, hazardous situations may exist requiring the use of adequate personal safety equipment including personal floatation devices and non-slip footwear. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

6.0 CAUTIONS

Only collect surface water samples if it can be done so safely. Many unsafe conditions exist on streams, rivers, ponds, and other surface water impoundments. Consult the site HASP before performing any sample collection.

7.0 INTERFERENCES

There are three primary interferences or potential problems with surface water sampling. These include cross-contamination of samples, improper sample collection, and improper sample preservation.

1. Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP #FLD-02.00.

2. Improper sample collection can involve disturbance of the stream substrate and/or sampling in an obviously disturbed area. To minimize potential for unrepresentative samples, consider sampling from downstream to upstream to avoid sampling where the substrate has been disturbed. Site sampling often involves multiple sampling procedures being deployed simultaneously. Therefore, well-organized team member coordination is essential to prevent improper sample collection.

3. Sample preservation is a critical component of sample collection. If the wrong preservative is used, the sample must be re-collected if possible. Improperly preserved samples cannot be analyzed. Refer to the Sample Preservation SOP #FLD-03.00 for proper field sample preservation guidelines.

8.0 PERSONNEL QUALIFICATIONS

Any personnel who are involved with field sampling activities must be cleared for health and safety. Clearance includes medical monitoring, respirator fit testing, and Occupational Health and Safety Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. Personnel who will be collecting surface water samples should familiarize themselves with this and other pertinent SOPs including: Sample Equipment Decontamination SOP #FLD-02.00; Sample Preservation SOP #FLD-03.00; Water Quality Measurements with the In-Situ® Multi-Parameter Meter SOP #FLD-09.00; Sample Custody and Labeling SOP #FLD-11.00; and General Field Sampling Protocols SOP #FLD-12.00.

9.0 EQUIPMENT AND SUPPLIES

Equipment needed for collection of surface water samples may include:

<u>HASP Required Gear</u> - personal floatation device, waders/gloves, proper footwear, safety glasses, insulating clothing for cold water, etc.

<u>Mapping & Location Tools</u> - GPS units, site/local area maps, compass, tape measure, survey stakes, pin flags, camera, 2-way radios

<u>Documentation Supplies</u> - field log book, field data sheet, Chains of Custody (COCs), labels, clear tape, pens, permanent marker, waterproof paper

<u>Sampling Tools</u> - plastic or other appropriate composition transfer device, bucket, rinse bottles, purified water, paper towels, filtering equipment, vacuum pump tool, vacuum pump stand, preservative, Ziploc™ plastic bags, cooler(s), ice, thermometer, preservative waste containment

<u>Sample Containers</u> - High-density polyethylene/Low Density Polyethylene (HDPE/LDPE) or other appropriate composition containers.

See Table 9.0-1 for a detailed list of surface water sampling equipment.

10.0 STANDARDS AND REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment (refer to SOP's #FLD-02.00 and #FLD-03.00). The preservatives required are specified by the analysis to be performed and will be specified in the SAP/QAPP but usually include nitric acid (Total Recoverable and Dissolved Metals samples) and phosphoric acid (Dissolved and Total Organic Carbon samples). Field sampling personnel should also be aware of any special sampling considerations, contamination issues, and sample compositing and mixing methods that could affect the sampling efforts. Appropriate regional guidance and procedures should be consulted for detailed sample collection, preservation, handling and storing, equipment decontamination, and Quality Assurance/Quality Control (QA/QC) procedures. Field sampling personnel should preserve and immediately cool all water samples to 4 degrees Celcius (°C) (±2°C) upon collection and samples should remain <6°C until the time of analysis (do not freeze water samples).

11.0 PROCEDURES

11.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods required, and the types and amounts of equipment and supplies needed. Use the site-specific SAP/QAPP for guidance to determine which kind of samples need to be collected.

2. Obtain the necessary sampling and monitoring equipment and ensure it is in working order.

3. Decontaminate equipment according to the procedures outlined in SOP #FLD-02.00, or use triple rinsed, dedicated disposable sample containers (non-filtering and not pre-

preserved).

4. Prepare scheduling and coordinate with staff, clients, and regulatory agencies where appropriate. It is also important to obtain site access agreements if sampling is to occur on private property.

5. Perform a general site survey prior to site entry in accordance with the site-specific HASP.

6. Use stakes, flagging, GPS markers, or photos to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

Generally, factors to consider in the selection of a device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

a. Can the sample be collected directly from the source? (i.e. is a transfer device needed for sample collection?)

b. What is the desired depth at which you wish to collect the sample?

c. What is the overall depth and flow direction of river or stream?

d. What type of analysis will be run (total recoverable metals, dissolved metals, alkalinity and anions, etc.)?

11.2 Sample Container Composition

A sample container should be selected based on analysis to be performed. A triple rinse should be performed on any sample container being used for direct sample collection. Filtered sample bottles or pre-preserved bottles should never be rinsed first.

11.3 Sample Collection

1. Direct collection is the optimal procedure for sample collection. After rinsing, the sample should be collected in a well-mixed area, as close to the middle of the stream as possible, in-between the streambed and the surface. The sample should be capped immediately.

2. Preserve the sample if appropriate. Refer to the site-specific SAP and SOP #FLD-03.00 for correct methods. The sample should be clearly labeled (and bagged in order to keep samples from the same location together) before being placed in a cooler on ice.

3. Record all pertinent site data (usually date, time, pH, conductance, dissolved oxygen, temperature, site ID, and anomalies) in the field logbook, field data sheets and/or sample container labels.

4. Complete the COC record. Refer to SOP #FLD-11.00 for guidelines on sample

custody and labeling documentation.

5. Attach custody seals to cooler prior to shipment where applicable. Refer to SOP #FLD-11.00 for guidelines on sample custody and labeling.

6. If a non-direct method was used for sampling (i.e. a bucket from a bridge or a dip sampler), decontaminate or condition all sampling equipment prior to the collection of additional samples with that sampling device as required by SOP #FLD 02.00. Sections 11.3.4 and 11.3.5 describe a few of the non-direct sampling methods that may be useful in Region 8.

7. If sampling on private property, sample receipts will be provided to property owners for all samples taken and removed from the property.

11.3.1 Direct Method

For streams, rivers, and lakes, the direct method may be utilized to collect water samples from the surface directly into the sample container. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Samples should be collected prior to all other activities as specified in the SAP/QAPP to avoid disturbing the substrate. Rinse the sample container three times (unless it's filtered or pre-preserved) with site water before procuring a sample. When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

11.3.2 Dip Sampling

Dip sampling is useful in situations where a sample is to be recovered from an outfall pipe or from a bridge where direct access is limited. The long handle or rope on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.

2. Extend the device to the sample location and collect the sample by dipping the sampler into the water at the sampling location.

3. Triple rinse the sampler with the site water

4. Retrieve the sampler and transfer the sample to the appropriate (triple rinsed) sample container

11.3.3 Synoptic Sampling

Synoptic sampling is a strategy used for evaluating a surge of water as it moves downstream. In general, the flow rate should be determined before executing a synoptic sampling event. Flow measurements are used to calculate when a surge of water will pass by a certain point or sample location. Floating visual objects may also be used to accurately determine when a surge of water passes by a sampling location. The synoptic sampling strategy is useful in determining where contaminants may be entering a watershed through seeps, fens, or other inflows that may not be visible. Below is a general guideline on synoptic sampling:

- Identify sample locations
- Conduct flow measurements; or test a floating object (ping pong ball, tangerine, etc.) to see if it will float through to the last sampling location (some objects may get caught in eddies or shallow areas)
- Calculate when the surge of water will pass through each sampling location
- Position sampling personnel or equipment where a sample can be captured at the required time
- Process samples

11.3.4 Large Stream or River Sampling

There are several techniques for sampling large rivers or streams. The most commonly used are Equal-Width Increment (EWI) sampling, Equal Discharge Increment (EDI) sampling, Single Vertical at Centroid of Flow sampling (VCF), dip sampling (section 11.3.2), direct method sampling (section 11.3.1), discrete sampling, and pump sampling (USGS, 2006). Below is a brief description of the sampling methods that have not yet been mentioned in this document:

EWI Method – A stream cross-section is divided into equal width intervals, and samples are collected by lowering and raising a sampler through the water column at the center of each interval. This produces a discharge weighted sample that is proportional to stream flow. This method cannot be used if the stream flow is less than what is required to fill the sampler during the isokintetic (constant rate) motion.

EDI Method – The objective of this method is to obtain a discharge weighted sample that represents the entire flow through a cross-section by obtaining a series of samples. For this method, the flow in the cross-section must be divided into points of equal discharge. Equal volume and depth integrated samples are collected at the center of the equal discharge interval along the cross-section. Flow measurements or historical data is necessary to determine interval number (usually more than 4, but less than 20) and location. This method may also require additional personnel to sample a large cross-section. If conducted properly, both the EWI and EDI methods should produce identical results.

VCF Method – This method is a simple version of the EDI method, but only one sample is collected at flow center (usually a smaller river or stream). This is to be used if the sample location is known to be homogenous and is warranted by the sampling plan objectives. Flow data should be obtained to determine where the flow center is located.

11.3.5 Shallow Stream and Still Water Sampling

Shallow streams and still water such as a pond are common locations to sample in Region 8. Below are three methods (in addition to ones mentioned above) that may be required.

Discrete (point) Sampling – This method is achieved by lowering a sample container to a specific depth in a body of water then opening and closing the container to obtain the sample.
Pump Sampling – This method is used to collect single point samples using a suction-lift or submersible pump. These are not used for collecting isokinetic samples (EWI, EDI, or VCF). Using the pump method is limited by electrical needs in remote areas. Always consult the SAP for sampling objective requirements.

Syringe Sampling – A 50 mL syringe can be used to collect sample from very shallow locations to avoid contact with substrate.

12.0 DATA RECORDS AND MANAGEMENT

Once collected, samples are preserved, labeled, and stored for transport. A COC must accompany all samples during transport and transfer between entities. Sample labels should contain the following information:

- Site Identification
- Date sampled
- Sampler initials
- Time
- Analysis to be performed

13.0 QUALITY CONTROL AND ASSURANCE

1. The following general QA procedures apply:

2. All data must be documented on field data sheets or within site logbooks.

3. In general, concurrent (duplicate) sample collection at a frequency of 10% is required for most sampling activities. Blanks at a frequency of one per day are also generally required. Consult the corresponding SAP/QAPP for specific QA/QC sampling frequency. Below is a list of typical QA/QC sample types and the inaccuracy they are intended to detect:

   - Field blank – checks cross-contamination during sample collection, preservation, and shipment as well as in the laboratory.
   - Equipment blank – equipment contamination due to inadequate decontamination procedures
   - Temperature blank – provides an accurate temperature measurement of field samples upon arrival to the laboratory and establishes whether the temperature range has been maintained while in transit
   - Trip blank – checks contamination of samples during handling, storage, and shipment from the field to the laboratory; carried through the same sampling and handling

protocols as field samples and placed in the cooler for the duration of the trip.

- MS/MSD – checks accuracy and precision of organic or inorganic analyses in specific sample matrices. They are collected from areas know or suspected to be contaminated.
- Sequential replicates – samples are pulled one after another to detect variability among field activities (collection, preservation, handling, etc.)
- Split samples – division of one sample into two, then submitting for identical analysis in order to detect variability in the process from collection to analysis
- Concurrent or collocated replicate samples (often referred to as “duplicate” samples) – two samples collected at the same location at the same time, intended to detect variability inherent in collection, processing, and handling procedures; Relative percent difference is usually calculated from these samples.

4. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer unless otherwise specified in the work plan or SAP/QAPP. Equipment calibration activities must be conducted and documented prior to sampling and/or operation of equipment.
5. Document any deviations from SOPs, work plan, SAP/QAPP, etc.

14.0 REFERENCES

Environmental Protection Agency (EPA) Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

U.S. Geological Survey. 1977. National Handbook of Recommended Methods for Water Data Acquisition. Office of Water Data Coordination, Reston, Virginia. (chapter updates available)

U.S. Geological Survey 2006. National Field Manual for the Collection of Water Quality Data. Chapter A4, version 2.0, Office of Water Quality.

Environmental Protection Agency (EPA), 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

Environmental Protection Agency (EPA), Environmental Response Team, Standard Operating Procedures - Surface Water Sampling: U.S. Environmental Protection Agency, 1994, SOP #2013.

Table 9.0-1 Surface Water Sampling Equipment

Category	**Item**	**Use**	**Comment**
Health and Safety	Gloves	Protection from absorption of contaminants	Nitrile or neoprene are recommended
Health and Safety	Waders	Slip/contaminant protection, warmth	Any type are acceptable
Health and Safety	Safety Glasses	Eye protection	Sunglasses for UV protection
Health and Safety	Layered Clothing	Protection from hypothermia	Polyester base layers only
Mapping/Location	GPS unit	Sample station locating	Pre-loaded with site locations
Mapping/Location	Maps	Location identification	Most current information required
Mapping/Location	Two-way radios	Communication	Extra batteries or charger required
Documentation	Field Logbook	Site data and conditions documentation	Waterproof pages
Documentation	Field Data Sheets (waterproof)	Marsh McBirney Flows	
Documentation	Chain of Custody	Sample handling/identification	Generated using Scribe
Documentation	Labels	Sample identification	Generated using Scribe
Documentation	Clear tape & Scissors	Label protection	
Sampling Tools	Bucket/Transfer Device	Sample transfer (if required)	Decontaminated between samples
Sampling Tools	Vacuum Pump	Dissolved sample processing	
Sampling Tools	Vacuum Stand	Dissolved sample processing	
Sampling Tools	Ziploc baggies	Sample containment	
Sampling Tools	Water Chemistry meters	In-situ water quality data gathering	Temp, pH, dissolved oxygen, conductivity
Sampling Tools	Flow measurement equipment	Flow measurements	
Sampling Tools	Cooler	Sample containment	Samples to be kept at 4°C
Sampling Containers	250 ml HDPE/LDPE	Total recoverable metals samples	
Sampling Containers	250 ml HDPE/DLPE filtered bottles	Dissolved Metals/ DOC samples	Single use only
Sampling Containers	500 ml HDPE/LDPE	Alkalinity+Anions samples	
Sampling Containers	VOA Vials	Volatile and Semi-Volatile organics analysis	
Reagents	Nitric Acid(HNO3) ampules	For preserving metals samples	
Reagents	Phosphoric Acid (H3PO4) ampules	For preserving DOC samples	
Reagents	Hydrochloric (HCl) Acid	For preserving VOA samples	
Reagents	CaCO3 Acid waste Containment	Ampule/acid waste disposal	Usually in a 1 liter cubitainer
Reagents	pH and Conductivity standards	Calibration of water quality equipment	Quantity for each day of sampling

Sampling Equipment Decontamination

APPROVED:

ESAT Region 8 QA Coordinator

06/06/12
Date

ESAT Region 8 Team Manager

6/6/12
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7/10/12
Date

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6/8/12
Date

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This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

2.0 SCOPE AND APPLICABILITY

These are standard procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and included with the final report. Mention of trade names or commercial products does not constitute Techlaw, Inc. endorsement or recommendation for use.

3.0 SUMMARY OF METHOD

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances. Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted.

Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site-specific work plan or subsequent report.

4.0 ACRONYMS AND DEFINITIONS

CFR	Code of Federal Regulations
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
DOT	Department of Transportation
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
EZ	Exclusion Zone
HASP	Health and Safety Plan
OSHA	Occupation Safety and Health Administration
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SZ	Safe Zone

<u>Code of Federal Regulations (CFR)</u>: The codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government

<u>Contamination Reduction Corridor (CRC)</u>: An area between the exclusion zone and the safe zone where equipment goes through the decontamination process. The decontamination line is usually set up in the CRC.

<u>Contamination Reduction Zone (CRZ)</u>: An area between the exclusion zone and contamination reduction corridor where preliminary decontamination activities occur.

<u>Department of Transportation (DOT)</u>: A government agency that oversees and regulates transportation functions.

<u>Exclusion Zone (EZ)</u>: The area at a site where work is being performed.

<u>Health and Safety Plan (HASP)</u>: A site-specific document that identifies safety hazards and proper safety procedures. This normally includes hospital route maps and material safety data sheets.

<u>Occupational Safety and Health Administration (OSHA)</u>: A regulatory agency that governs health and safety standards in the United States.

Personal Protective Equipment (PPE): Refers to protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury by blunt impacts, electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes.

Safe Zone (SZ): An area at a site where work is not being performed. Equipment and personnel in the SZ should be considered contaminant free.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

5.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. Environmental Protection Agency (EPA), corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms. Material generated from decontamination activities requires proper handling, storage, and disposal. Proper PPE may be required for these activities. Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

6.0 CAUTIONS

Any personnel who participate in decontamination activities in the field must familiarize themselves with the site decontamination plan, which is part of the site HASP. Furthermore, decontamination activities should be done so with proper PPE. The HASP should provide guidelines for required PPE in the field.

7.0 INTERFERENCES

The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system. If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns. Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

8.0 PERSONNEL QUALIFICATIONS

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. In addition, any personnel who will participate in decontamination activities must read, understand, and sign the site-specific HASP and associated Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP).

9.0 EQUIPMENT AND SUPPLIES

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums. The following standard materials and equipment are recommended for decontamination activities:

9.1 Decontamination Solutions

Non-phosphate detergent selected solvents, (acetone, hexane, nitric acid, etc.) Virkon® disinfectant virucide, tap water distilled, or deionized water.

9.2 Decontamination Tools/Supplies

Long and short handled brushes, bottle brushes, drop cloth/plastic sheeting, paper towels, plastic or galvanized tubs or buckets, pressurized sprayers (H_2O) solvent sprayers, and aluminum foil.

9.3 Health and Safety Equipment

Safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, and emergency eye wash.

9.4 Waste Disposal

Trash bags, trash containers, 55-gallon drums, metal/plastic buckets/containers for storage and disposal of decontamination solutions

10.0 STANDARDS AND REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes: 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern. Acetone, hexane, and methanol are used for organic compound decontamination. A solvent may not be required if organics are not a chemical of concern. Virkon® is used for decontamination of non-disposable PPE (see section 11.3 Personal Protective Equipment Decontamination).

11.0 PROCEDURES

As part of the HASP, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enters the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations
- Decontamination equipment needed
- Appropriate decontamination methods
- Methods for disposal of contaminated clothing, equipment, and solutions

Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

11.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

11.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

<u>Mechanical</u>
Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

<u>Air Blasting</u>
Air blasting equipment uses compressed air to force abrasive material through a nozzle at

high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting
Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

11.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water
This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water
This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water
This system produces a water jet that is pressured from 1,000 to 4,000 atm. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing
Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal
In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization
Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

11.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

11.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop
Place plastic sheeting on the ground (Figure 2). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal with A High-Pressure Washer (Optional)
Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the rinsate. A high-pressure wash may be required to remove compounds which are difficult to remove by washing with brushes. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 ½ foot deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed over the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Station 3: Physical Removal with Brushes and a Wash Station
Prior to setting up station 3, place plastic sheeting on the ground to cover the areas under station 3 through station 10.

Fill a wash basin or large bucket with non-phosphate detergent soap and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending on the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Low-Pressure Sprayers
Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the rinsate.

Station 5: Nitric Acid Sprayers
Fill a spray/squeeze bottle with 10% nitric acid. This procedure is useful only for inorganic contaminants. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 6: Organic Solvent Sprayers
Fill a spray/squeeze bottle with an organic solvent. After each rinse, the equipment should be rinsed with distilled/deionized water and dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a bucket or basin to contain the rinsate.

11.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop
Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal with a High-Pressure Washer (Optional)
Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal with Brushes and a Wash Basin
Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

<u>Station 4: Low-Pressure Rinse</u>
Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

<u>Station 5: Nitric Acid Sprayers (required only if metals are a contaminant of concern)</u>
Using a spray bottle, rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

<u>Station 6: Organic Solvent Sprayers</u>
Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

11.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated

from the decontamination process.

11.3 Personal Protective Equipment Decontamination

Non-disposable PPE such as waders, wading boots, or life vests will require special decontamination (if exposed) between sites in order to mitigate cross-contamination and/or transfer of invasive species. The EPA approved disinfectant is Virkon®, a compound that is used widely for various cleaning purposes. The manufacturer recommends for equipment disinfection to add 10 grams of Virkon® to a liter of water and pressure wash or brush until the surface appears clean. If soaking the PPE is preferred, place in 1:100 diluted Virkon® until solution appears soiled or for a period of 4-5 days.

12.0 DATA RECORDS AND MANAGEMENT

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

13.0 QUALITY CONTROL AND ASSURANCE

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field. Rinsate blanks are samples obtained by running analyte-free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross-contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

14.0 REFERENCES

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

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15.0 ATTACHMENTS

Table 1 - Soluble Contaminants and Recommended Solvent Rinse

SOLVENT(1)	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water, tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid, acetic acid, boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds phenol thiols some nitro and sulfonic compounds
Organic Solvents (2)	Alcohols ethers ketones aromatics straight chain alkalines (e.g., hexane) common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent(2)	Hexane	PCBs

(1) Material Safety Data Sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard.

(2) WARNING: Some organic solvents can permeate and/or degrade the protective clothing.

Figure 1 - Contamination Reduction Zone Layout

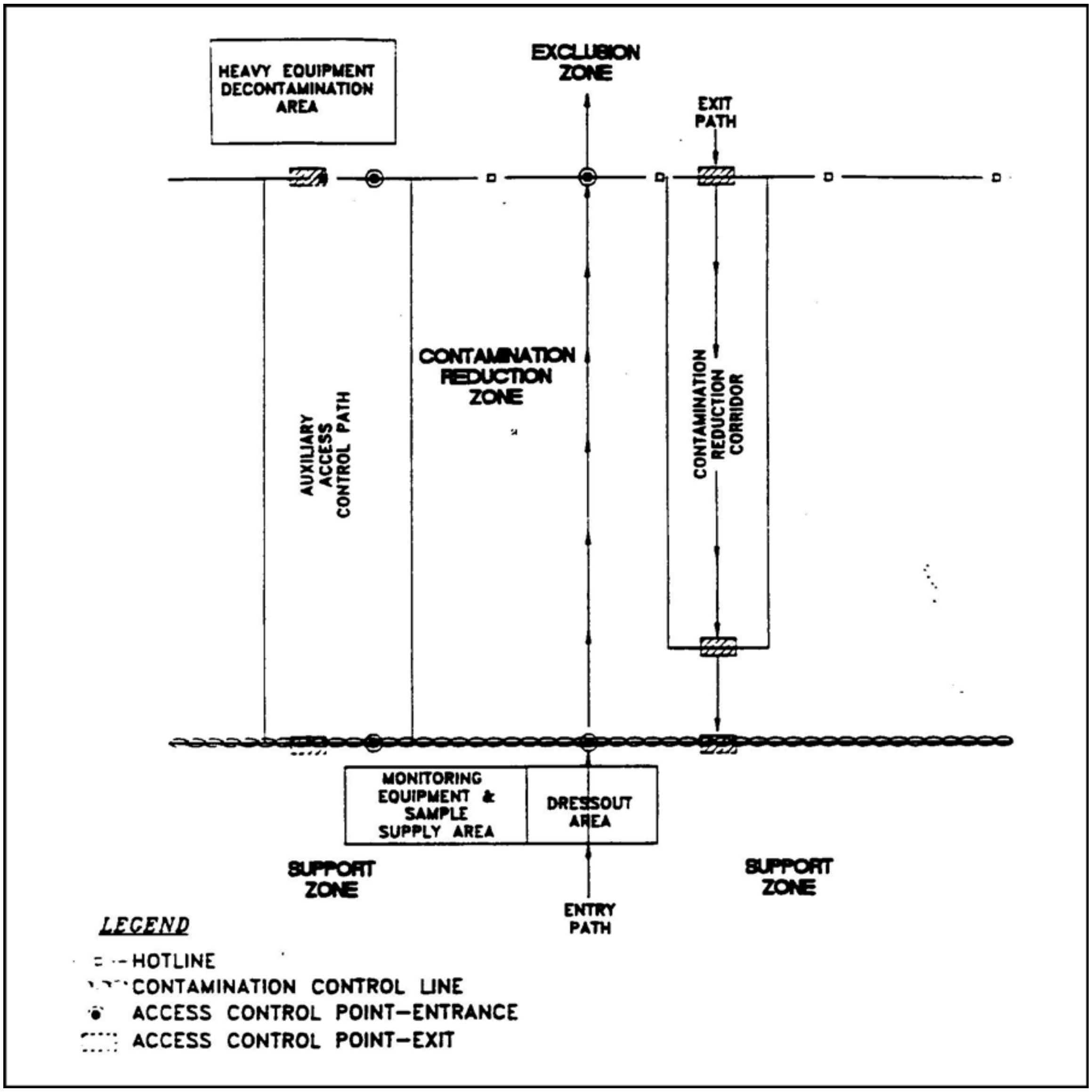
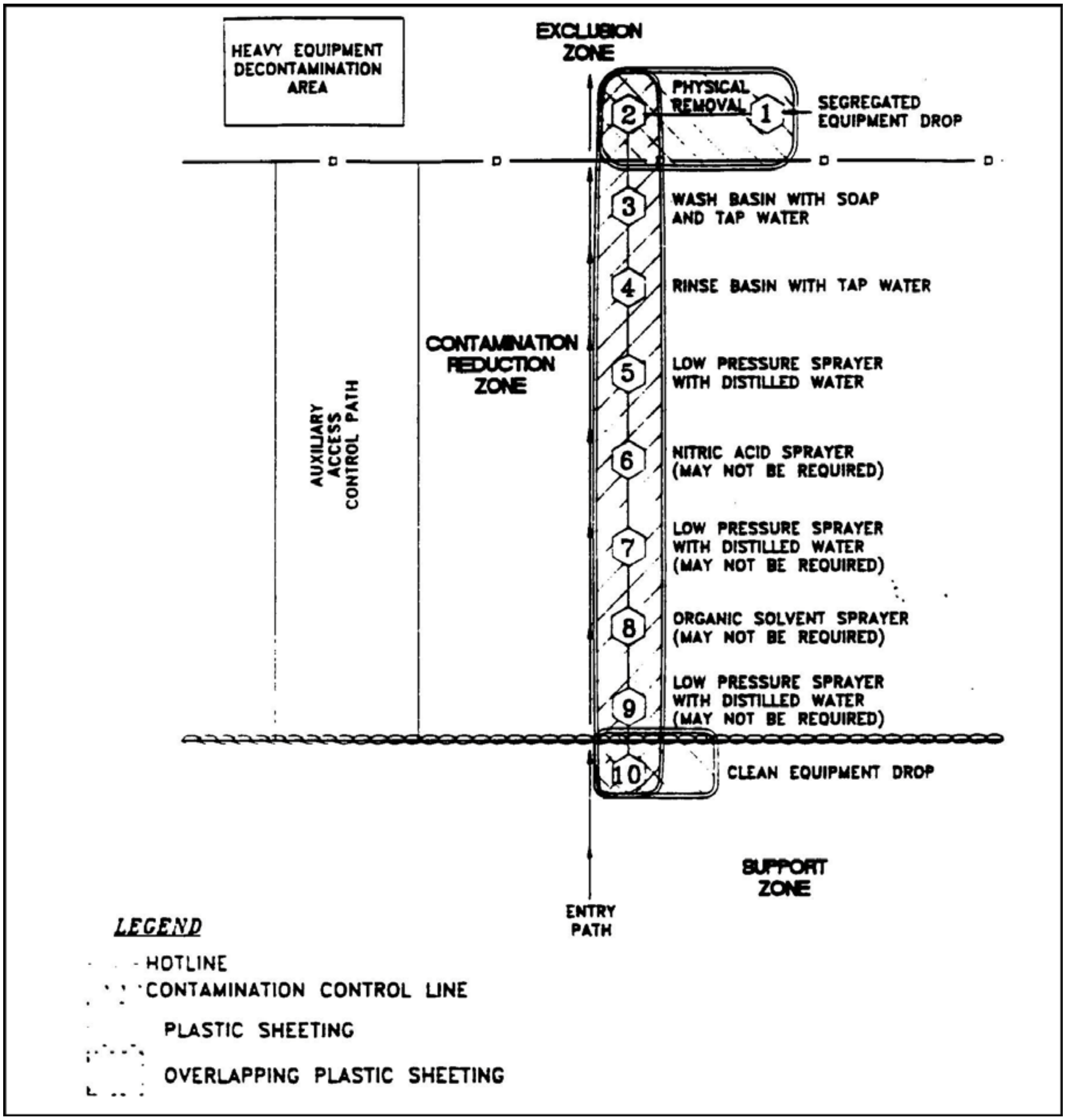


Figure 2 - Contamination Reduction Zone Layout (2)



Sample Preservation

APPROVED:

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04/04/12
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DCN: EP8-7-7061

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standard approach for Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) Region 8 personnel to preserve samples during field activities.

2.0 SCOPE AND APPLICATION

This SOP is specifically intended for application by EPA and ESAT personnel who conduct sample preservation in field work activities.

3.0 SUMMARY OF METHOD

For purposes of this SOP, proper sample preservation techniques and methods are reviewed. This SOP is based on industry standard instructions.

4.0 ACRONYMS AND DEFINITIONS

ESAT	Environmental Services Assistance Team
DOC	Dissolved Organic Carbon
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
MSDS	Material Safety Data Sheet
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
EPA	United States Environmental Protection Agency
VOA	Volatile Organic Analytes

Ampule: A small sealed vial which is used to preserve a sample usually nitric, phosphoric, hydrochloric, or sulfuric acid.

Health and Safety Plan (HASP): A site-specific document that outlines potential site hazards and hazard mitigation practices.

Material Safety Data Sheets (MSDS): A form with data regarding the properties of a particular substance.

Personal Protective Equipment (PPE): Refers to protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury by blunt impacts, electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes.

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

Sampling and Analysis Plan (SAP): A site-specific document that specifies events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

5.0 HEALTH AND SAFETY

The procedures outlined in this SOP have general health and safety issues associated with it. This includes the use of proper PPE when conducting sample preservation. The most important health and safety items while preserving samples are latex gloves to prevent skin contact and safety eyewear to protect from splash hazards. Always refer to the applicable HASP and MSDS any time field work or preservation activities are conducted.

6.0 EQUIPMENT

- Acid Ampules
- PPE (gloves, eye protection, cover-alls)
- First-Aid kit
- Disposal equipment (ampoule waste container, garbage bags)
- Sample Filter equipment

7.0 SAMPLE PRESERVATION

Complete and unequivocal preservation of samples with total stability of every constituent maintained, regardless of the nature of the sample, can never be achieved. At best, preservation techniques can only minimize the chemical and biological changes that inevitably continue after the sample is removed from the parent source. Proper preservation methods, such as pH control, chemical addition, filtration, and refrigeration are intended to retard biological and chemical effects, reduce volatility of constituents, and limit absorption effects.

Because of the potential vulnerability samples may have to a number of influences, it is best that sample analyses occur as soon as possible after collection. However, since the majority of sampling events do not have on-site mobile laboratories, and travel time from the field to the laboratory may be multiple days, it is critical that effective sample preservation techniques are employed to ensure sample integrity.

7.1 Chemical Influences on Samples

Chemical changes to samples may result when physical conditions alter the chemical structure of the constituents. Many of the chemical processes that occur once a sample is taken will ultimately depend on the type and amount of sample taken, the medium to which the sample is housed, and the storage and transportation environment for that particular sample. Examples of chemical effects to samples might include metal cations precipitating as hydroxides or forming complexes with other constituents; cations or anions changing valence states under certain reducing or oxidizing conditions; or other constituents dissolving or volatilizing with the passage of time. Metal cations may also adsorb onto surfaces (glass, plastic, quartz, etc.), such as, iron and lead.

7.2 Biological Influences on Samples

Biological changes may occur when a sample changes the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. Nitrogen and phosphorus cycles are examples of biological influence on sample composition.

7.3 Sample Types to Preserve

Sample preservation mainly pertains to water samples (surface water, groundwater, pore water), but other sample types that might require preservation include sediment, macroinvertabrates, or waste rock. For all non-water based samples, the basic practice of storing and transporting in coolers with ice will suffice for a preservation method. However, be sure to consult with the analyzing laboratory with regard to any specific preservation requirements (for both water and non-water samples) before going into the field.

8.0 PRESERVATION PROCEDURES AND TECHNIQUES

Samples collected in the field are generally preserved by chilling or chemical treatment. It is important that the sample crew be knowledgeable of the following before and during the field event:

1. The required sample-designation code for each sample.

2. The sample requirements for filtration, chilling and chemical treatment.

3. The holding time restrictions required by the analyzing laboratory.

8.1 Water Sample Preservation

There are a number of things to consider when preparing for a water sampling event. Before field deployment, be sure to have all the equipment and supplies necessary to collect, preserve, store, and transport your samples in the proper way.

8.2 Meet Sample Volume Requirements

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. It is extremely important that samplers refer to their specific SAP and QAPP to identify and collect the correct sample volume during each sampling event. Once the sample volume requirement is understood, the appropriate container size can be chosen to accommodate the sample.

8.3 Proper Preservation for Water Sample

Whether the preservation method is chilling or chemical treatment, the preservation specifics will vary based on the analysis. The variability involved in sample preservation can best be understood in the Preservation Requirement Tables (section 8.5.1 – 8.5.4). In these tables, you will see how different analyses (physical, metals, organics, inorganics or non-metallics), dictate a different set of preservation requirements.

8.4 Preservation Methods

Each preservation method has specific standard procedures that need to be followed when preserving a sample.

8.4.1 Chemical Treatment

Chemicals used for sample preservation will depend on the target analyte (see section 8.5.1 – 8.5.4). For purposes of EPA Region 8 sampling, nitric acid (HNO_3), sulfuric acid (H_2SO_4) hydrochloric acid (HCl), and phosphoric acid (H_3PO_4) are most commonly used. It is important to wear appropriate PPE when involved in any part of the sample preservation process, especially in the chemical treatment process. An MSDS should be available for all preservatives to be used on site.

Preservation chemicals may be in the form of bulk liquid or ampoules.

Common chemical preservation in EPA Region 8 water sampling:

Measurement	**Chemical Treatment**
Total and Dissolved Metals	Nitric Acid (HNO_3)
Semi-Volatile Organics	Hydrochloric Acid (HCl)
Dissolved Organic Carbon (DOC)	Phosphoric Acid (H_3PO_4)
Nutrients	Sulfuric Acid (H_2SO_4)

8.4.2 Using Preservation Ampules

Preservation chemicals, such as nitric acid (HNO_3), hydrochloric acid (HCl), and phosphoric acid (H_3PO_4), can come in the form of ampoules. Ampoules are small plastic or glass containers that hold an exact amount of a chemical in a liquid form. They are designed to be used once per sample.

When preparing to treat a sample with a chemical from an ampoule, first break the tip of the ampoule with two hands (while wearing proper PPE), and pour the liquid into the sample bottle. When all liquid has been removed from the ampoule, place the broken components of the glass ampoule into a specifically designated and labeled acid neutralization container that has a secure screw top. It is acceptable for one acid waste container to be used to neutralize all acids.

8.4.3 Using Bulk Concentrated Acid

Preservation acid can also come in the form of bulk concentrated acid, typically at a concentration level of 70%. When using bulk concentrated acid, a disposable pipet may be used to extract the necessary quantity from the parent vessel to then be released in the water sample. The pipet may be used multiple times if the same chemical is being transferred. Never cross-contaminate pipets with different chemicals or different samples.

8.4.4 Chilling

Chilling samples is almost always a part of the sample preservation process. Once a sample is collected (and potentially treated with chemicals) it is to be immediately packed in ice or placed in a refrigerator and maintained at a temperature of 4 degrees Celsius or less, without freezing, until analyzed. To avoid problems that can result from sample expansion, allow sufficient headspace in the sample bottle before chilling it (An exception to this method includes Volatile Organic Analytes (VOA). In the case of VOAs, do not leave head space in the sample bottle). If using glass bottles, use foam sleeves to protect them. Another method that can be used to avoid the potential of melting ice water seeping into sample bottles is the use of plastic bags to contain the samples. This method doubles as a way to group subsamples from the same sample location.

8.5 Preservation Requirement Tables

Preservation requirements for physical, metals, organics, and inorganic sample types can be understood in the following tables.

8.5.1 Physical Preservation Requirements

Measurement	**Volume (ml)**	**Container**	**Preservative**	**Holding Time**
Color	50	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Conductance	100	Plastic or Glass	Cool, 4 Degrees Celsius	28 Days
Hardness	100	Plastic or Glass	HNO_3 – pH below 2	6 Months
Odor	200	Glass	Cool, 4 Degrees Celsius	24 Hours
pH	25	Plastic or Glass	None required	Analyze Immediately
Temperature	1000	Plastic or Glass	None required	Analyze Immediately
Turbidity	100	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours

8.5.2 Metals Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
Dissolved	250	Plastic* or Glass	Filter on site first. HNO_3 – pH below 2	6 Months
Suspended	250	Plastic* or Glass	Filter on site. HNO_3 – pH below 2	6 Months
Total	500	Plastic* or Glass	HNO_3 – pH below 2	6 months
Dissolved (Mercury)	250	Plastic* or Glass	Filter on site first. HNO_3 – pH below 2	28 Days
Total (Mercury)	250	Plastic* or Glass	HNO_3 – pH below 2	28 Days

*Polyethylene with a polypropylene cap (no liner) is preferred.

8.5.3 Organics Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
BOD	1000	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
COD	50	Plastic or Glass	Cool, 4 Degrees Celsius. H_2SO_4 – pH below 2	28 Days
DOC	500	Plastic or Glass	Cool, 4 Degrees Celsius. Add H_3PO_4.	28 Days
Oil & Grease	1000	Glass only	Cool, 4 Degrees Celsius. H_2SO_4 – pH below 2.	28 Days
Phenolics	500	Glass only	Cool, 4 Degrees Celsius. HNO_3 – pH below 2.	28 Days
Semi-volatiles	1000	Glass only	Cool, 4 Degrees Celsius	7-14 Days

8.5.4 Inorganics & Non-Metallics Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
Acidity	100	Plastic or Glass	Cool, 4 Degrees Celsius	14 Days
Alkalinity	250	Plastic or Glass	Cool, 4 Degrees Celsius	14 Days
Bromide	100	Plastic or Glass	None required	28 Days
Chloride	250	Plastic or Glass	None required	28 Days
Cyanides	500	Plastic or Glass	Cool, 4 Degrees Celsius. NaOH – pH over 12. 0.6g	14 Days (24 Hours when

			ascorbic acid (only in presence of residual chlorine)	sulfide is present)
Fluoride	250	Plastic or Glass	None required	28 Days
Iodide	100	Plastic or Glass	Cool, 4 Degrees Celsius	24 Hours
Nitrogen (Ammonia)	500	Plastic or Glass	Cool, 4 Degrees Celsius. H_2SO_4 – pH below 2	28 Days
Nitrate & Nitrite	250	Plastic or Glass	Cool, 4 Degrees Celsius. H_2SO_4 – pH below 2	28 Days
Nitrate	250	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Nitrite	250	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Sulfate	250	Plastic or Glass	Cool, 4 Degrees Celsius	28 Days
Sulfide	250	Plastic or Glass	Cool, 4 Degrees Celsius. Add 2 ml Zinc Acetate plus NaOH – pH over 9.	7 Days

9.0 PERSONNEL QUALIFICATIONS

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. It is important for field personnel to familiarize themselves with other applicable SOP's such as Sampling Equipment Decontamination SOP FLD 02.00, Surface Water Sampling SOP FLD 01.00, Sample Custody and Labeling SOP FLD 11.00, and General Field Sampling Protocols SOP FLD 12.00. In addition, any personnel who will participate in sample preservation activities must read, understand, and sign the site-specific HASP and SAP/QAPP.

10.0 REFERENCES

Environmental Protection Agency. 1983. Sample Preservation. pp.xv-xx. In Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020. EPA Cincinnati, Ohio, USA.

United States Geological Survey. 2002. Processing of Water Samples (Version 2, 4/02). P. 89-94. In National Field Manual for the Collection of Water-quality data. USGS, Washington DC, USA.

Shallow Stream Sediment Sampling

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TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide field personnel a set of guidelines for the proper collection of stream sediment samples.

2.0 SCOPE AND APPLICABILITY

This SOP is applicable to the collection of shallow stream sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- Toxicity
- Biological availability and effects of contaminants
- Benthic biota
- Extent and magnitude of contamination
- Contaminant migration pathways and source
- Fate of contaminants
- Grain size distribution

The methodologies discussed in this SOP are applicable to the sampling of sediment in lotic environments. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions, equipment limitations and requirements of the site-specific Sampling and Analysis Plan (SAP). However, if modifications occur, they should be documented in field data sheet/field notebook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer in rivers and streams. Mention of trade names or commercial products for use in sediment sample collection does not constitute endorsement or recommendation for use.

3.0 SUMMARY OF METHOD

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type. Sediment is collected from beneath an aqueous layer directly, using a hand held device such as a shovel, trowel, or plastic scoop. Following collection, sediment is transferred from the sampling device to an appropriate sample container. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested.

The homogenization procedure should not be used if sample analysis includes volatile organics. In this case, if sediment is to be analyzed for volatile organics then the sample must be transferred to the appropriate sample container directly after collection. The sample bottle is filled completely and tapped lightly to get the trapped air out of the bottle. If the sediment settles in the bottle creating airspace then additional sediment should be collected. Repeat this step as many times necessary in order to have the sample bottle completely filled without having any air gaps.

4.0 ACRONYMS AND DEFINITIONS

COC	Chain of Custody
GPS	Global Positioning Systems
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High-Density Polyethylene
OSHA	Occupational Health and Safety
QA	Quality Assurance
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SOP	Standard Operating Procedure

Chain of Custody (COC): A chronological document that tracks movement of samples between entities from collection to disposal.

Composite Sampling: Sampling from several points or intervals and consolidating them into a larger sample.

Discrete Sampling: Sampling from a single location.

Global Positioning System (GPS): A geospatial referencing tool that is used for mapping and identification

Health and Safety Plan (HASP): A site specific document that identifies safety hazards and proper safety procedures. This normally includes hospital route maps and material safety data sheets.

Sampling and Analysis Plan (SAP): A site specific document that specifies events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site specific document that specifies quality assurance activities and data quality objectives.

5.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow United States Environmental Protection Agency (EPA), Occupational Safety and Health Agency (OSHA), and corporate health and safety procedures. More specifically, when sampling sediment from water bodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the water body, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel, appropriate protective measures and procedures must be implemented.

6.0 CAUTIONS

Only collect sediment samples if it can be done so safely. Many unsafe conditions exist on streams and rivers. Also, review the SAP/QAPP or any other planning documents for analytical requirements and equipment selection. Consult the site HASP before performing any sample collection.

7.0 INTERFERENCES

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a water body. Contaminants are more likely to be concentrated in sediments typified by fine particle size and high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosion zones.

8.0 PERSONNEL QUALIFICATIONS

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. In addition to this, any personnel who will participate in sediment sampling activities must read, understand, and sign the site specific HASP and the associated SAP/QAPP. Additionally, field personnel would benefit from understanding relevant SOPs including Sampling Equipment Decontamination SOP FLD 02.00, Sample and Labeling SOP FLD 11.00, and the General Field Sampling Protocols SOP FLD 12.00.

9.0 EQUIPMENT AND SUPPLIES

Equipment needed for collection of sediment samples may include:

> <u>Health and Safety Plan (HASP)</u> - Personal floatation device, life line, neoprene waders/gloves, proper footwear, safety glasses, insulating clothing for cold water, etc.
>
> <u>Mapping & Location Tools</u> - GPS units, site/local area maps, tape measure, compass, survey stakes, pin flags, camera, and 2-way radios.
>
> <u>Documentation</u> - Field log book, field data sheet, chain of custody (COC), labels & clear tape, pens/sharpie, waterproof paper.
>
> <u>Sampling Tools</u> - Plastic or other appropriate composition scoop, shovel, spade, trowel, homogenization container with mixing tool, rinse bottle, purified water, and paper towels.
>
> <u>Sample Containers</u> -High-density polyethylene (HDPE) or other appropriate composition containers (50 mL and 1 liter [bulk] are frequently used), amber glass jars (organics analysis) labels, clear tape, pens, permanent marker, sealable plastic bags, cooler(s), and ice.

See Table 9.0-1 for a detailed list of sediment sampling equipment.

10.0 STANDARDS AND REAGENTS

Reagents are not used for preservation of sediment samples.

11.0 PROCEDURES

11.1 Sample Preservation, Containers, Handling and Storage

Chemical preservation of solids is not recommended. Cooling to 4 degrees Celsius (ºC) is recommended for sediment samples. HDPE containers with Teflon^{TM} lined caps are typically used for sediment samples. Sample container size is typically 50 milliliter (mL) for metal analysis and 1 liter for sediment toxicity testing. However, the sample volume is a function of the analytical requirements and will be specified in the SAP/QAPP. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses requested. Transfer is accomplished with a decontaminated stainless steel or plastic lab spoon or equivalent.

If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition containers. The sediment is then homogenized thoroughly, to obtain a composite sample that is representative of the area and is then transferred to a labeled container. Transfer of sediment is accomplished with a stainless steel or plastic lab scoop or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection. It is important that when collecting sediment for volatile organic compounds analysis, the sample container is filled completely full and the sample container is tapped lightly to ensure all air is purged from the sample. This is done to minimize loss of contaminant due to volatilization.

All sampling devices should be decontaminated following procedures described in the Sample Equipment Decontamination SOP FLD 02.00. The sampling device should remain in its wrapping until it is needed. Each sampling device should be used for only one sample. Although disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required, such devices may prove efficient and effective for difficult terrain/remote locations. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP FLD 02.00.

11.2 Preparation

Determine the objective(s) and extent of the sampling effort. Obtain access to private property if sample locations are located within private boundaries. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives specified in the SAP and QAPP.

- Obtain the necessary sampling and monitoring equipment.
- Prepare schedules, and coordinate with staff, client, and regulatory agencies where appropriate.
- Decontaminate or pre-clean equipment, and ensure that it is in working order.

- Perform a general site survey prior to site entry in accordance with the site-specific HASP.
- Use stakes, flagging, or buoys in addition to using a GPS (Refer to SOP FLD 07.00) to identify and mark all sampling locations. Specific site factors including flow regime, basin morphology, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

11.3 Sample Collection

Selection of a sampling device is most often contingent upon the depth of water at the sampling location and the physical characteristics of the sediment to be sampled. The following procedure consists of sampling surface sediment with a scoop, trowel or shovel from beneath a shallow aqueous layer:

For the purpose of this method, surface sediment is considered to range from 0 to 1 inch in depth and a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water may render this method less accurate than other methods such as utilizing a handheld dredge or coring device. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team lead. A plastic scoop will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, collect the desired thickness and volume of sediment from the sampling area.

2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

11.3.1 Composite Sampling

Composite sampling consists of taking several sub-samples from a location and consolidating them into a larger sample. If data quality objectives dictate that each sub-sample of a composite be measured, it can be done two ways; by mass or by volume. For remote site field sampling activities (such as ones that typically occur in Region 8), it is recommended that sub-samples be measured by volume. This can be done with a graduated beaker/measuring cup or cylinder. Place the sub-sample in the measuring device, record the measurement, and transfer the sub-sample into a larger container where the complete composite sample will be processed.

Composite representative sample collection can also be accomplished without measurement of sub-samples. For sediment collection that does not require sub-sample measurement, larger amounts of sample can be collected in areas where sediment is more readily available. This method is used very frequently in high-gradient streams such as those found in the region.

11.3.2 Discrete Sampling

Discrete sampling consists of taking a sample from a single location. This method requires that the selected location for a sediment sample have sufficient amount of material for the analytical requirements. In general, sediment samples in a stream are difficult to obtain from a single location; therefore composite samples are more commonly collected.

12.0 DATA RECORDS AND MANAGEMENT

Once collected, samples are labeled and stored for transport (at 4°C). A COC must accompany all samples during transport and transfer between entities. Sample labels should contain the following information:

- Site Identification
- Date sampled
- Sampler initials
- Time
- Analysis to be performed

13.0 QUALITY CONTROL AND ASSURANCE

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the SAP and QAPP. Equipment inspection must occur prior to sampling, and they must be documented.

3. QA samples should be sampled at a standardized frequency. Field duplicates are generally sampled at a rate of 1:20.

14.0 REFERENCES

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

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de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

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Table 9.0-1: Sediment Sampling Equipment

Category	Item	Use	Comment
Health and Safety	Gloves	Protection from absorption of contaminants	Nitrile or neoprene are recommended
Health and Safety	Waders	Slip/contaminant protection	Any type are acceptable
Health and Safety	Safety Glasses	Eye protection	Sunglasses for UV protection
Health and Safety	Layered Clothing	Protection from hypothermia	Polyester base layers only
Mapping/Location	GPS unit	Sample station locating	Pre-loaded with site locations
Mapping/Location	Maps	Location identification	Must contain most current information
Mapping/Location	Two-way radios	Communication	Extra batteries or charger required
Documentation	Field Logbook	Site data and conditions documentation	Waterproof pages
Documentation	Chain of Custody	Sample handling/identification	Pre-printed using Scribe
Documentation	Labels	Sample identification	Pre-printed using Scribe
Documentation	Clear tape & Scissors	Label protection	
Sampling Tools	Bucket/Transfer Device	Sample transfer (if required)	Can also be used for sample homogenization
Sampling Tools	Sediment Scoop	Sediment sampling	Select based on analysis
Sampling Tools	Cooler	Sample containment	Cool to 4°C
Sampling Containers	Amber glass jars	Volatile Organics Analysis sample containment	Tight cap seal
Sampling Containers	50 ml HDPE (widemouth)	Metals analysis sample containment	
Reagents	10% Nitric Acid (HNO3) solution	For decontamination of metals sampling equipment	Pre-mixed at lab
Reagents	10% Hydrochloric Acid (HCl) solution	For decontamination of organics sampling equipment	Pre-mixed at lab

Pore Water Sampling

APPROVED:

ESAT Region 8 QA Coordinator

04/04/12
Date

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6/6/12
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7/10/12
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This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedures, methods, and considerations to be used when obtaining a pore water sample using PushPoint® samplers.

2.0 SCOPE AND APPLICABILITY

This document describes procedures for pore water sampling using PushPoint® samplers and is based on the Operators Manual and Applications Guide provided by MHE Products (Ver. 2.01,2/15). It is intended to be used by field personnel when collecting and handling samples in the field. All deviations from this SOP must be noted in the site-dedicated field logbook.

3.0 SUMMARY OF METHOD

Sediment pore water is collected using a pore water extractor, called a PushPoint® (Figure 1) which is made out of stainless steel tubing developed by MHE Products. The sampling end of the PushPoint® is inserted into the sediment to the desired depth, and pore water is extracted using a syringe or peristaltic pump.

4.0 ACRONYMS AND DEFINITIONS

COC	Chain of Custody
DOC	Dissolved Organic Compounds
DOT	United States Department of Transportation
DQO	Data Quality Objective
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IATA	International Air Transportation Association
OSHA	Occupational Safety and Health Administration
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compound
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

Health and Safety Plan (HASP): A site-specific document outlining potential safety hazards and hazard mitigation techniques.

Occupational Safety and Health Administration (OSHA): An agency that regulates health and safety standards in the United States.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

5.0 HEALTH AND SAFETY

Proper safety precautions must be observed when collecting pore water samples. Refer to Environmental Services Assistance Team (ESAT) site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. When following this SOP, minimize exposure to potential health hazards in the field by using personal protective equipment (protective clothing, eye wear and gloves). Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

6.0 SAMPLE MANAGEMENT

The following precautions should be considered when collecting pore-water samples:

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.

- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party (see SOP FLD-11.00, or current version, “Sample Custody and Labeling”).

- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.

- Shipped samples must conform to all United States Department of Transportation (DOT) and/or International Air Transportation Association (IATA) hazardous materials shipping requirements.

- Documentation of field sampling is done in a bound logbook.

- Chain of custody (COC) documents must be filled out and remain with the samples until custody is relinquished until analysis is complete (or samples are disposed).

- All shipping documents, such as bills of lading, etc., shall be retained by the project leader and stored in a secure place.

7.0 INTERFERENCES

The following sections describe potential interferences when sampling for trace level contaminants. For decontamination procedures, see the Sampling Equipment Decontamination SOP FLD 02.00.

7.1 Potential Volatile Organic Analysis (VOA) Sampling Interferences

Pore water samples for volatile organic compound (VOC) and semi-volatile organic compounds (SVOC) analysis must be collected in 40-ml amber glass vials with Teflon® septa. The vials may be preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas, unpreserved samples have only a seven day holding time. Normally, either preserved or unpreserved vials can be used, but there are instances where the use of unpreserved vials is preferred. For example, if the surface water sample contains a high concentration of dissolved calcium carbonate, there may be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

Samples for VOC and SVOC analysis must be collected using either stainless steel or Teflon® equipment. Samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial, and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be refilled. Care should be taken not to flush any preservative out of the vial during topping off. If bubbles are still present after attempting to refill and cap the vial, a new vial should be obtained and the sample re-collected.

7.2 Potential Dissolved Metals or Dissolved Organic Compound Sampling Interferences

If a dissolved metals or Dissolved Organic Compounds (DOC) pore water sample is to be collected, in-line filtration or post-collection filtrations are acceptable approaches. The in-line filter apparatus uses disposable, high capacity filter cartridges (barrel-type) or membrane to filter the sample. The high capacity, barrel-type filter works well due to the higher surface area associated with this configuration. Post-collection filtration involves two approaches. The first approach is to take the sample water and filter it through a .45 micron filter apparatus. The second approach involves the use of a syringe with a .45 micron acrodisc filter attached to end of syringe.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations, including filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency of sample technique and filter characteristics is critical in the comparison of short-term and long-term results.

7.3 Special Precautions for Trace Contaminant Pore Water Sampling

1. A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled, and the gloves should be donned prior to handling sampling equipment and sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.

2. Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately from samples suspected of only having trace levels of contaminants.

3. All background or control samples shall be collected and placed in separate ice chests or shipping containers. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.

4. Samplers must use new, verified, certified clean disposable equipment, or pre-cleaned non-disposable equipment.

8.0 PERSONNEL QUALIFICATIONS

Any personnel involved with field sampling activities must be cleared for health and safety. Clearance includes medical monitoring, respirator fit testing, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. Personnel who will be collecting pore water samples must be familiar with this SOP and any other relevant SOPs, including the Sample Equipment Decontamination SOP FLD 02.00, Sample Preservation SOP FLD 03.00, Water Quality Measurements with the In-Situ® Multi-Parameter Meter SOP FLD 09.00, Sample and Labeling SOP FLD 11.00, and General Field Sampling Protocols SOP FLD 12.00.

9.0 EQUIPMENT AND SUPPLIES

The PushPoint® sampler consists of a tubular 3/16 stainless steel body with a screened zone at one end and a sampling port at the other. It comes with a guard rod that is nested in the tube during deployment in order to provide structural support and to prevent plugging and deformation of the screened zone (Figure 1). The screened zone consists of a series of interlaced machined slots that form a short screened zone with approximately 20% open area. Additional filters can be placed over the screened zone if additional screening is needed. Pore water is collected through the opposite end of the PushPoint® sampler through peristaltic flexible tubing using a syringe through the sampling port. Tygon® tubing is the preferred tubing to be used with PushPoint® samplers. However, other tubing can be used, if allowed by data quality objectives (DQOs) for the specific application. PushPoint® samplers can be custom made to any width or length.

There are many modifications that can be incorporated into the procedure to satisfy DQOs for a specific application. The procedures discussed in the following sections provide guidance on the basic operation of the PushPoint® and issues to consider when deploying the PushPoint® sampler to collect pore water.

Other equipment used in the process of pore water sample collection includes syringes, flanges, tubing, sample bottles or containers, and filters.

10.0 STANDARDS AND REAGENTS

Reagents will be used for preserving samples and for decontaminating sampling equipment (refer to the Sampling Equipment Decontamination SOP FLD 02.00 and Sample Preservation SOP FLD 03.00). The preservatives required are determined by the analysis to be performed and will be specified in the Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP), but usually include nitric acid (total recoverable and dissolved metals samples), hydrochloric acid (VOC samples), and phosphoric acid (DOC samples). 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. Appropriate regional guidance and procedures should be consulted for detailed sample collection, preservation, handling and storing, equipment decontamination, and quality assurance/quality control (QA/QC) procedures. The sampler should preserve and immediately cool all water samples to 4°C (±2°C) upon collection and samples should remain cooled until the time of analysis (do not freeze water samples).

11.0 PROCEDURES

It is critical in the collection of pore water to avoid surface water intrusion. Water will flow in a path of least resistance. If space is created around the sides of the PushPoint® sampler during deployment, surface water may flow down the outside of the tube to the screened area and into the intended sample. Therefore, the PushPoint® can be used with a sampling platform or flange (Figure 2), especially when collecting pore water near the sediment-surface water interface. However, if pore water is collected from deep in the sediments or in cobble-bottom streams, a flange may not be necessary. Additionally, it is important to note that a platform is only useful in specific situations when you are sampling multiple holes and specific depths and when sampling at shallow depths where the integrity of the hole may be a concern. It is critically important to collect samples from the hyporheic zone, or the area beneath the streambed where shallow groundwater is mixed with surface water (this area is critical to benthic macro-invertebrates and fish spawning activity). When inserted though the sampling platform, or flange, the flange should fit securely around the PushPoint® to eliminate surface water intrusion from around the PushPoint® body during sample collection.

The flange can be made of any material that will not cross contaminate the intended sample. If full scan analytical analysis is required, the flange should be made of inert material such as stainless steel or Teflon®. The size of the flange depends on the volume of pore water to be collected. If large volumes of pore water are to be collected, use a large flange size. If it is not practical to use a large flange, then multiple PushPoints® with smaller flanges can be deployed and smaller volumes can be collected from several PushPoints® for a composite sample. If multiple PushPoints® are deployed, they should be spaced at least 30 cm apart.

11.1 PushPoint® Sampler Basic Operation

The PushPoint® sampler should be inserted into the sediment as carefully as possible (Figure 2). When deploying the PushPoint®, care must be taken not to disturb the sampling area. If the sampler is wading in the water body, the sampler should lean out and insert the PushPoint® as far as possible away from where he/she is standing in order to reduce potential effects of the sampler on the integrity of the pore water sample. Depth of penetration of the PushPoint® into the sediment depends on the objectives of the specific investigation. Once depth is established for sample collection, be sure to measure and record the sampling depth in the logbook.

After the PushPoint® has been deployed, carefully remove the guard rod and attach the sample tubing (Figure 3). The other end of the sample tubing can be connected to the sample withdrawing device, such as a peristaltic pump or syringe (Figure 4). Before collecting a pore water sample, be sure to purge out all air and surface water from the PushPoint® sampler and sample tubing with the appropriate amount of pore water. At least three volumes of pore water (until water is clear) should be purged before sample collection.

11.2 Peristaltic Pump/Vacuum Jug Collection

The peristaltic pump/vacuum jug can be used for sample collection because it allows for sample collection without the sample coming in contact with the pump head tubing. This is accomplished by placing a Teflon® transfer cap assembly onto the neck of a clean standard 1-liter amber glass container. Teflon® tubing (3-inch outside diameter) connects the container to both the pump and the sample source. The pump creates a vacuum in the container, thereby drawing the sample into the container without it coming into contact with the pump head tubing.

Because the sample is exposed to a vacuum and is agitated as it enters the vacuum jug, this method cannot be used for collection of VOC samples. An alternative method for collecting VOC samples involves filling the Teflon® tubing with sample by running the pump for a short period of time. Once the tubing is full of water, the tubing is removed from the PushPoint® and, after the tubing is disconnected from the pump head tubing, the water is allowed to drain, by gravity, into the sample vials. Alternatively, without disconnecting the tubing from the pump head, the contained sample can be pushed out of the tubing and into the sample vials by reversing the peristaltic pump at low speed.

For samples that are collected for metals analyses, or other analysis not affected by the silastic tubing, it is permissible to collect the sample directly from the discharge of the pump head tubing after an adequate purge has been completed. When collecting samples in this manner, there are several considerations to be aware of. The pump head tubing (silastic, etc.) must be changed after each sample and a rinsate blank must be collected from a representative piece of the pump head tubing (only one blank per investigation). Also, precautions must be taken to ensure that the end of the discharge tubing is not allowed to touch the ground, or other surface, in order to maintain the integrity of the sample when it is collected in this manner.

11.3 Syringe

Syringes, in conjunction with PushPoint® samplers, can be used to collect pore water samples if the integrity of the sample analysis will not be compromised. The tubing from the sampling port of the PushPoint® can be directly attached to a syringe and a pore water sample can be manually withdrawn from the sediment. The syringe can be used as the final sample container or the pore water can be transferred to another container, depending on project objectives and analytical requirements.

11.4 Sample Handling and Preservation Requirements

1. Pore water will typically be collected from sediments using a PushPoint® and placed directly into the sampling containers. A syringe may then be used to transfer the sample from the sampling container into the appropriate container.

2. When transferring the pore water sample from a collection device, make sure that the device does not come in contact with the final sample containers. The syringe used in the sample transfer is the only piece of equipment that should be in contact with the transfer vessel and the final sample container.

3. Place the sample into the appropriate labeled container. Samples collected for VOC

analysis must not have any headspace (see Section 7.1). All other sample containers must be filled with an allowance for ullage.

4. All samples requiring preservation must be preserved as soon as practically possible after sample collection. If preserved VOA vials are used, these will be preserved with concentrated hydrochloric acid prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be specified in the site-specific SAP. The adequacy of sample preservation will be checked after the addition of the preservative for all samples, except for the samples collected for VOC analysis. If it is determined that a sample is not acceptably preserved, additional preservative should be added to achieve adequate preservation. Preservation requirements for surface water samples will be specified in the site-specific SAP/QAPP and the Sample Preservation SOP FLD 03.00.

12.0 DATA RECORDS AND MANAGEMENT

Once collected, samples are preserved, labeled, and stored for transport. A chain of custody form must accompany all samples during transport and transfer between entities. Sample labels should contain the following information:

- Site identification
- Date sampled
- Location identification
- Sampler initials
- Time
- Analysis to be performed
- Preservative

Any other pertinent data should be recorded in the site dedicated field logbook.

13.0 QUALITY CONTROL AND ASSURANCE

The following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. In general, concurrent (duplicate) sample collection at a frequency of 10% is required for most sampling activities. Field blanks at a frequency of one per day are also generally required. Consult the corresponding SAP/QAPP for specific QA/QC sampling frequency. Below is a list of usual pore water QA/QC sample types and the inaccuracy they are intended to detect:

   - Duplicate sample – two samples collected at the same location at the same time, intended to detect variability inherent in collection, processing, and handling procedures
   - Field blank – checks cross-contamination during sample collection, preservation, and shipment as well as in the laboratory.
   - Rinsate blank – detects equipment contamination due to inadequate decontamination

procedures

3. All instrumentation should be operated in accordance with operating instructions as supplied by the manufacturer unless otherwise specified in the work plan or SAP/QAPP. Equipment calibration activities should be conducted and documented prior to sampling and/or operation of equipment.
4. Document any deviations from SOPs, work plan, SAP/QAPP, etc.

14.0 REFERENCES

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

MHE Products, PushPoint® Sampler (US Pat. # 6,470,967), Operators Manual and Applications Guide, Ver. 2.01, 2/15.

15.0 FIGURES

Figures 1-4 show equipment operation and basic sampling techniques.

Figure 1 - Pore Water PushPoint®

Figure 1. Pore Water PushPoint

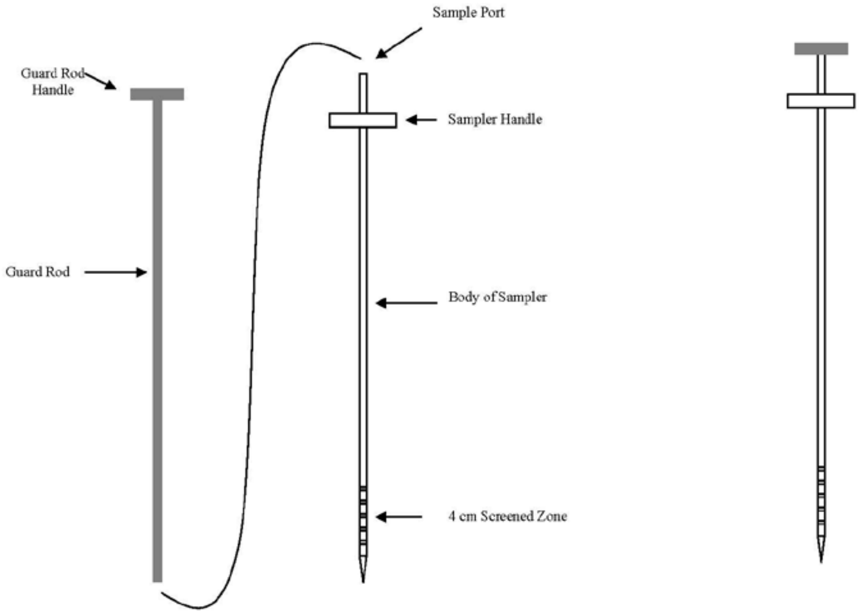


Figure 1A. Disassembled PushPoint

Figure 1B. Assembled PushPoint

Actual length and width of PushPoints will vary, depending on sampling needs and site conditions.

Figure 2 - PushPoint® deployed with a Sampling Platform

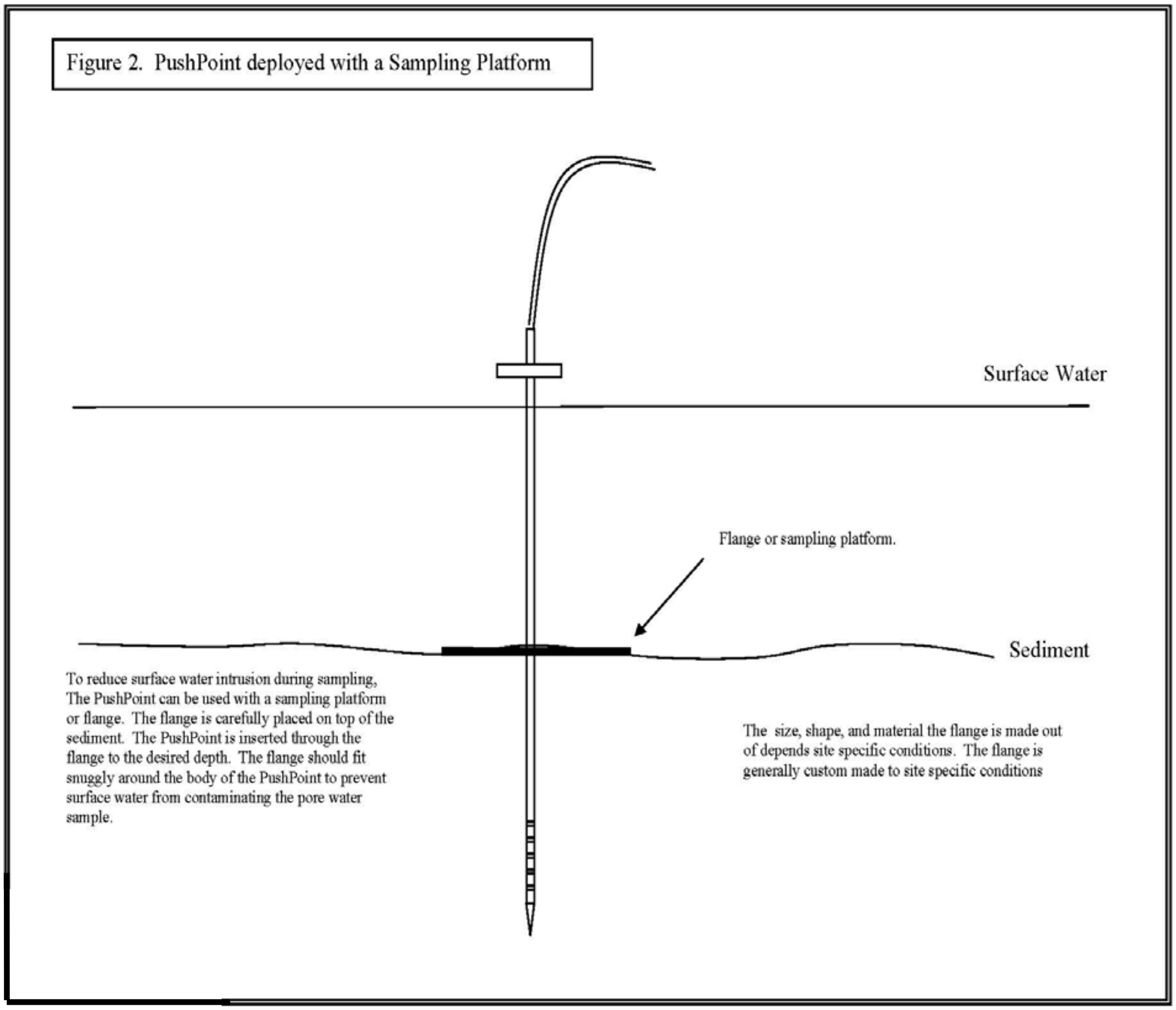


Figure 2. PushPoint deployed with a Sampling Platform

To reduce surface water intrusion during sampling, The PushPoint can be used with a sampling platform or flange. The flange is carefully placed on top of the sediment. The PushPoint is inserted through the flange to the desired depth. The flange should fit snuggly around the body of the PushPoint to prevent surface water from contaminating the pore water sample.

The size, shape, and material the flange is made out of depends site specific conditions. The flange is generally custom made to site specific conditions

Figure 3 - PushPoint® Being Deployed into the Sediment

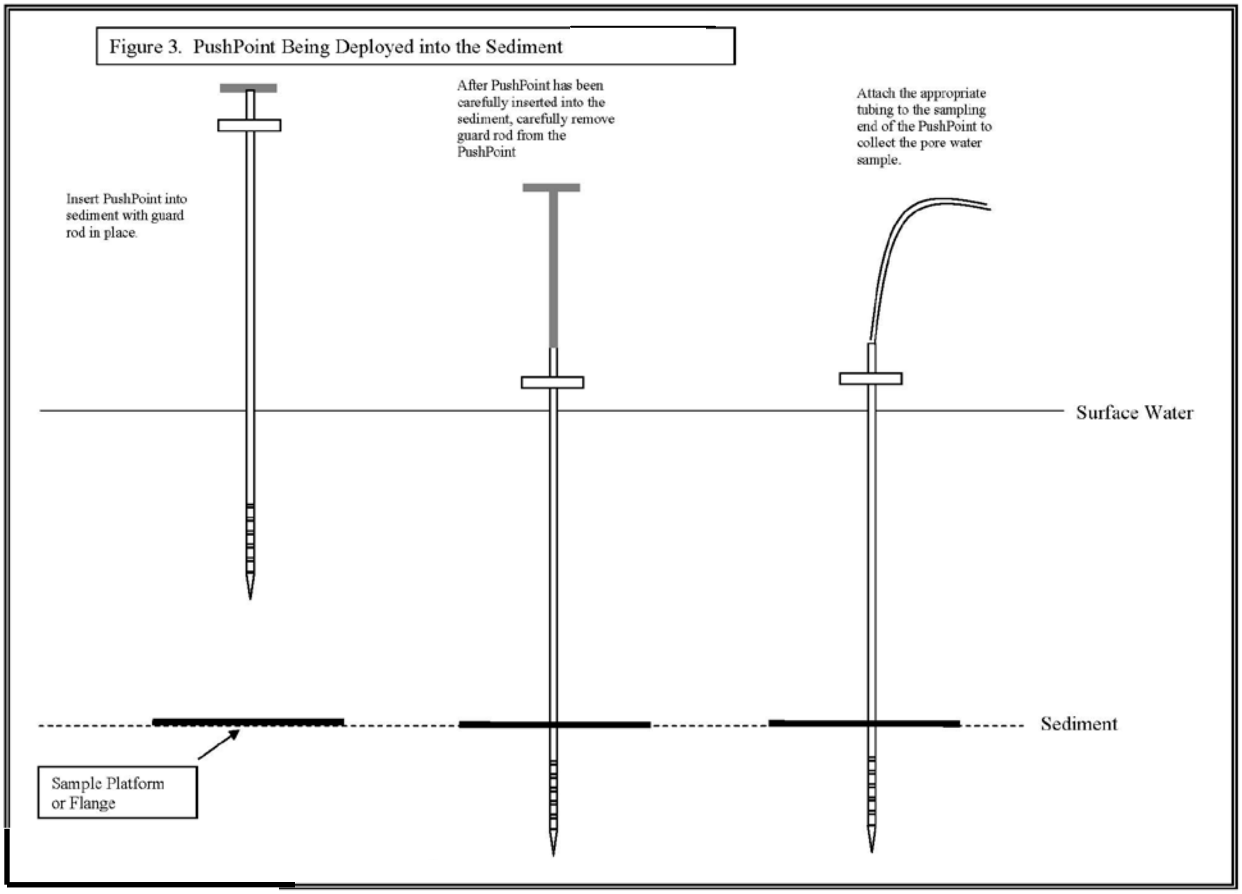
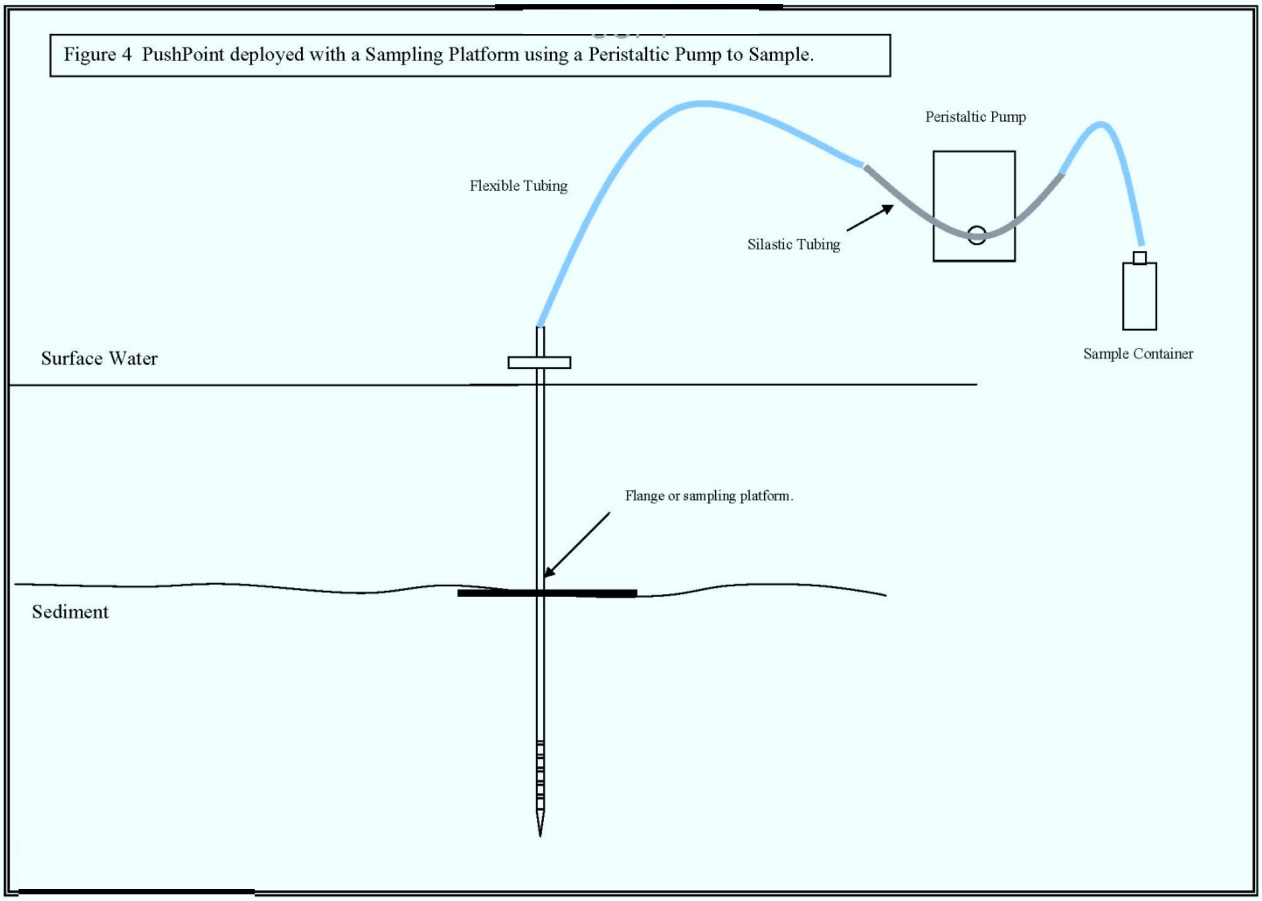


Figure 4 - PushPoint® deployed with a Sampling Platform using a Peristaltic Pump to Sample



Sample Custody and Labeling

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TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to assist field personnel in developing proper sample custody and sample identification methods for the collection of environmental samples. This includes the use of chain of custody (COC) forms and labels for samples collected in the field. These procedures are critical in ensuring the integrity of environmental samples.

2.0 SCOPE AND APPLICABILITY

To ensure the integrity of a sample collected in the field or generated in a laboratory setting, documentation is needed to chronicle all sample handling for collection or creation through analysis and/or disposal. Any sample that is collected in the field or generated in a laboratory setting will require that records are kept as it transfers from various entities. This is the basis for generation of a COC. Uniquely, labeling samples with information, such as sample location, date, time, preservation method, and analytical requirements, keeps samples organized. A COC is initiated for each sample, either at the time of sample collection or generation or as part of preparation for a sampling event. This SOP will cover the best practices for sample custody and the method of COC and label generation.

3.0 SUMMARY OF METHOD

Once a sample is collected, several steps need to be taken to ensure the required information is collected and maintained as it is transferred from the point of collection to the laboratory. If sample nomenclature and location is known before a field event, a COC will be generated before deployment into the field. When generating the COC, it is important to know the analytical fate of samples required for each sample location (e.g. total recoverable metal, dissolved metals, etc.). This information can be found in the site-specific Sampling and Analysis Plan (SAP) and other sampling event planning documents. Some software programs (e.g. Scribe) that generate COCs also have the ability to generate labels. Scribe is the Laboratory Information Management System (LIMS) used by the lab. It is important to keep in mind that it is not mandatory to generate COCs and labels before a sampling event, but it is preferred. If it is not known where samples will be collected or the nomenclature of the sites is unclear, sample containers can be labeled with permanent marker with tape placed over it, and a blank COC can be filled out at the time of sample collection. Once the method of custody is established, a specific person, known as the sample custodian, is then responsible for maintaining the integrity of the samples as they move from and within various locations.

4.0 ACRONYMS AND DEFINITIONS

CLP	Contract Lab Program
COC	Chain of Custody
EPA	United States Environmental Protection Agency
ERT	Environmental Response Team
ID	Identification
LIMS	Laboratory Information Management System
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

Chain of Custody (COC): A document used to chronologically track movement of samples between entities from collection to disposal.

Sampling and Analysis Plan (SAP): A site-specific document that describes the events to take place in the field.

Scribe: – A software tool developed by the United States Environmental Protections Agency (EPA) Environmental Response Team (ERT) to assist in the process of managing environmental data. Scribe captures sampling, observational, and monitoring field data.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

5.0 HEALTH AND SAFETY

There are no specific health and safety hazards associated with sample custody and labeling, but these activities sometimes take place on-site during a sampling event. It is important for field personnel to familiarize themselves with the site-specific Health and Safety Plan before deployment to a site. In terms of personal interaction with the sample throughout the process of sample custody, there exists the possibility that the samples can leak. It is important to be aware of such hazards, especially when interacting with samples that are highly contaminated.

6.0 CAUTIONS

Samples sometimes require specific storage and maintenance, such as temperature preservation requirements. Proper storage of samples is critical in maintaining their integrity. Labeling is also critical in the process of sample custody. Samples usually are labeled with a series of letters and numbers that correspond to a site location, which sometimes are very similar to each other. Sample nomenclature will be designated in the approved SAP and will be followed in the field. Once a COC or label is generated, it is very important to have it reviewed for quality assurance purposes. Sample label and COC review is necessary to ensure that they match site documents.

7.0 INTERFERENCES

Once a COC and group of labels are reviewed and deployed, it is critical that the proper label ends up on the correct sample container. There will be more than one subsample collected at the majority of sampling locations in the region. This means that sample numbers can be very close in nomenclature, which puts more emphasis on attention to detail when labeling the sample containers. If the wrong label is attached to a sample, it may result in improper preservation, improper analysis, or rejection by the analytical laboratory.

8.0 PERSONNEL QUALIFICATIONS

It is critical that field personnel have proper clearance and health and safety training. Anyone who performs sample custody activities should also familiarize themselves the site-specific SAP and Quality Assurance Project Plan (QAPP), as well as with applicable SOPs: Surface Water Sampling SOP FLD 1.00, Groundwater Sampling SOP FLD 04.00, Soil Sampling SOP FLD 5.00, Pore Water Sampling SOP FLD 10.00, and Shallow Stream Sediment Sampling SOP FLD 06.00.

9.0 EQUIPMENT AND SUPPLIES

Below is a list of equipment and supplies required for COC activities (refer to the site specific SAP for additional items that maybe needed:

- Scribe software
- A SAP that details sample locations and analytical requirements
- Printer (that accepts corresponding labels)
- Blank COC pages in case of unexpected opportunistic sampling
- Permanent marker for preliminary labeling
- Clear tape for label protection from moisture
- Printable labels
- Field Logbook

10.0 STANDARDS AND REAGENTS

There are no standards or reagents associated with this SOP.

11.0 PROCEDURES

The following sections outline the general procedures for sample custody and labeling, filling out COCs with the proper information, and relinquishing samples. See Attachment A for an example of a blank COC and Attachment B for an example of a sample label.

11.1 Generating a Blank COC and Sample Labels

There are several types of data management software that can be used to generate COCs and labels. Scribe is used at the EPA Region 8 laboratory. Some training is required before an individual can use Scribe; however, once the basics of Scribe are understood, it can be used to generate COCs and labels for any type of sample or analysis. A COC that is generated prior to deployment should have the following information:

- Site Identification
- Analysis to be performed
- Preservation
- Tag Identification

The following information should not be filled out until sampling occurs:

- Date
- Time
- Sampler identification
- Comments describing anomalies

Labels can be produced with the same information found in the COCs.

11.2 Populating COC Fields and Affixing Labels

Sample containers should always be marked with a permanent marker with the site identification (ID), time of collection, analysis to be performed, date, and sampler initials prior to sample collection. Once samples have been collected, and a safe place to fill out COC and labels is established, field personnel should fill out the pre-populated COCs and labels with information such as date, time of collection, sampler initials, and comments. It is imperative that the information written on the sample container in permanent marker is the same information on the sample labels and the COC. The same information should also be recorded in a site-dedicated field logbook.

Once the labels have been verified to have the correct information, they should be affixed to the sample containers. Always be sure to double check that the proper label is placed on the corresponding sample container by cross-referencing it with the markings. Once the label is affixed to the sample container, place clear packing tape over the label and wrap completely around the container. This will prevent moisture from dissolving the label adhesive and blurring the writing. It also prevents holes, knicks, or tears from rendering the label unreadable.

11.3 Review/Custody Transfer

Once sample information is written on the COC and labels, and the label IDs have been verified against the permanent marker ID on the container, they are then ready for transfer of custody. Whether the samples are going to the EPA Region 8 lab or a Contract Lab Program (CLP) laboratory partner, the samples must be properly shipped at the required temperature (4°C for water and sediment samples) and done so in a way that containers are not compromised. In order to not compromise the integrity of the samples, the handler needs to make sure the cooler or other transporting vessel is not dropped, exposed to moisture or extreme weather, or in any other way disturbed. A signed copy of the COC intended for the receiving laboratory (samples IDs and event information should not be viewable to the lab) must be included in the shipping container. If samples are returning to the Region 8 Laboratory, they should be properly stored on ice in the field until delivered to the lab. To protect against sample contamination, place the ice in the coolers in plastic bags. When at the lab, samples should be placed in the walk-in coolers located in the sample receiving room. A signed copy of the COC is given to the sample receiving coordinator. In order to ensure samples are transferred to the correct party with the appropriate information and communication, a mutual signing of the COC by the sampler or transport agency and the sample coordinator can be arranged.

12.0 DATA RECORDS AND MANAGEMENT

As mentioned earlier, a COC should have information such as site ID, sample location, sample time, sample date, sampler initials, analytical requirements, sample matrix, preservative type, and a comments field. A sample label should have information such as sample location, time, date, matrix, preservative, and sampler initials. Any other field observations that require an explanation should be noted in the field forms or site-dedicated field notebook. Data such as sample ID, time, date, field parameters, (pH, temperature, conductivity, and dissolved oxygen) and sampler initials will eventually be entered into Scribe.

13.0 QUALITY CONTROL AND ASSURANCE

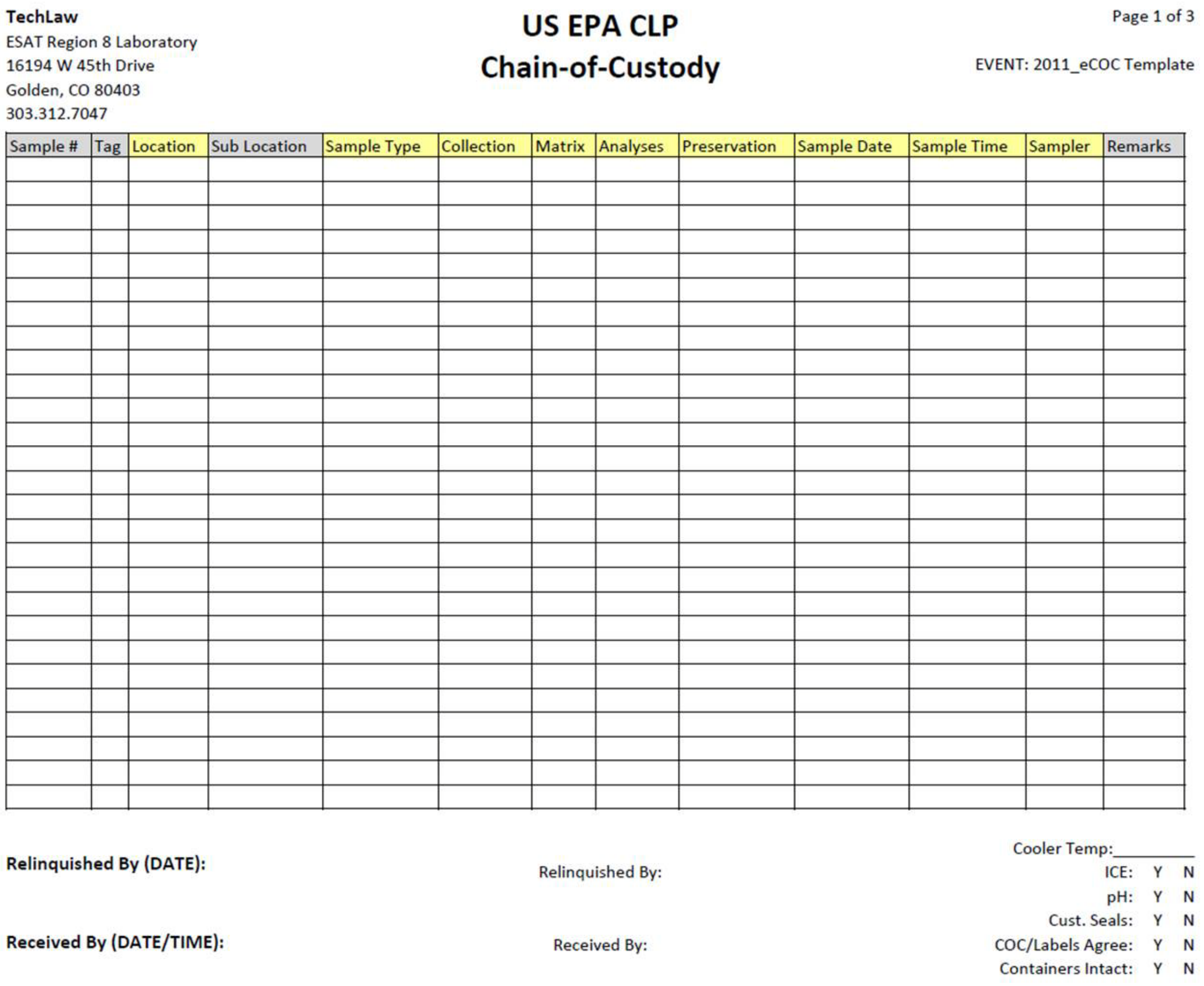
Proper sample custody and labeling requires a number of quality control and assurance steps. A COC generated in Scribe should always be crossed-checked by another person with the sample list found in the SAP. Completed COCs and labels should also be compared for accuracy before being relinquished to the receiving analytical laboratory. Any incorrect information on a COC or label may cause the lab to reject the shipment.

14.0 REFERENCES

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

15.0 ATTACHMENTS

Attachment A: Example Chain of Custody Form



TechLaw
ESAT Region 8 Laboratory
16194 W 45th Drive
Golden, CO 80403
303.312.7047

US EPA CLP
Chain-of-Custody

Page 1 of 3

EVENT: 2011_eCOC Template

Sample #	Tag	Location	Sub Location	Sample Type	Collection	Matrix	Analyses	Preservation	Sample Date	Sample Time	Sampler	Remarks

Relinquished By (DATE):

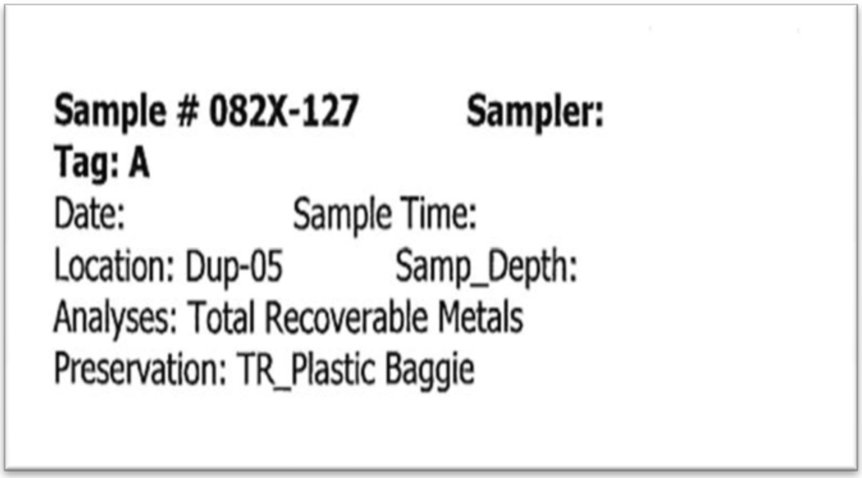
Relinquished By:

Received By (DATE/TIME):

Received By:

Cooler Temp:__________
ICE: Y N
pH: Y N
Cust. Seals: Y N
COC/Labels Agree: Y N
Containers Intact: Y N

Attachment B: Example Sample Label



Sample # 082X-127 **Sampler:**
Tag: A
Date: Sample Time:
Location: Dup-05 Samp_Depth:
Analyses: Total Recoverable Metals
Preservation: TR_Plastic Baggie

General Field Sampling Protocols

APPROVED:

ESAT Region 8 QA Coordinator

04/04/12
Date

ESAT Region 8 Team Manager

6/6/12
Date

EPA Task Order Project Officer

7/10/12
Date

ESAT Region 8 Task Lead

6/8/12
Date

DCN: EP8-7-7051

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

2.0 SCOPE AND APPLICABILITY

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

3.0 SUMMARY OF METHOD

Sampling is the selection of a representative portion of a larger population, area or body. Through examination of a sample, the characteristics of the larger entity from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment. The sampling design is a fundamental part of data collection for scientifically based decision making. A well-developed sampling design plays a critical role in ensuring that data are sufficient to draw the conclusions needed. The goals of a sampling design can vary widely. Typical objectives of a sampling design for environmental data collection are:

- To support a decision about whether contamination levels exceed a threshold of unacceptable risk
- To determine whether certain characteristics of two populations differ by some amount
- To estimate the mean characteristics of a population or the proportion of a population that has certain characteristics of interest
- To identify the location of “hot spots” (areas having high levels of contamination) or plume delineation
- To characterize the nature and extent of contamination at a site
- To monitor trends in environmental conditions or indicators of health

A well-planned sampling design is intended to ensure that resulting data are adequately representative of the target population and defensible for their intended use. Representativeness may be considered as the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Throughout the sampling design process, the efficient use of time, money, and human resources are critical considerations. A good design should meet the needs of the study with a minimum expenditure of resources. If resources

4.0 ACRONYMS AND DEFINITIONS

EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
DOT	Department of Transportation

HAZWOPER	Hazardous Waste Operations and Emergency Response
IATA	International Air Transport Association
MI	Multi-increment
OSHA	Occupational Safety and Health Administration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

Occupational Safety and Health Administration (OSHA): A regulatory agency that governs health and safety standards in the United States.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

5.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and corporate health and safety procedures. Always review the site Health and Safety Plan (HASP) before beginning work at any site.

6.0 CAUTIONS

In general, health and safety of field team members and sample/data integrity are the two main concerns during a field sampling event. Field personnel must understand sampling procedures and be familiar with health and safety protocols before deployment to a site. Always consult the HASP before entering a site.

7.0 INTERFERENCES

The nature of the object or materials being sampled may be challenging to characterize. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of spatial and temporal changes in the material. Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample. Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

8.0 PERSONNEL QUALIFICATIONS

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. In addition, any personnel who will participate in sampling activities must read, understand, and sign the site-specific HASP and associated Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP).

9.0 EQUIPMENT AND SUPPLIES

The equipment required to collect samples must be determined on a site-specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment required for sampling.

10.0 STANDARDS AND REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP FLD 02.00.

11.0 PROCEDURES

11.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with high levels of hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree. The importance of making the distinction between environmental and hazardous samples is two-fold:

1. Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel. Personnel handling potentially hazardous substances should always wear proper Personal Protective Equipment.

2. Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

11.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab (Discrete) Samples
A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite (Multi-Increment) Samples
Multi-increment (MI) or composite sampling is a structured sampling protocol that reduces data variability and increases sample representativeness. The objective of MI sampling is to obtain a single sample for analysis that has a mean analyte concentration representative of the decision unit. The decision unit size is site-specific and represents the smallest area on which to base a decision or conclusion. Samples are collected from multiple locations within the decision unit and composited so the samples are spatially representative of the decision unit. The decision unit must be defined so that the results are relevant to explicitly articulated sampling objectives. Note that establishment of decision units is necessary to develop any effective sampling approach, whether using MI or discrete sampling.

The MI sampling strategy improves the reliability and defensibility of sampling data by reducing their variability compared to conventional discrete sampling strategies. The data distribution for MI replicate samples tends to be normally distributed, as contrasted to the positively skewed distribution seen with discrete samples. Fewer non-detect results can be expected using MI, thus mitigating problems caused by using censored data sets and lessening the chance of missing significant contamination. In addition, levels of statistical confidence and decision uncertainty that would require a large number

11.3 Types of Sampling Strategies

It is important to select an appropriate sampling approach for accurate characterization of site conditions. Prior to undertaking any sampling program, it is necessary to establish appropriate measurement and system Data Quality Objectives. Refer to the U.S. Environmental Protection Agency (EPA) Soil Sampling Quality Assurance User's Guide (listed in Section 14.0 References) for guidance in establishing Data Quality Objectives, statistical sampling methodologies and protocols for each of the sampling approaches. Each approach is defined below.

Judgmental or Biased Sampling
Judgmental or Biased sampling is used primarily for documenting an observed release to the groundwater, surface water, air or soil exposure pathways. This form of sampling is based on the subjective selection of sampling locations where contamination is most likely to occur. Locations are based on relative historical site information and on-site investigation (site walk-over) where contamination is most likely to occur.

There is no randomization associated with this sampling approach because samples are primarily collected at areas of suspected highest contaminant concentrations. Any statistical calculations based on the results of this sampling technique will be biased.

Random Sampling

Random sampling, used for the characterization of a heterogeneous non-stratified waste, involves arbitrary collection of samples within a defined area. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for Random Sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table which can be found in the text of any basic statistics book. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample.

Stratified Random Sampling

Stratified random sampling, used for the characterization of a heterogeneous stratified waste, involves arbitrary collection of samples within a defined area and strata. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for stratified random sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table which can be found in the text of any basic statistics book. A random sample is then collected from each strata at the selected numbers or units on the grid. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample.

Systematic Grid Sampling

Systematic grid sampling involves dividing the area of concern into smaller sampling areas using a square or triangular grid. Samples are then collected from the intersection of the grid lines or nodes. The origin and direction for placement of the grid should be selected by using an initial random point. The distance between nodes is dependent upon the size of the site or area of concern and the number of samples to be collected. Generally, a larger distance is used for a large area of concern.

Systematic Random Sampling

Systematic random sampling involves dividing the area of concern into smaller sampling areas. Samples are collected within each individual grid cell using random selection procedures.

Search Sampling

Search sampling utilizes a systematic grid or systematic random sampling approach to define areas where contaminants exceed clean-up criteria. The distance between the grid lines and number of samples to be collected are dependent upon the acceptable level of error (i.e., the chance of missing a hot spot). This sampling approach requires that assumptions be made regarding the size, shape, and depth of hot spots.

Transect Sampling

Transect sampling involves establishing one or more transect lines, parallel or non-parallel, across the area of concern. If the lines are parallel, this sampling approach is similar to systematic grid sampling. The advantage of transect sampling over systematic grid sampling is the relative ease of establishing and relocation transect lines versus an entire grid. Samples are collected at regular intervals along the transect line at the surface and/or at a specified depth(s). The distance between the sample locations is determined by the length of the line and the number of samples to be collected.

11.4 Quality Assurance Project Plans (QAPP)

A Quality Assurance Project Plan (EPA, 2006) is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation
- Basis upon which data will be evaluated
- Information known about the site including location, type and size of the facility, and length of operations/abandonment
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives

Note that this list of QAPP components is not all-inclusive and that additional element(s) may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAPP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAPPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

11.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

12.0 DATA RECORDS AND MANAGEMENT

There are many data parameters and custody records that require attention to detail. Refer to the specific SOPs for data management activities that are associated with sampling techniques.

13.0 QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

14.0 REFERENCES

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6. April 2007.
EPA Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4). February 2006.

EPA Guidance on Choosing a Sampling Design for Environmental Data Collection (QA/G-5S). December, 2002

16-DAT-01.01

Data Management for Field Operations and Analytical Support

Technical Approval: Scott C. Walker
PRINT NAME

SIGNATURE
Date: 4/25/2018

QA Management Approval: Holly J. Sprunger
PRINT NAME

SIGNATURE
Date: 4/25/18

This document was prepared by the ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of ESAT support services. This is a controlled document and may only be provided to a third party, such as consultants or other government agencies, at the direction of EPA and if all said third party recipients agree that the contents of this document remain confidential. If the document is provided as a controlled document, the user agrees to surrender the document upon request of EPA or ESAT Region 8. If the document is provided as an uncontrolled document, the user understands that subsequent revisions may not be provided.

Table of Contents

1.0 SOP Description

The purpose of this standard operating procedure (SOP) is to provide a consistent format for all Region 8 Environmental Services Assistance Team (ESAT) data management personnel who perform uploads to Scribe and management of associated databases and reports.

This SOP is applicable to all ESAT personnel who prepare, process, review, and load analytical data into the Scribe database for the Field Operations Group and the Analytical Support and Data Validation Group.

2.0 Abbreviations and Acronyms

EDD	Electronic Data Deliverable
ERT	Environmental Response Team
ESAT	Environmental Services and Assistance Team
LIMS	Laboratory Information Management System
SOP	Standard Operating Procedure
TDF	Technical Direction Form
TO	Task Order
USEPA	United States Environmental Protection Agency
DMT	Data Management Team
eCOC	Electronic Chain of Custody
SAR	Sampling Activities Report

3.0 Health and Safety

All office-related safety precautions must be followed. Consideration is given to ergonomics for staff members using a keyboard and sitting in front of a computer terminal for extended periods of time and all other work conditions where ergonomics may be an issue.

4.0 Equipment and Supplies

Standard office supplies are required for this SOP, such as a personal computer and central filing system. Specific equipment and supplies are listed below:

- Internet connection and access to the ESAT network drive
- Access to Scribe and the Scribe databases associated with Technical Direction Forms (TDFs) issued by the client
- Login capabilities to the Scribe.NET website
- Microsoft Office software applications
- External hard drive containing the appropriate databases for upload

5.0 General Procedures

ESAT personnel are responsible for acquiring, compiling, reviewing, and loading sample and analytical data into the appropriate Scribe database associated with a specific TDF. If an electronic Chain of Custody (COC) is not provided, the Data Management Team (DMT) will transfer the information from the paper COC to a .xlsx COC template. The field Team collects the samples following “SOP_Collector_Field_Guidance_2017” then the data is transferred to the iCloud platform following “SOP_Survey123_Field_Guidance_2017”. The Field Data and lat/long Electronic Data Deliverables (EDDs) are forwarded to the DMT for import. Analytical Result

EDDs are posted to the network drive from the Laboratory Information Management System (LIMS) on or before the EDD due date.

NOTE: The field data import will be described in section

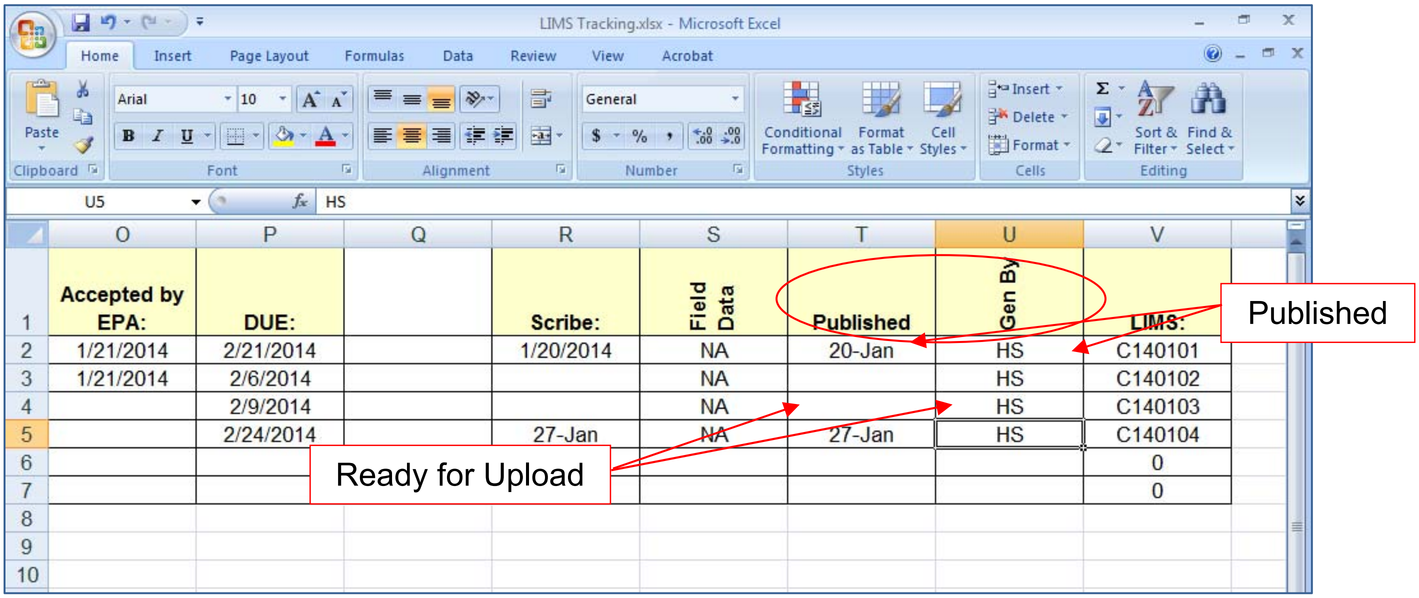
5.1 Review, Obtain, and Prepare COC and Analytical EDDs to be uploaded to Scribe

This is done by converting the .xls or .xlsx to .csv. For the analytical data, the analysts and/or Data Package Coordinator posts EDDs to the appropriate Task Order (TO) and project folder on the network drive upon completion. Prior to uploading or publishing a project to Scribe, review the LIMS Tracking spreadsheet to ensure that the Data Package Coordinator has completed assembly and finalization of the current Sample Event(s) (Figure 5.2). EDDs that are complete and ready for upload are listed in the LIMS Tracking spreadsheet (located on the network drive), and will be signed off in the “Gen By” (generated by) column (Figure 5.1). EDDs that have been published will contain a date in the “Published” column (Figure 5.1).

Note: TO Numbers and TDFs are not permanent, and are subject to change based on the contract year, as well as the type and number of sample events.

- Review the "Gen By" and "Published" columns. If the Data Package Coordinator's initials are listed in the "Gen by" column, but a date is not included in the "Published" column, that sampling event is ready for uploading to the database.

Figure 5.1 LIMS Tracking Spreadsheet Example



U5 HS

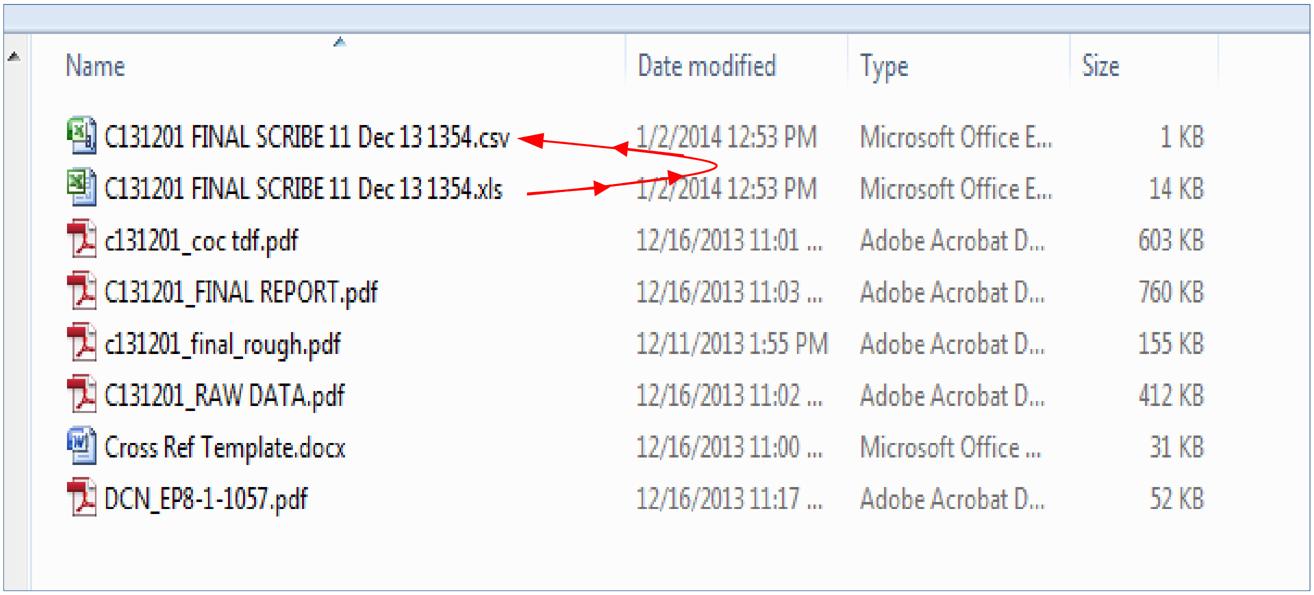
	O	P	Q	R	S	T	U	V
1	Accepted by EPA:	DUE:		Scribe:	Field Data	Published	Gen By	LIMS:
2	1/21/2014	2/21/2014		1/20/2014	NA	20-Jan	HS	C140101
3	1/21/2014	2/6/2014			NA		HS	C140102
4		2/9/2014			NA		HS	C140103
5		2/24/2014		27-Jan	NA	27-Jan	HS	C140104
6								0
7								0
8								
9								
10								

Published

Ready for Upload

- Navigate to the TO and Projects to be uploaded
- Select the .xls EDD files, and within the same folder, convert them to .csv format for uploading to Scribe
- Repeat with all other EDDs noted from the LIMS Tracking spreadsheet

Figure 5.2 Example of Sample Event Folder from the Network Drive



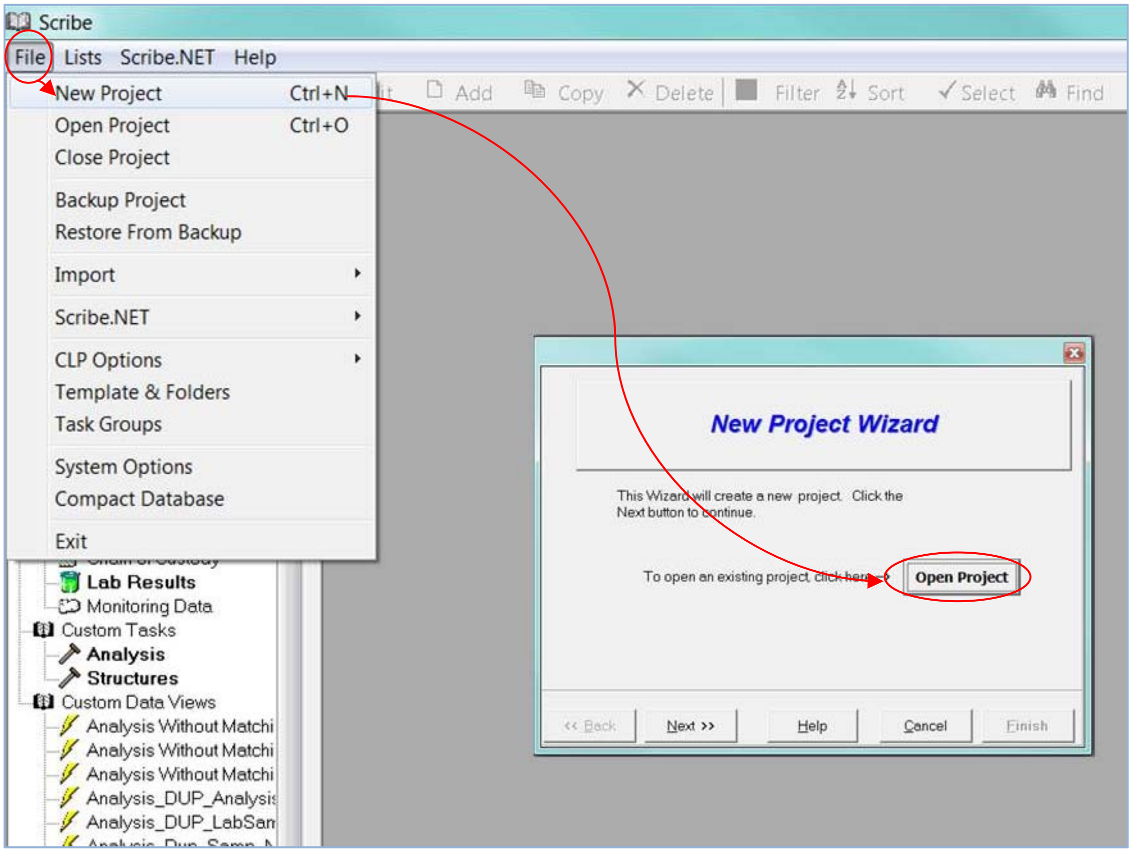
Name	Date modified	Type	Size
C131201 FINAL SCRIBE 11 Dec 13 1354.csv	1/2/2014 12:53 PM	Microsoft Office E...	1 KB
C131201 FINAL SCRIBE 11 Dec 13 1354.xls	1/2/2014 12:53 PM	Microsoft Office E...	14 KB
c131201_coc tdf.pdf	12/16/2013 11:01 ...	Adobe Acrobat D...	603 KB
C131201_FINAL REPORT.pdf	12/16/2013 11:03 ...	Adobe Acrobat D...	760 KB
c131201_final_rough.pdf	12/11/2013 1:55 PM	Adobe Acrobat D...	155 KB
C131201_RAW DATA.pdf	12/16/2013 11:02 ...	Adobe Acrobat D...	412 KB
Cross Ref Template.docx	12/16/2013 11:00 ...	Microsoft Office ...	31 KB
DCN_EP8-1-1057.pdf	12/16/2013 11:17 ...	Adobe Acrobat D...	52 KB

5.2 Scribe Data Load

Each TO project/TDF has its own database. Several separate sample events may occur under each project and will be managed according to the associated TO and project.

- Access the external hard drive containing the appropriate TO databases
- Open the Scribe Database Program
- Select "File" from the menu then "New Project"
- Select "Open Project" in the "New Project Wizard" dialogue box (this will open a Windows Explorer window from which to choose the appropriate folder pathway and database file)

Figure 5.3 Scribe Database "Open Project"



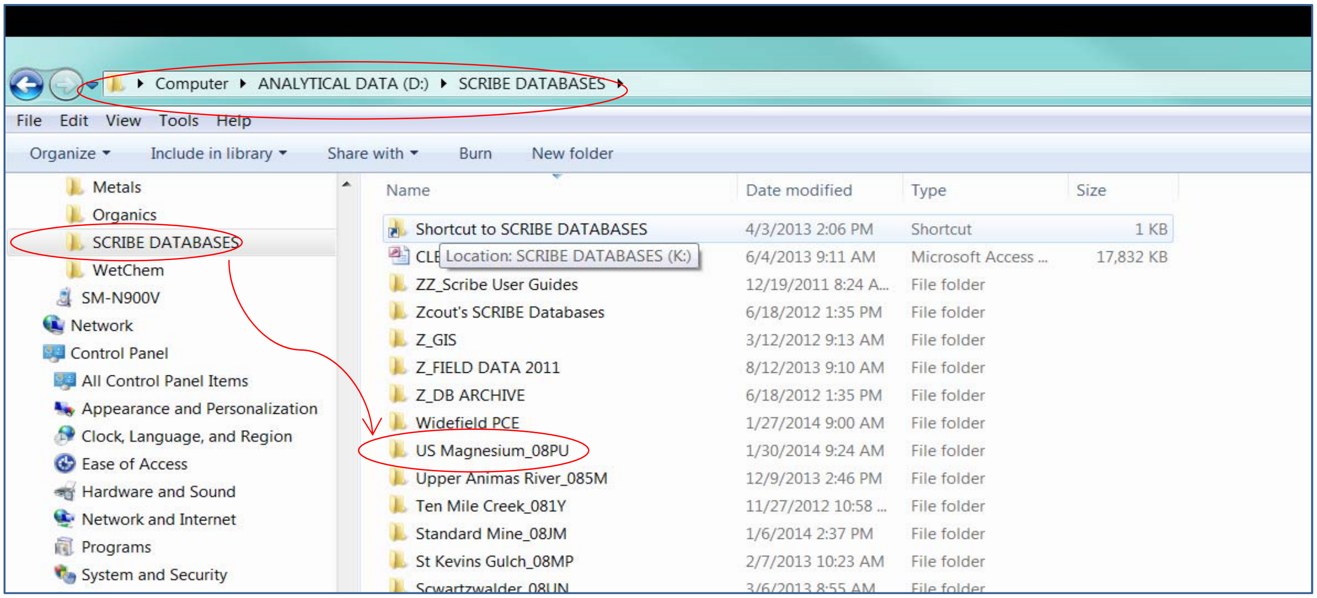
This Wizard will create a new project. Click the Next button to continue.

To open an existing project, click here

- Navigate to the current TO and Project to be uploaded

  Note: Databases for the current TO are stored on an external hard drive as shown in Figure 5.4, but the external storage location, pathways, and TO numbers are subject to change.

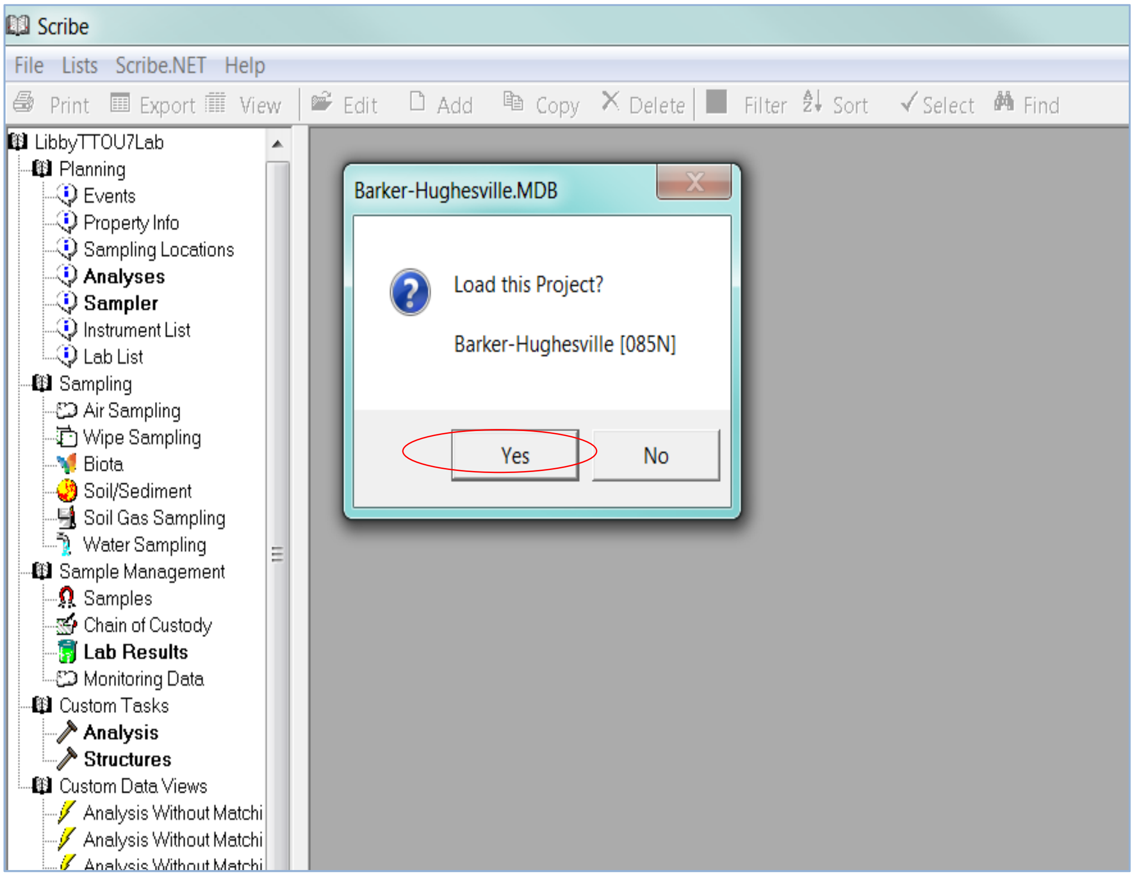
Figure 5.4 Scribe Database Project Pathway



Name	Date modified	Type	Size
Shortcut to SCRIBE DATABASES	4/3/2013 2:06 PM	Shortcut	1 KB
CLE Location: SCRIBE DATABASES (K:)	6/4/2013 9:11 AM	Microsoft Access ...	17,832 KB
ZZ_Scribe User Guides	12/19/2011 8:24 A...	File folder	
Zcout's SCRIBE Databases	6/18/2012 1:35 PM	File folder	
Z_GIS	3/12/2012 9:13 AM	File folder	
Z_FIELD DATA 2011	8/12/2013 9:10 AM	File folder	
Z_DB ARCHIVE	6/18/2012 1:35 PM	File folder	
Widefield PCE	1/27/2014 9:00 AM	File folder	
US Magnesium_08PU	1/30/2014 9:24 AM	File folder	
Upper Animas River_085M	12/9/2013 2:46 PM	File folder	
Ten Mile Creek_081Y	11/27/2012 10:58 ...	File folder	
Standard Mine_08JM	1/6/2014 2:37 PM	File folder	
St Kevins Gulch_08MP	2/7/2013 10:23 AM	File folder	
Scwartzwalder_08UN	3/6/2013 8:55 AM	File folder	

- Select "Yes" in the "Load this Project" dialogue box

Figure 5.5 Scribe Database Load Project

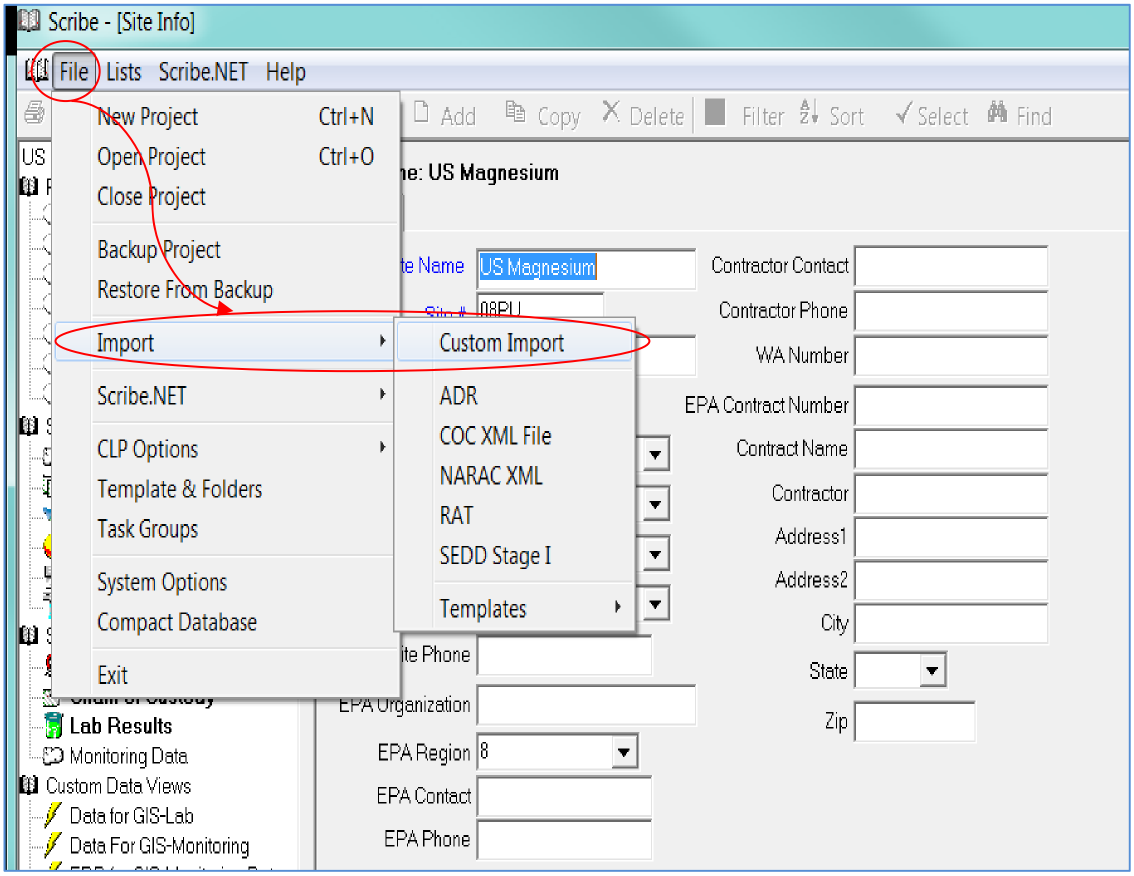


Load this Project?

Barker-Hughesville [085N]

- Select "File -> Import -> Custom Import"
- Select "No" in the resulting "Backup Now?" dialogue box

Figure 5.6 Scribe "File/Import/Custom Import"



ne: US Magnesium

te Name: US Magnesium

08PU

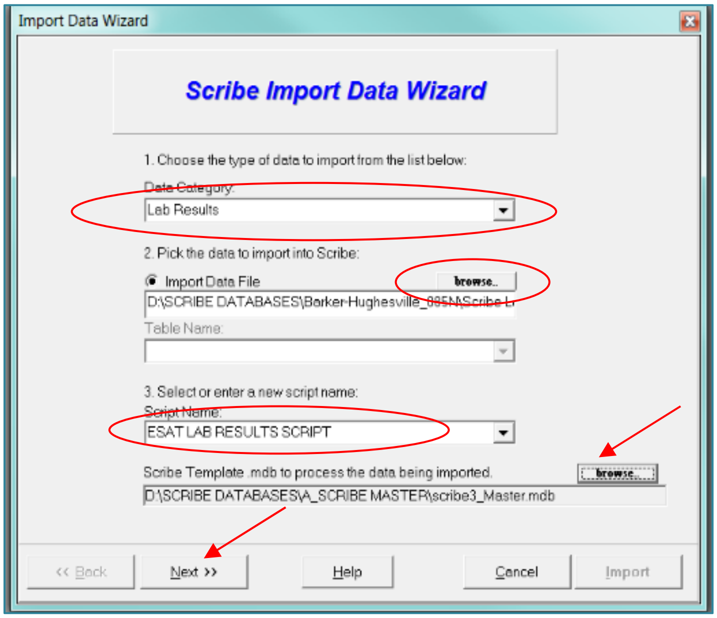
EPA Region: 8

  - Select either “Samples” for COC imports, “Water Sampling” for Field Data imports, "Lab Results" for analytical imports or “Sampling Locations” for lat/long imports, etc. from the drop-down arrow list in the Data Category field
  - Select the correct EDD using the "browse" button above the Import Data File field

    Note: Result EDDs will be obtained from the folders located on the network drive pathways discussed in Section 5.1.

- For the “Script Name” field, Select “eCOC SAMPLE Upload” for COC imports, select “FIELD DATA” for the Water Sampling, “ESAT Station Location Import” for lat/long imports or "ESAT Lab Results Script" for Analytical imports.
  - Select the most current Master Scribe template using the "browse" button above the Scribe Template field; this template is located on the external drive in SCRIBE DATABASES/A_SCRIBE MASTER
  - Select "Next"

Figure 5.7 Scribe "Import Data Wizard"



1. Choose the type of data to import from the list below:

Data Category: Lab Results

2. Pick the data to import into Scribe:

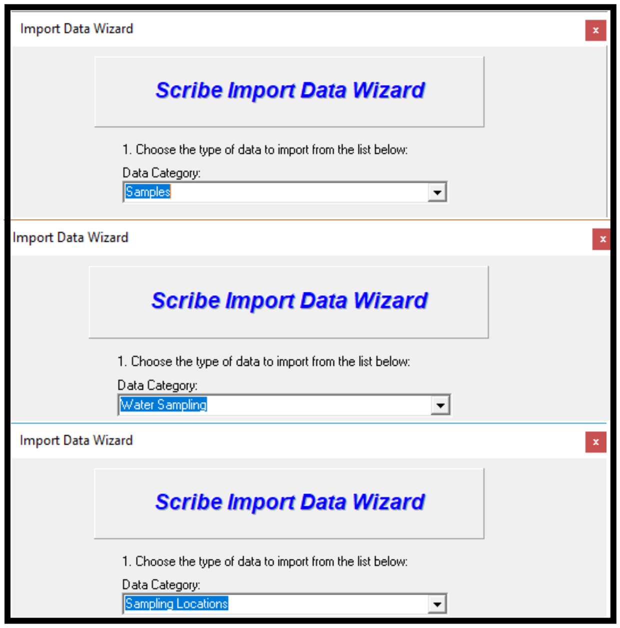
● Import Data File: D:\SCRIBE DATABASES\Barker-Hughesville_085N\Scribe L

Table Name:

3. Select or enter a new script name:

Script Name: ESAT LAB RESULTS SCRIPT

Scribe Template .mdb to process the data being imported.: D:\SCRIBE DATABASES\A_SCRIBE MASTER\scribe3_Master.mdb



1. Choose the type of data to import from the list below:

Data Category: Samples

1. Choose the type of data to import from the list below:

Data Category: Water Sampling

1. Choose the type of data to import from the list below:

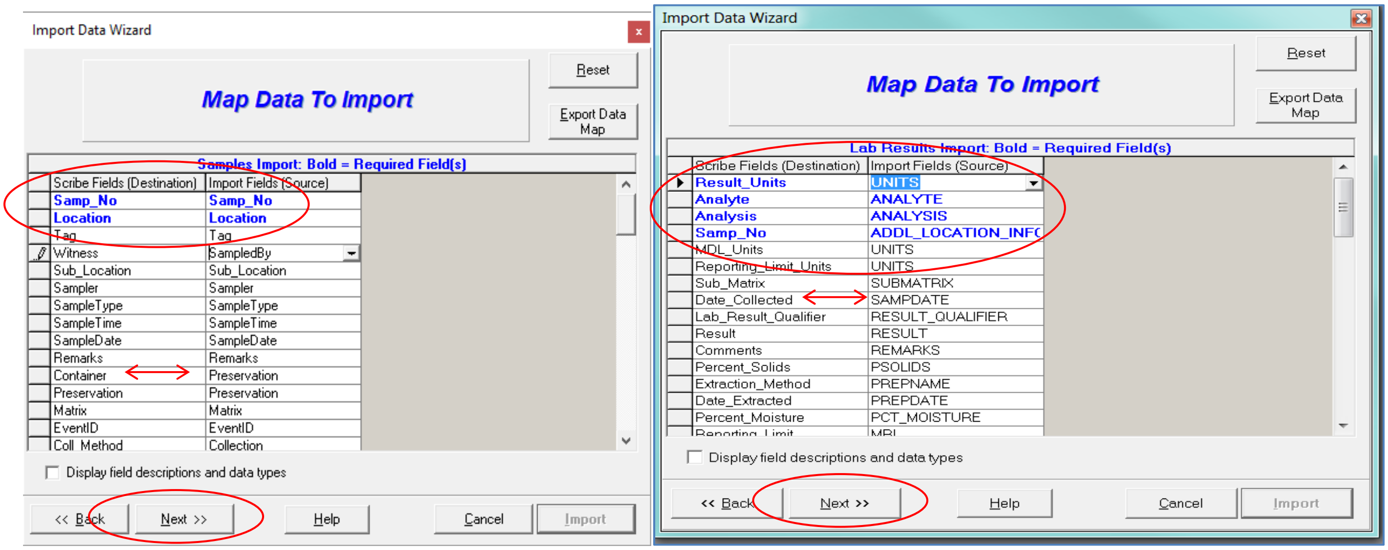
Data Category: Sampling Locations

Review the field mapping dialogue box to ensure that all necessary fields match up with Scribe fields.

> *Note: The fields in blue bolded text are Scribe required fields. The remaining fields (listed below the blue bolded font) may not match exactly in name. Ensure that they match in type and meaning regardless of the slight differences in names and case. In addition, not all "Import Fields" fields will be present for "Scribe Fields".*

- Select "Next"

Figure 5.8 Scribe "Map Data to Import"



Samples Import: Bold = Required Field(s)

Scribe Fields (Destination)	Import Fields (Source)
Samp_No	**Samp_No**
Location	**Location**
Tag	Tag
Witness	SampledBy
Sub_Location	Sub_Location
Sampler	Sampler
SampleType	SampleType
SampleTime	SampleTime
SampleDate	SampleDate
Remarks	Remarks
Container	Preservation
Preservation	Preservation
Matrix	Matrix
EventID	EventID
Coll_Method	Collection

Lab Results Import: Bold = Required Field(s)

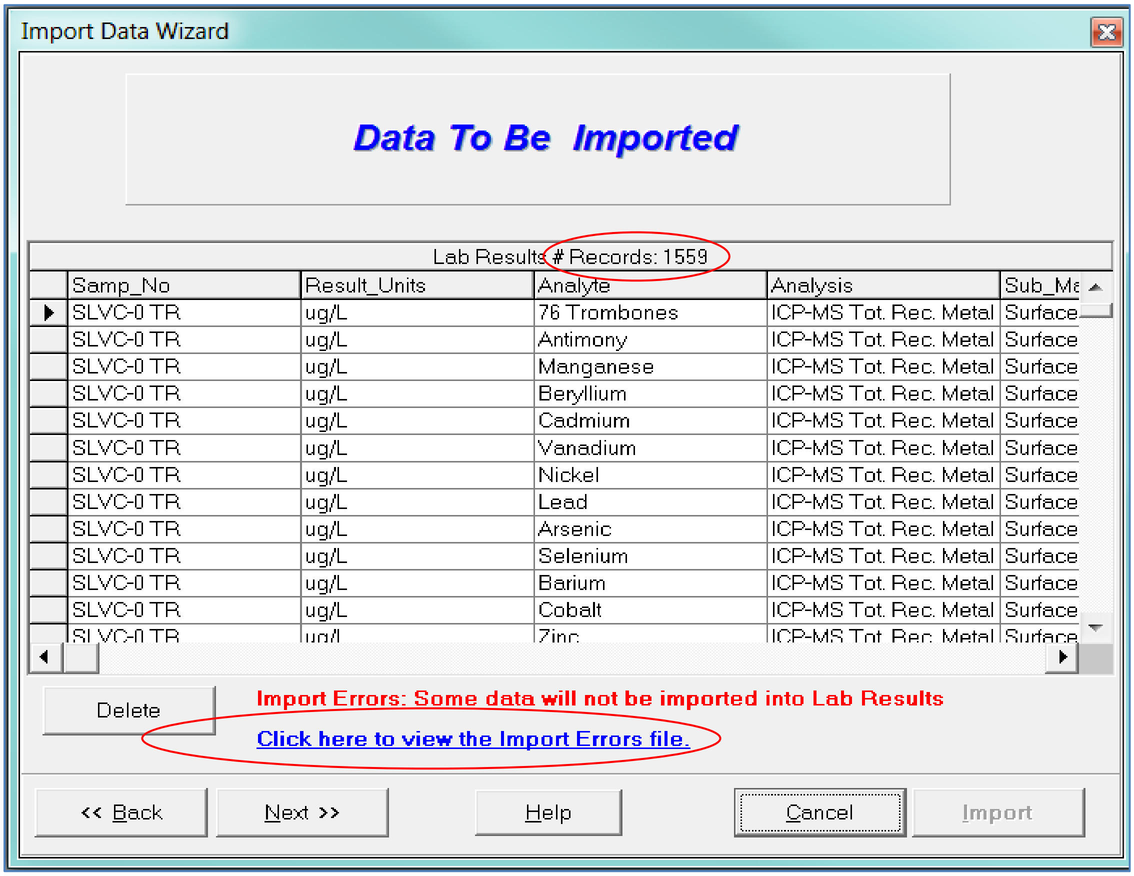
Scribe Fields (Destination)	Import Fields (Source)
Result_Units	**UNITS**
Analyte	**ANALYTE**
Analysis	**ANALYSIS**
Samp_No	**ADDL_LOCATION_INF**
MDL_Units	UNITS
Reporting_Limit_Units	UNITS
Sub_Matrix	SUBMATRIX
Date_Collected	SAMPDATE
Lab_Result_Qualifier	RESULT_QUALIFIER
Result	RESULT
Comments	REMARKS
Percent_Solids	PSOLIDS
Extraction_Method	PREPNAME
Date_Extracted	PREPDATE
Percent_Moisture	PCT_MOISTURE
Reporting_Limit	MRL

- Review the total in the "*********** # Records:" field
- Ensure that the total number of records matches the total in the EDD that is being imported.

  Note: The Excel formatted EDD can be opened and reviewed to verify that the total number of samples to be imported matches the number of samples contained in the EDD.

- Select the blue bolded "Import Errors file" link to obtain a list of errors if the import is unsuccessful (list will open in Excel format)

Figure 5.9 Scribe "Data to be Imported" Import Errors



Data To Be Imported

Lab Results # Records: 1559

Samp_No	Result_Units	Analyte	Analysis	Sub_Ma
SLVC-0 TR	ug/L	76 Trombones	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Antimony	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Manganese	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Beryllium	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Cadmium	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Vanadium	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Nickel	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Lead	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Arsenic	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Selenium	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Barium	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Cobalt	ICP-MS Tot. Rec. Metal	Surface
SLVC-0 TR	ug/L	Zinc	ICP-MS Tot. Rec. Metal	Surface

Import Errors: Some data will not be imported into Lab Results

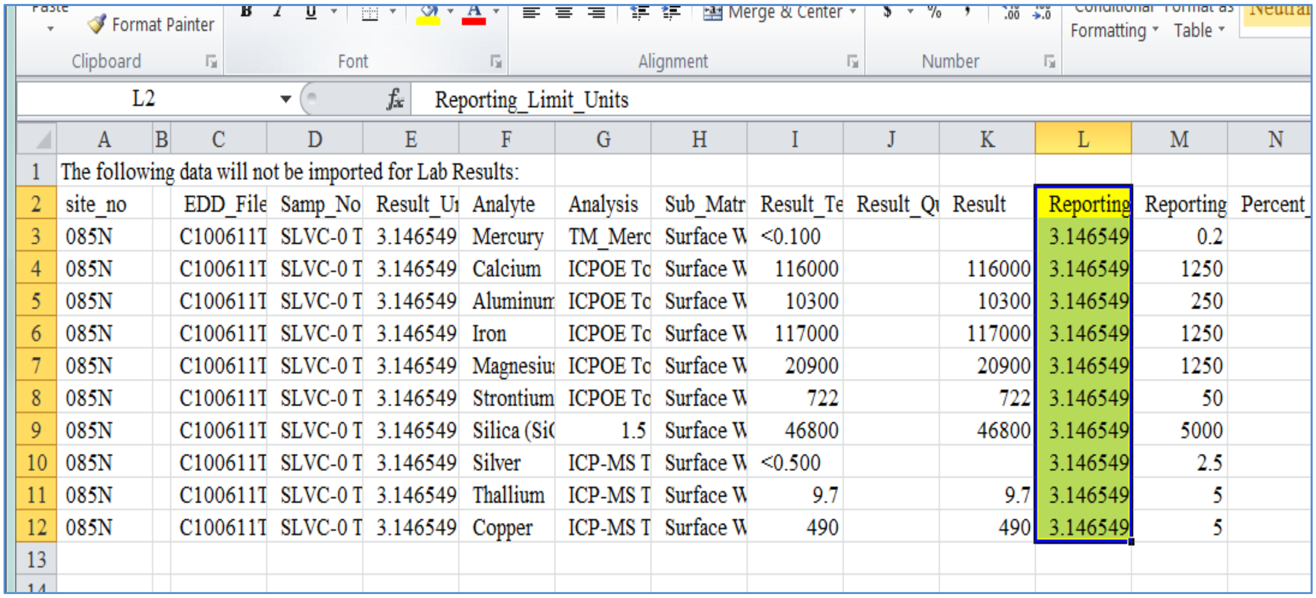
Click here to view the Import Errors file.

- Review the error report, open the appropriate EDD, and correct the errors. As shown in the example report below, the "Reporting Units" field has a numerical value, which is incorrect. Because this is a text field, the necessary correction would be to insert the appropriate unit text, which for this EDD would be ug/L.

  Note: The example below contains one of the common types of errors that may occur. That is, one that is correctable within the EDD itself and by the Scribe uploader. However, this is not the only possible error type. If a more complex error occurs, one that cannot be corrected within the EDD, an ESAT analyst may need to be contacted for assistance and the error may need to be corrected at an earlier point in the process.

  Errors within the Scribe program itself are essentially non-existent for the Analytical Support Group and Field Operations databases. If an upload error occurs, it is generally caused by incorrect selections of either the database script or the Scribe Master template. In those cases, return to the import screen and ensure that all scripts and templates selected are correct. If the database still shows errors that are not correctable in the EDD, the error(s) may be Scribe-related. If an error occurs that cannot be corrected within the EDD, or by correcting possible upload procedure errors, contact the Environmental Response Team (ERT) Software Support department for assistance. ERT can be contacted by email: ertsupport@epa.gov or by phone: 800-999-6990.

Figure 5.10 Scribe Example of Import Errors File

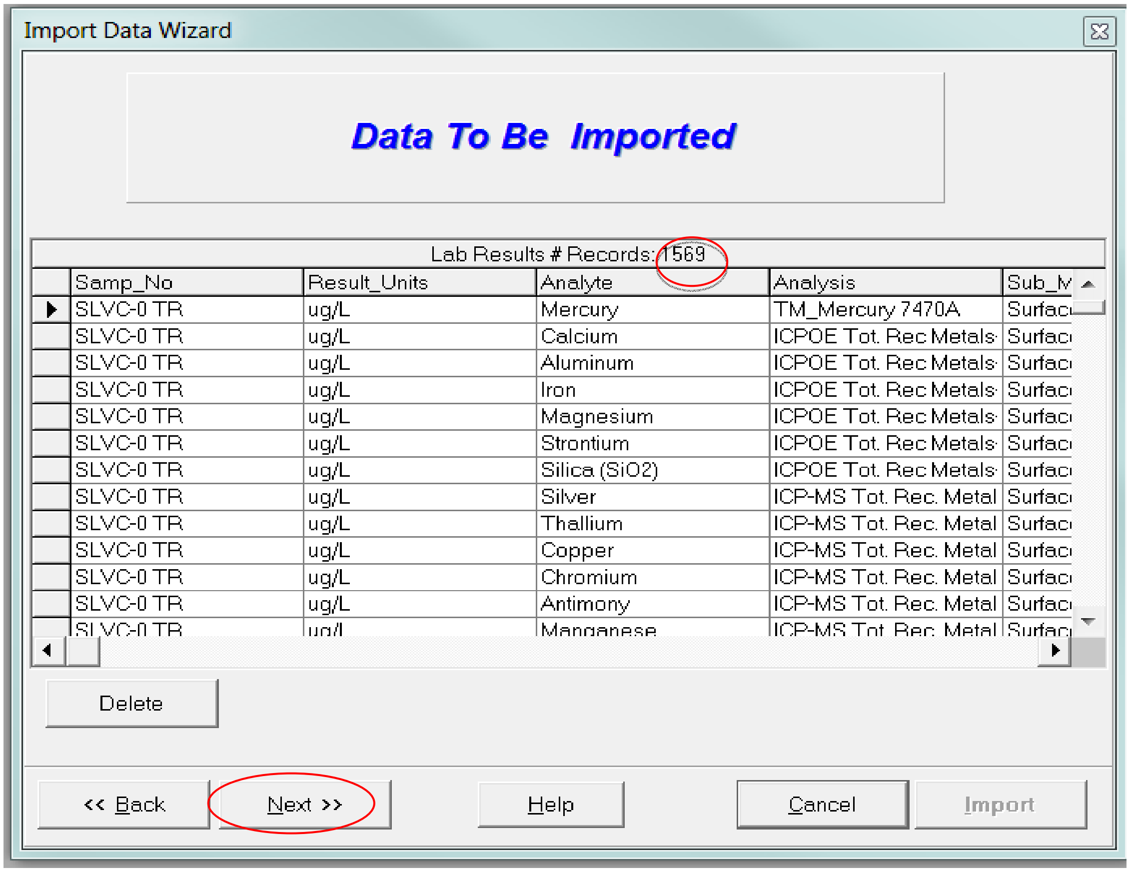


L2 Reporting_Limit_Units

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	The following data will not be imported for Lab Results:													
2	site_no		EDD_File	Samp_No	Result_Ui	Analyte	Analysis	Sub_Matr	Result_Te	Result_Qı	Result	Reporting	Reporting	Percent_
3	085N		C100611T	SLVC-0 T	3.146549	Mercury	TM_Merc	Surface W	<0.100			3.146549	0.2	
4	085N		C100611T	SLVC-0 T	3.146549	Calcium	ICPOE Tc	Surface W	116000		116000	3.146549	1250	
5	085N		C100611T	SLVC-0 T	3.146549	Aluminum	ICPOE Tc	Surface W	10300		10300	3.146549	250	
6	085N		C100611T	SLVC-0 T	3.146549	Iron	ICPOE Tc	Surface W	117000		117000	3.146549	1250	
7	085N		C100611T	SLVC-0 T	3.146549	Magnesiu	ICPOE Tc	Surface W	20900		20900	3.146549	1250	
8	085N		C100611T	SLVC-0 T	3.146549	Strontium	ICPOE Tc	Surface W	722		722	3.146549	50	
9	085N		C100611T	SLVC-0 T	3.146549	Silica (Si(	1.5	Surface W	46800		46800	3.146549	5000	
10	085N		C100611T	SLVC-0 T	3.146549	Silver	ICP-MS T	Surface W	<0.500			3.146549	2.5	
11	085N		C100611T	SLVC-0 T	3.146549	Thallium	ICP-MS T	Surface W	9.7		9.7	3.146549	5	
12	085N		C100611T	SLVC-0 T	3.146549	Copper	ICP-MS T	Surface W	490		490	3.146549	5	
13														

- Select "Next" once the errors have been corrected and continue the import process

Figure 5.11 Scribe Corrected "Data to be Imported"

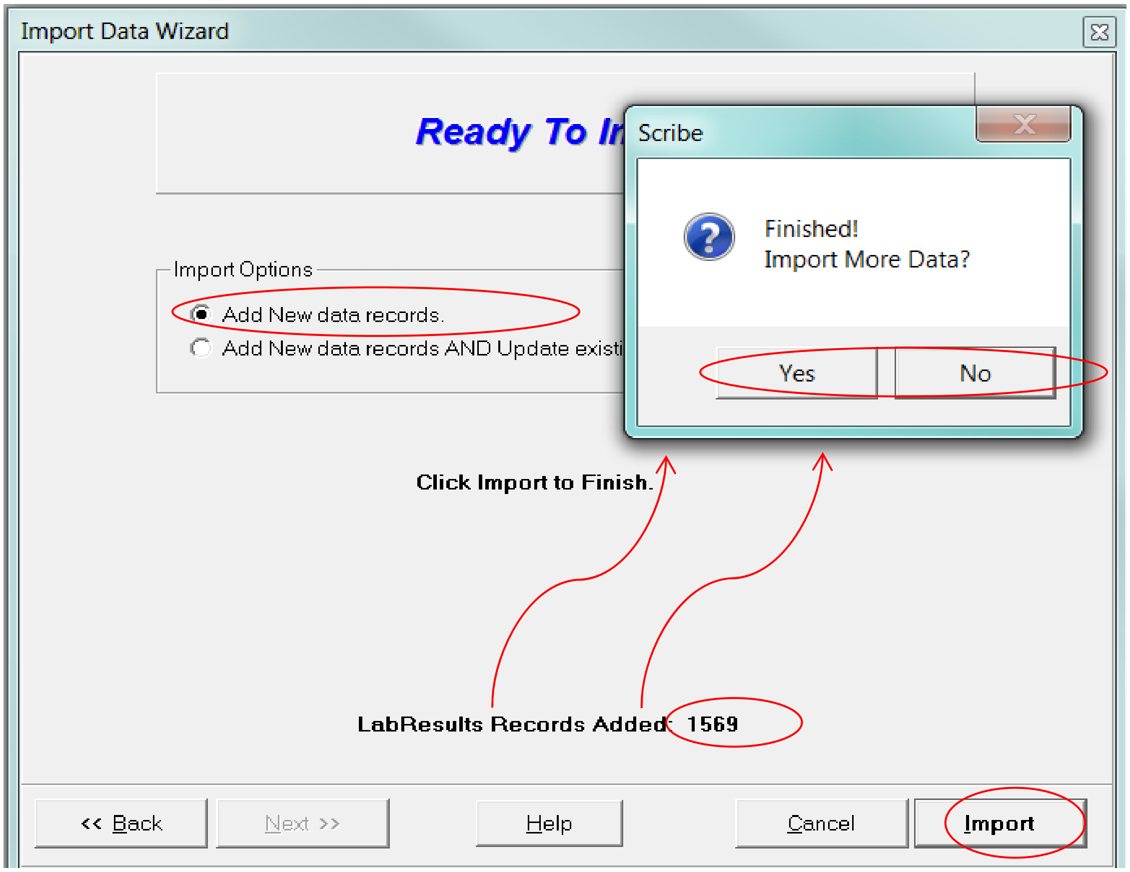


Lab Results # Records: 1569

Samp_No	Result_Units	Analyte	Analysis	Sub_M
SLVC-0 TR	ug/L	Mercury	TM_Mercury 7470A	Surfac
SLVC-0 TR	ug/L	Calcium	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Aluminum	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Iron	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Magnesium	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Strontium	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Silica (SiO2)	ICPOE Tot. Rec Metals	Surfac
SLVC-0 TR	ug/L	Silver	ICP-MS Tot. Rec. Metal	Surfac
SLVC-0 TR	ug/L	Thallium	ICP-MS Tot. Rec. Metal	Surfac
SLVC-0 TR	ug/L	Copper	ICP-MS Tot. Rec. Metal	Surfac
SLVC-0 TR	ug/L	Chromium	ICP-MS Tot. Rec. Metal	Surfac
SLVC-0 TR	ug/L	Antimony	ICP-MS Tot. Rec. Metal	Surfac
SLVC-0 TR	ug/L	Manganese	ICP-MS Tot. Rec. Metal	Surfac

- Select the "Add New Records" box
- Select "Import"
- Move the "Finished!" dialogue box away from the center portion of the "Import Data Wizard" dialogue box so that the "LabResults Records Added" total can be viewed
- Ensure that the "LabResults Records Added" is the same as the total in the "Data to be Imported" dialogue box (Figure 5.11)
- Select "Yes" if more EDDs for the same TO and Project will be loaded
- Select "No" if complete

Figure 5.12 Scribe "Import More Data?"



Import Data Wizard

Ready To Im

Import Options
● Add New data records.
○ Add New data records AND Update existi

Click Import to Finish.

LabResults Records Added: 1569

Scribe

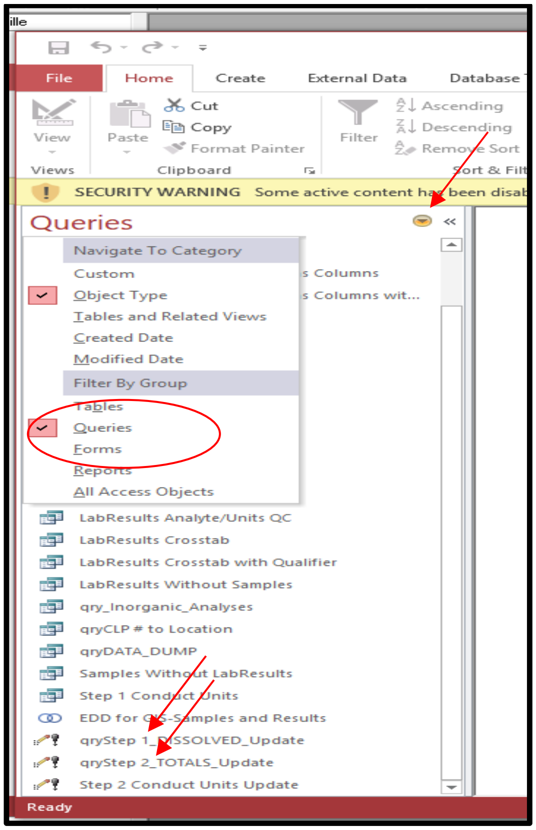
Finished!
Import More Data?

- Continue with all completed EDDs (those noted as ready to upload in the LIMS Tracking spreadsheet)

5.3 Total or Dissolved Metals Update Query

After the analytical data has been imported, the update queries need to be ran. In the Access database in the “Queries” section double-click “qryStep 1_DISSOLVED_Update and then double-click “qryStep 2_TOTALS_Update.

Figure 5.13 Total or Dissolved Update Queries

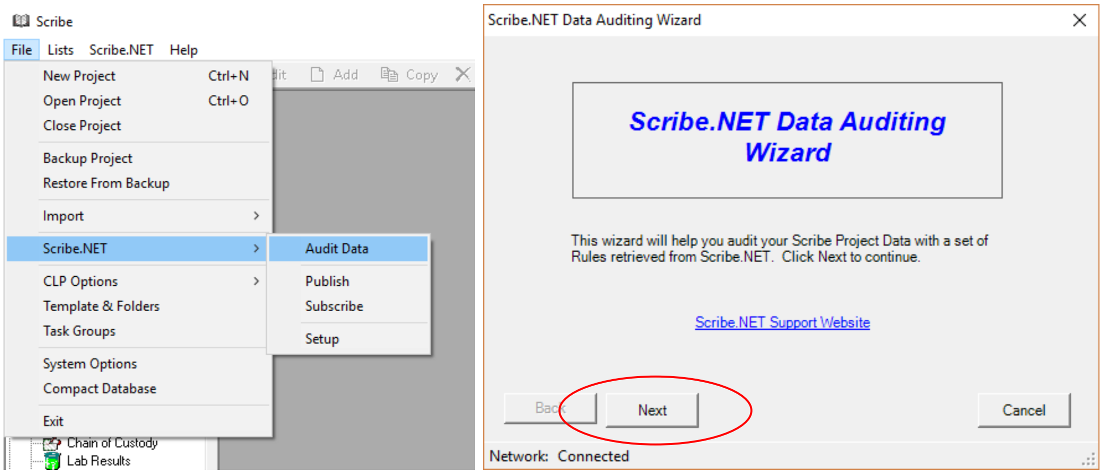


5.4 Auditor

The auditor is a tool with a series of queries that checks for Valid Values, documented in “R8_Data Elements & VV_#######”, reports when required fields are not populated, units of measure are missing, samples without results and vice versa. This is a living tool, it is continually updated as new discoveries are found in data that need to be audited to provide the most consistent data possible.

- Go to File – Scribe.NET – Audit Data
- The Auditing Wizard will pop up – Click “Next”

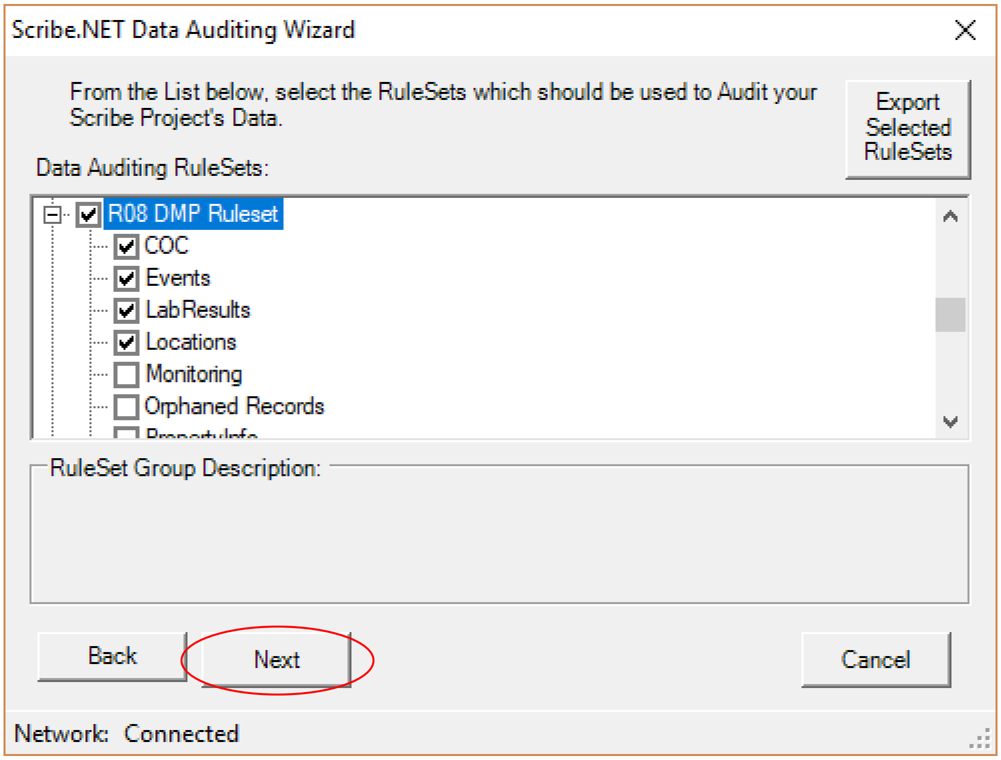
Figure 5.14 Opening the Audit Wizard



This wizard will help you audit your Scribe Project Data with a set of Rules retrieved from Scribe.NET. Click Next to continue.

- In the window, select “R08 DMP Ruleset” from the auditor choices.
- Within the chosen auditor, select what needs to be audited. Click “Next”

Figure 5.15 Audit Selections



From the List below, select the RuleSets which should be used to Audit your Scribe Project's Data.

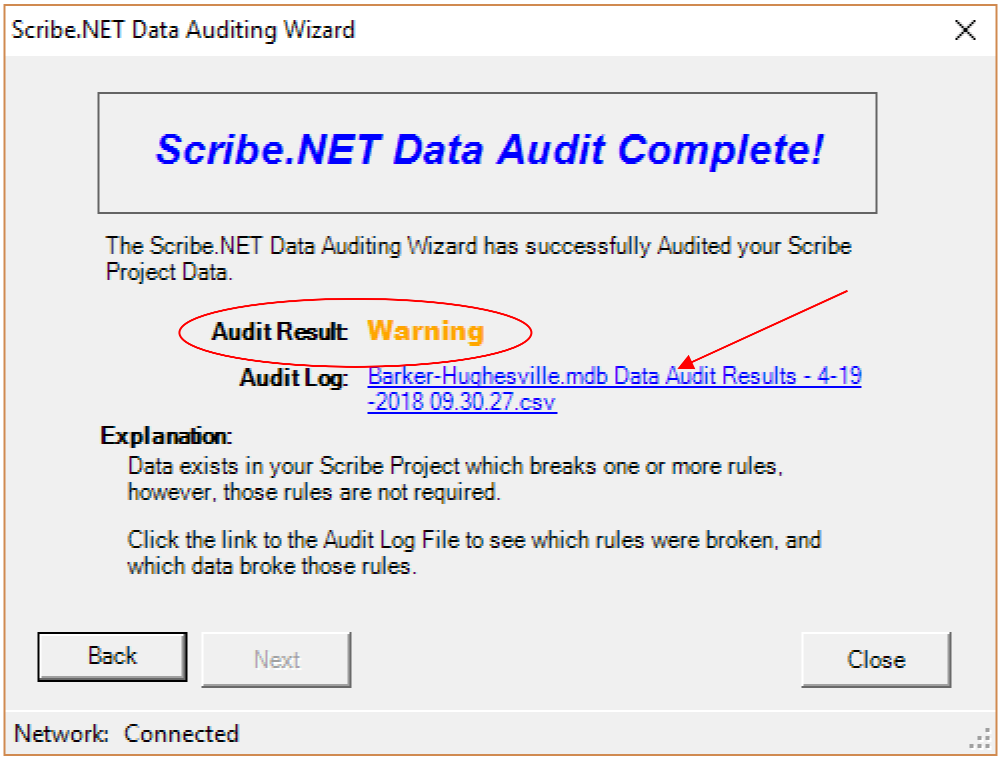
Data Auditing RuleSets:

- ☑ R08 DMP Ruleset
  - ☑ COC
  - ☑ Events
  - ☑ LabResults
  - ☑ Locations
  - ☐ Monitoring
  - ☐ Orphaned Records
  - ☐ PropertyInfo

RuleSet Group Description:

- The auditor will run through all the queries in the areas selected. When complete, the “Data Audit Complete!” will pop up. If there are queries that do not pass, an “Audit Result: Warning” and “Audit Log” will appear.
- Click on the blue “…Data Audit Results…” to see what needs to be addressed.

Figure 5.16 Data Audit Results Box



Scribe.NET Data Audit Complete!

The Scribe.NET Data Auditing Wizard has successfully Audited your Scribe Project Data.

Audit Result: Warning

Audit Log: Barker-Hughesville.mdb Data Audit Results - 4-19-2018 09.30.27.csv

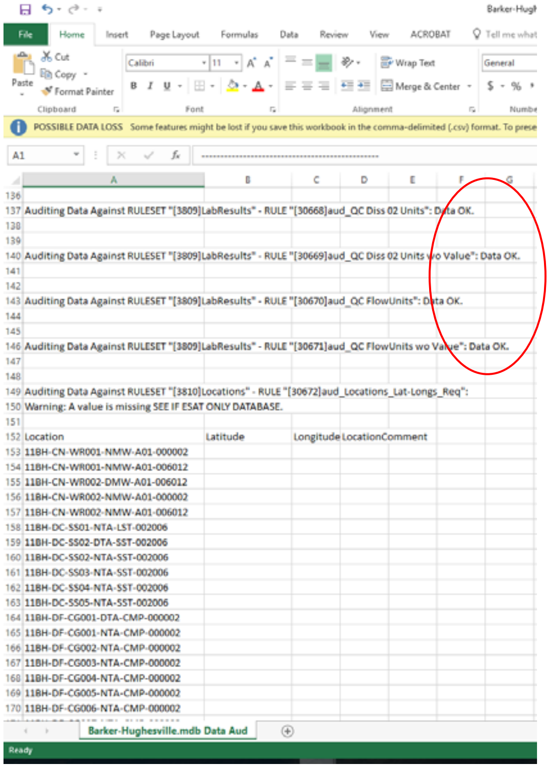
Explanation:

Data exists in your Scribe Project which breaks one or more rules, however, those rules are not required.

Click the link to the Audit Log File to see which rules were broken, and which data broke those rules.

Network: Connected

Figure 5.17 Data Audit Results Report



POSSIBLE DATA LOSS Some features might be lost if you save this workbook in the comma-delimited (.csv) format. To prese

```
Auditing Data Against RULESET "[3809]LabResults" - RULE "[30668]aud_QC Diss 02 Units": Data OK.


Auditing Data Against RULESET "[3809]LabResults" - RULE "[30669]aud_QC Diss 02 Units wo Value": Data OK.


Auditing Data Against RULESET "[3809]LabResults" - RULE "[30670]aud_QC FlowUnits": Data OK.


Auditing Data Against RULESET "[3809]LabResults" - RULE "[30671]aud_QC FlowUnits wo Value": Data OK.


Auditing Data Against RULESET "[3810]Locations" - RULE "[30672]aud_Locations_Lat-Longs_Req":
Warning: A value is missing SEE IF ESAT ONLY DATABASE.

Location                          Latitude         Longitude LocationComment
11BH-CN-WR001-NMW-A01-000002
11BH-CN-WR001-NMW-A01-006012
11BH-CN-WR002-DMW-A01-006012
11BH-CN-WR002-NMW-A01-000002
11BH-CN-WR002-NMW-A01-006012
11BH-DC-SS01-NTA-LST-002006
11BH-DC-SS02-DTA-SST-002006
11BH-DC-SS02-NTA-SST-002006
11BH-DC-SS03-NTA-SST-002006
11BH-DC-SS04-NTA-SST-002006
11BH-DC-SS05-NTA-SST-002006
11BH-DF-CG001-DTA-CMP-000002
11BH-DF-CG001-NTA-CMP-000002
11BH-DF-CG002-NTA-CMP-000002
11BH-DF-CG003-NTA-CMP-000002
11BH-DF-CG004-NTA-CMP-000002
11BH-DF-CG005-NTA-CMP-000002
11BH-DF-CG006-NTA-CMP-000002
```

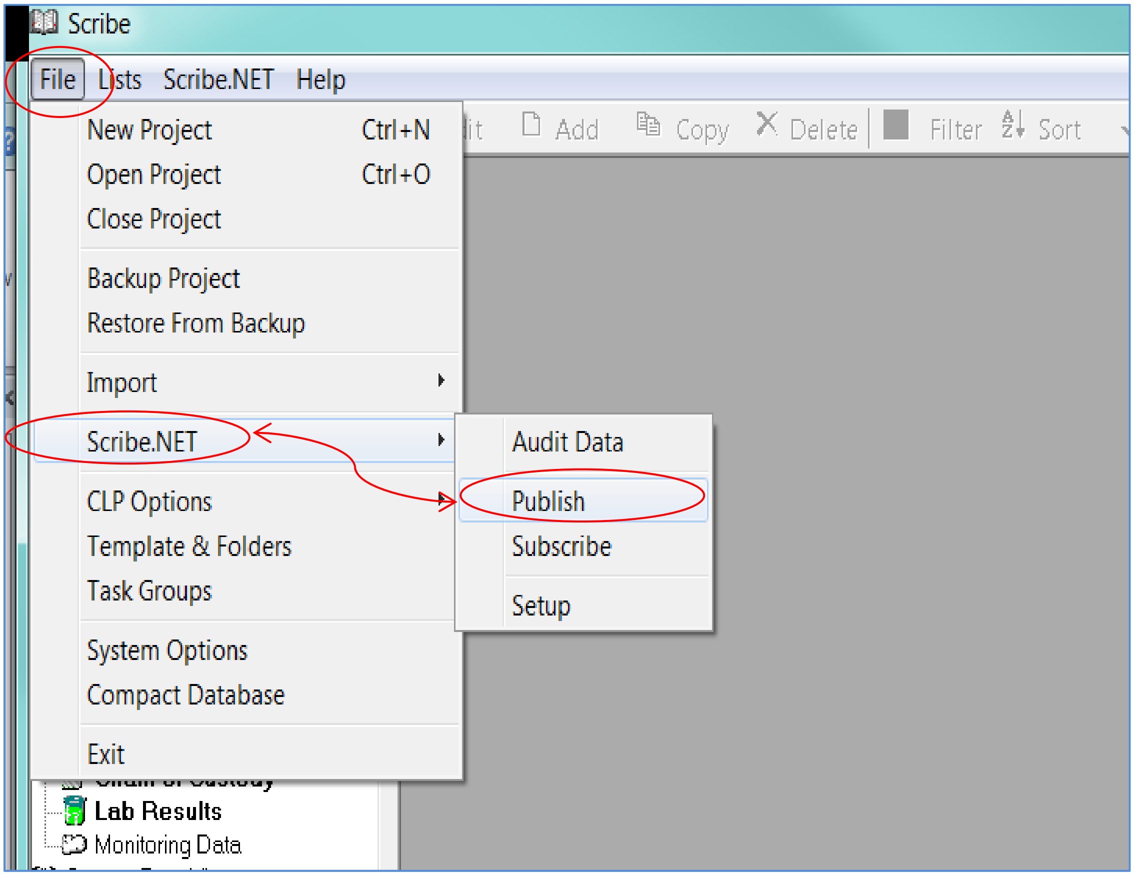
- When a query passes it will have “Data Ok” at the end.
- When a query has something to report it will list what it found below the query’s name. In the example above, the query is checking for missing lat/longs. On the left, it shows the locations and to the right it shows no value for the Latitude or Longitude.
- When all the corrections that can be made are completed, the database is ready to publish.

5.5 Publish Databases in Scribe

Once all EDD uploads for a specific project are loaded to Scribe, the project can be published to Scribe.NET.

- Navigate to the LIMS Tracking spreadsheet on the network drive as described in Section 5.1 and shown in Figure 5.1
- Open the LIMS Tracking spreadsheet
- Follow the steps for opening a specific database as shown in Section 5.2, Figure 5.3, Figure 5.4, and Figure 5.5
- Select "File ->Scribe.net->Publish"

Figure 5.18 Scribe "File/Scribe.NET/Publish"



- Select "Next" on the Scribe.NET Publisher Wizard dialogue box

Figure 5.19 "Scribe.NET Publisher Wizard"

Scribe.NET Publisher Wizard

This wizard will Publish your Scribe project to Scribe.NET. Click Next to Continue.

Scribe.NET Support Website.

Network: Connected

- Select "USEPA Region 8" from the dropdown list on the resulting dialogue box; leave the password field as is
- Select "Publish"

Figure 5.20 Scribe Publish Dropdown

Scribe.NET

Scribe.NET Publisher Wizard

Enter your Publisher ID or Select a Publication ID from the list below.
Then Click Publish to publish the Scribe project to Scribe.NET.

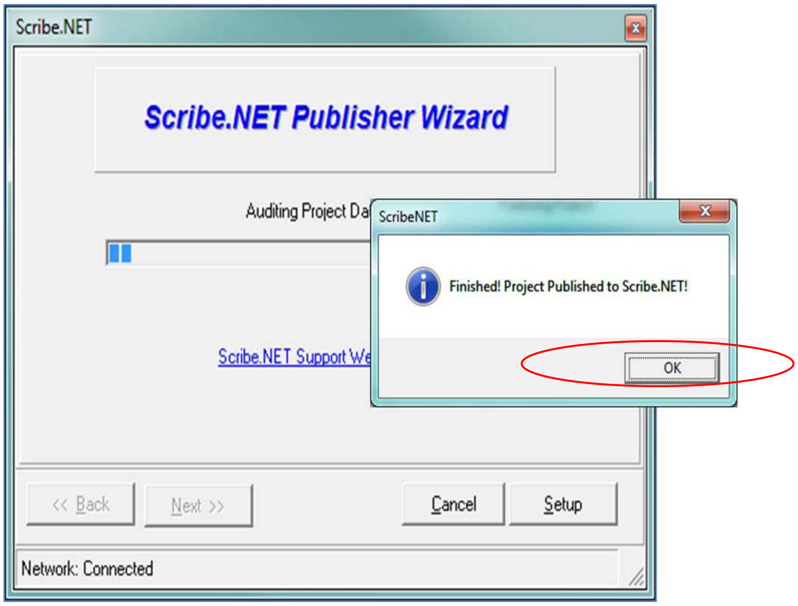
Publisher ID: USEPA Region 8

Password: *****

Network: Connected

- Select "OK" in the "Finished! Project Published to Scribe.NET!" dialogue box

- **Figure 5.21 Scribe.NET "Project Published"**



Scribe.NET

Scribe.NET Publisher Wizard

Auditing Project Da

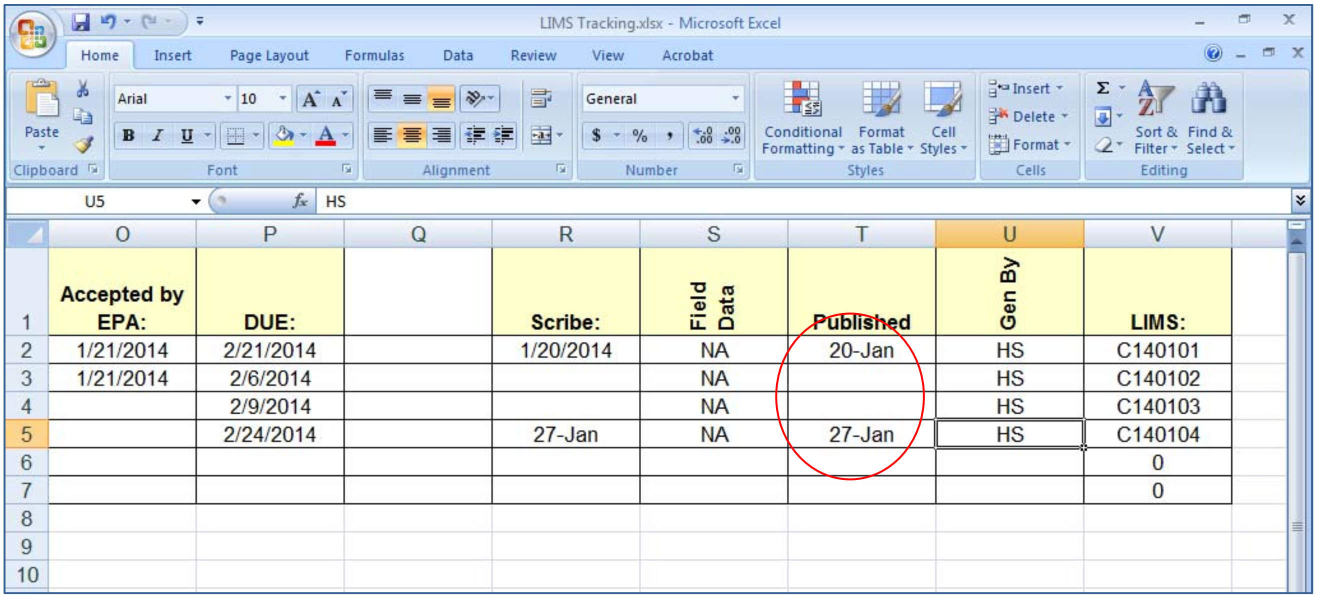
ScribeNET

Finished! Project Published to Scribe.NET!

Network: Connected

- Move completed and published project folders to the correct TO subfolder titled "Final Folder" (located on the network drive, as described in Section 5.1)
- Open the LIMS Tracking spreadsheet and record the Publish date (date format defaults to spreadsheet formatting) for each Sample Event completed
- Continue with remaining TO Sample Events

Figure 5.17 LIMS Tracking Spreadsheet Input Published Date



U5 fx HS

	O	P	Q	R	S	T	U	V
1	Accepted by EPA:	DUE:		Scribe:	Field Data	Published	Gen By	LIMS:
2	1/21/2014	2/21/2014		1/20/2014	NA	20-Jan	HS	C140101
3	1/21/2014	2/6/2014			NA		HS	C140102
4		2/9/2014			NA		HS	C140103
5		2/24/2014		27-Jan	NA	27-Jan	HS	C140104
6								0
7								0
8								
9								
10								

5.6 End of Field Season

At the end of the season the field team creats a Sampling Activities Report (SAR) for the year. There may be changes to the data from when it was entered and when it was QC'd for this report. To ensure that the report and the data in the database match, the DMT will do a comparison prior to distributing the SAR to the client.

6.0 Data Records and Management

The Data Package Coordinator will combine documents contained within each specific TO and Project folder and create and assemble the final Data Package for submittal to the client. Both the Excel and .csv versions of the EDD, as well as the data package and other associated documents, will be located in the appropriate TO Project file and Sample Event folder as shown in Figure 5.3.

7.0 Quality Control and Assurance

This SOP meets all the requirements of the ESAT Quality Management Plan.

8.0 References

ESAT Region 8, SOP,16-QAQ-03.00, Document Control, effective November 11, 2013.

ESAT Region 8, Quality Management Plan, version 7, effective June 2013.

TechLaw, Inc., Health and Safety Program Plan, effective November 2013.

TechLaw Inc., Corporate Quality Management Plan, effective November 2013.

United States Environmental Protection Agency, Environmental Response Team Software Support, accessed online at: http://www.ertsupport.org/scribe_home.htm. February 7, 2014.

United States Environmental Protection Agency Guidance for Preparing Standard Operation Procedures, EPA QA/G-6, April 2007.

Document Change History			
Revision No.	**Status[1] (I, R, C)**	**Effective Date**	**Changes Made**
0	I	03/12/14	Initial Document
1	R	04/18/2018	Added creating electronic COCs, importing samples, field data, location data, how to audit databases before publishing and the year-end comparison before SARs are distributed.

[1] Status: I = Initial, R= Revision, or C = Cancelled

U.S. EPA Region 8
Field Data Collection Using GPS and Collector for ArcGIS

Region 8 Ecosystems Protection and Remediation

Program Support

Data Systems Unit

GIS

Version1.0

March 21, 2017

Document Revision History

Date	Author	Version	Description
03/21/2017	Ryan Bahnfleth	1.0	Final

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TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide personnel a standard approach for the use of a Global Positioning System (GPS) for data collection during field activities.

2.0 APPLICABILITY/SCOPE

This SOP is specifically intended for personnel who conduct field work using ESRI's Collector for ArcGIS on an Apple iPad coupled with a Trimble R1 GNSS GPS receiver.

3.0 SUMMARY OF METHOD/PROCEDURE

This SOP covers the use of Collector for ArcGIS on an Apple iPad coupled with a Trimble R1 GNSS GPS receiver for field data collection. This SOP is based on Esri's (manufacturers') instructions. Using Collector on an iPad requires preparing map layers in an office setting and downloading those maps to the iPad when connected to WiFi or Cellular signal. Prior to entering the field, users should login to the maps on the iPad while connected to WiFi or Cellular signal to avoid the possible disruption of WiFi or Cellular service in the field.

4.0 PERSONNEL QUALIFICATIONS & RESPONSIBILITIES

Personnel who will be collecting data with the specified equipment should practice with the equipment before use. Additionally, personnel who conduct fieldwork should familiarize themselves with the standard health and safety practices associated with the particular field event they are participating in.

5.0 ACRONYMS/DEFINITIONS

EPA	United States Environmental Protection AgencyGIS Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HASP	Health and Safety Plan
SDE	Spatial Data Engine
SOP	Standard Operating Procedure

Geographic Information System (GIS): A system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data.

Global Positioning System (GPS): A navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

Collector for ArcGIS: Software used on mobile devices that captures and stores locational data and attributes of features collected in the field.

Trimble: A private GPS Company that provides hardware, software, and technical support, including the R1 GNSS GPS units and the Trimble GNSS Status application.

6.0 EQUIPMENT & SUPPLIES

- Trimble R1 GNSS GPS unit and accessories.
- Apple iPad and accessories.
- Computer and/or external hard drive and accessories.

7.0 HEALTH & SAFETY CONSIDERATIONS

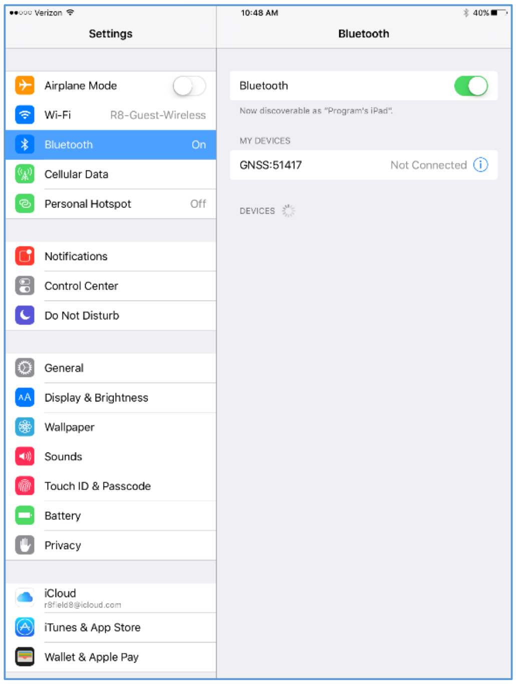
There are no health and safety issues requiring mention in this SOP; however, refer to the applicable site-specific Health and Safety Plan (HASP) any time field work is conducted.

8.0 PROCEDURAL STEPS/EQUIPMENT OPERATION

8.1 Establishing Bluetooth connection between the iPad and the Trimble R1 GNSS Receiver.

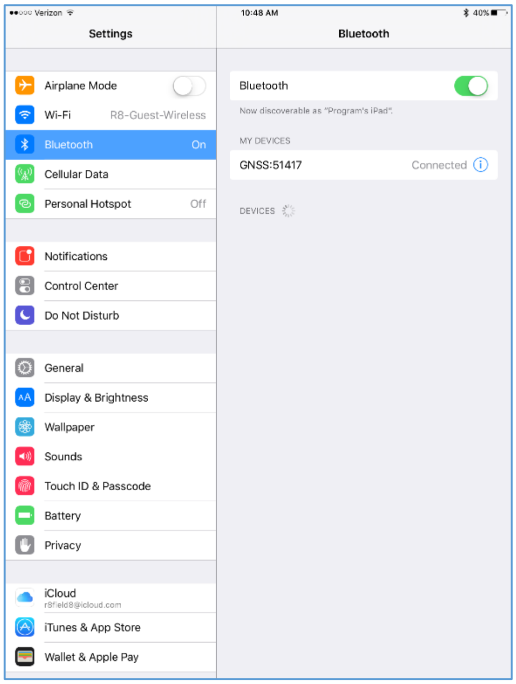
To establish a Bluetooth connection between the iPad and the Trimble R1 GNSS receiver, open the iPad’s Settings App and tap on “Bluetooth” to enable a Bluetooth connection. Follow the printed Trimble instructions for enabling a Bluetooth connection for the Trimble R1 GNSS receiver that accompanied the GPS unit. Once enabled, the device will be listed in the “My Devices” window.

Figure 1: Establishing a Bluetooth connection on an iPad



Wi-Fi: R8-Guest-Wireless
Bluetooth: On
Personal Hotspot: Off

Bluetooth ●
Now discoverable as "Program's iPad".
GNSS:51417 Not Connected

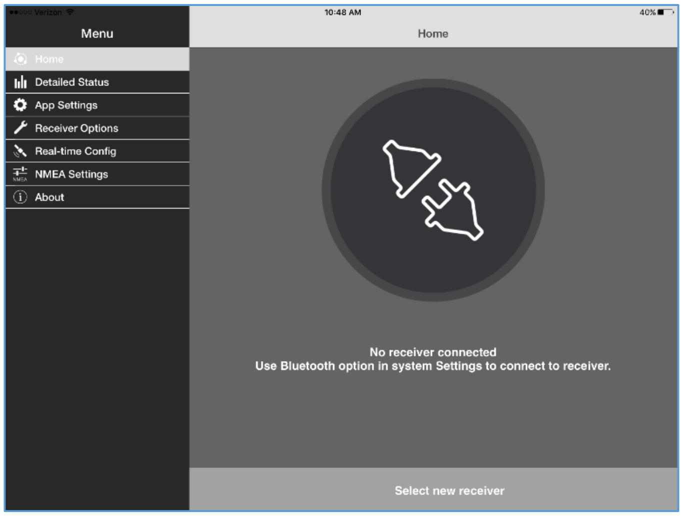


Wi-Fi: R8-Guest-Wireless
Bluetooth: On
Personal Hotspot: Off

Bluetooth ●
Now discoverable as "Program's iPad".
GNSS:51417 Connected

As shown in Figure 2, open the Trimble R1 GNSS Utility application to view satellite constellation and reported accuracy. It is recommended that you give the receiver 5-10 minutes on initial start up to lock in signals from satellites. To assist in locking onto satellites it is recommended that the user maintain an unobstructed view of the southern sky. Once a connection is established, the user can open the Collector for ArcGIS application.

Figure 2: The Trimble R1 GNSS Utility Application



No receiver connected
Use Bluetooth option in system Settings to connect to receiver.

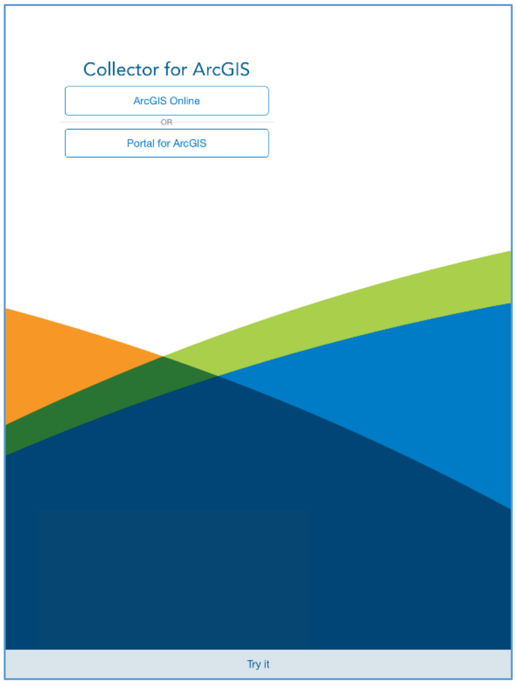
8.2 Collector for ArcGIS Application

To open the Collector for ArcGIS application, you begin by tapping on the Collector App icon on the home screen. Opening the application requires signing into the EPA GeoPlatform Online when connected to WiFi or Cellular signal. Using the application is restricted to EPA and ESAT personnel only due to Collector's reliance on the EPA Single Sign-on.

Figure 3: Collector App icon

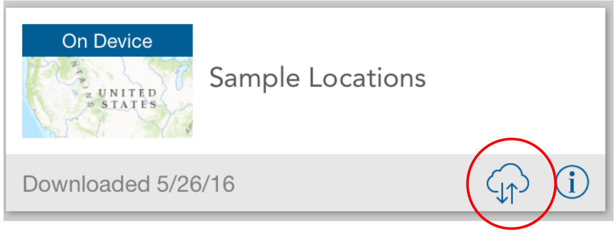
In order to sign into the EPA GeoPlatform Online, choose the first option, "ArcGIS Online" (see Figure 4)and choose to Sign in with an "Enterprise Account." Then enter "epa" to complete the url as epa.maps.arcgis.com. Sign into EPA GeoPlatform Online "Using Your ArcGIS Account." Use the device ID and Password specific to the iPad you are using.

Figure 4: Collector for ArcGIS sign in to EPA GeoPlatform Online



Once Collector for ArcGIS is opened, choose the appropriate map project. The Cloud icon with up and down arrows indicate that a map is stored on the device and is available for use in the field without WiFi or Cell service; see Figure 5.

Figure 5: Map project thumbnail indicating downloaded on device



Open the map on the iPad by touching the thumbnail. The map will center to you current position by tapping the icon ◉.

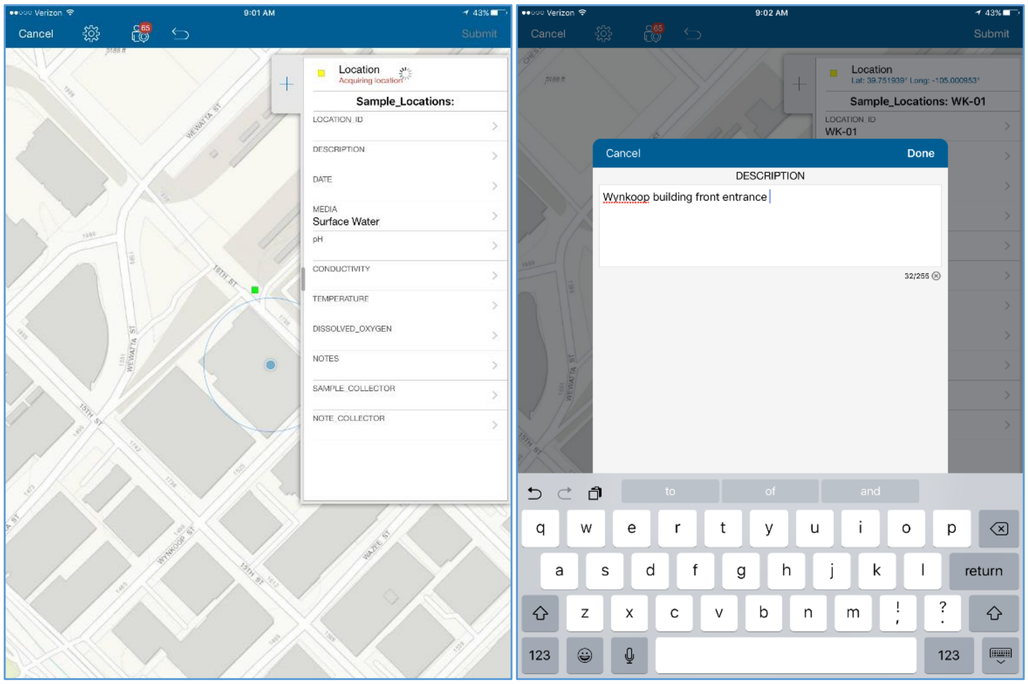
8.3 Settings in Collector for ArcGIS

Before beginning field collection, you must ensure that the appropriate settings have been applied. On the "Maps" screen in Collector, tap on the Action icon and choose "Settings." Under "Location" click "Provider" and confirm the Trimble Unit that you have connected to with Bluetooth is listed and checked. Then set the height above ground to where you will be carrying the unit (example: 1 meter) by clicking the "information" icon.

8.4 Capturing New Features with Collector

When you are ready to collect a **new** feature, click on the "+", plus symbol that brings up a form that can be filled out; see Figure 6. Your GPS location will be logged by Collector via the Bluetooth connection to the Trimble R1 GNSS receiver. For point locations, the GPS coordinates will be logged and your Latitude and Longitude will be reported at the top of the form. For line and polygons, you must press "Start Streaming" before walking the line or polygon feature. You can press "End Streaming" to finish collecting the feature.

Figure 6: New feature form for Collector for ArcGIS



MEDIA
Surface Water

Location
Lat: 39.751939° Long: -105.000953°

Sample_Locations: WK-01

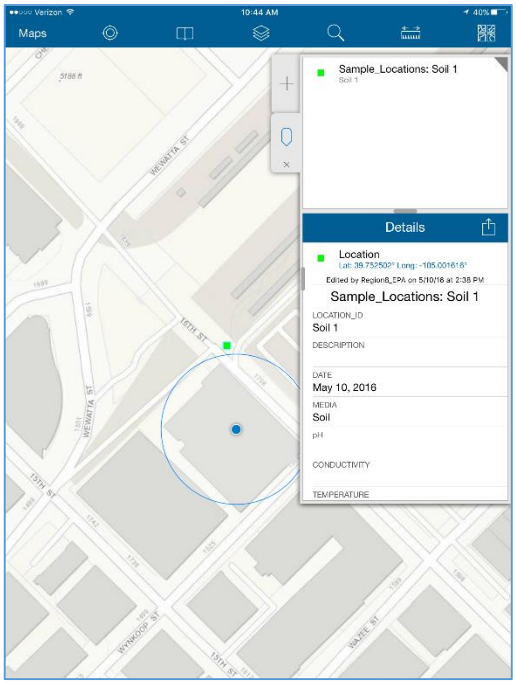
LOCATION_ID
WK-01

DESCRIPTION
Wynkoop building front entrance

8.5 Updating Existing Features with Collector

Field personnel have the ability to make updates to locations that have been pre-loaded to the Collector for ArcGIS application. This may occur when changes to the location (Latitude and Longitude), changes to attributes, or collecting new pictures are necessary. When updating an existing feature, tap the feature on the map to bring up the item details. Select the Action icon and select "Edit." Fill out the form as necessary. When finished, click the "Update" button located in the top right of the screen; see Figures 7 and 8.

Figure 7: Pop Up showing details for a selected map feature.



🟩 Sample_Locations: Soil 1
Soil 1

Details

🟩 Location
Lat: 39.752502° Long: -105.001616°
Edited by Region8_EPA on 5/10/16 at 2:38 PM

Sample_Locations: Soil 1

LOCATION_ID
Soil 1

DESCRIPTION

DATE
May 10, 2016

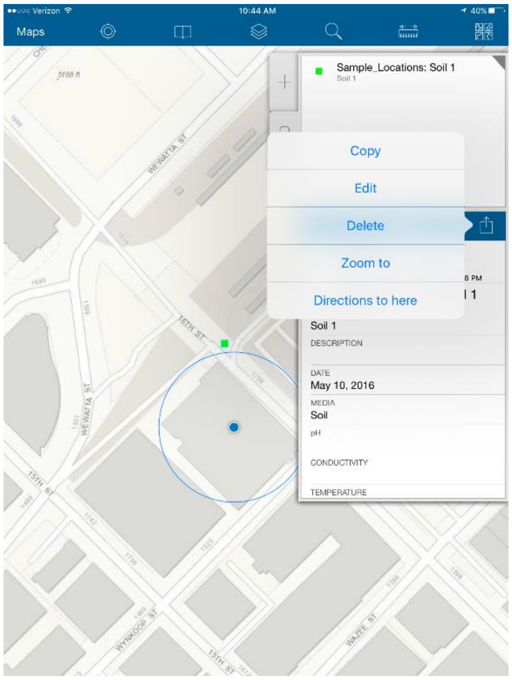
MEDIA
Soil

pH

CONDUCTIVITY

TEMPERATURE

Figure 8: Select Edit to update an existing map feature.



Sample_Locations: Soil 1
Soil 1

Soil 1
DESCRIPTION

DATE
May 10, 2016
MEDIA
Soil
pH

CONDUCTIVITY

TEMPERATURE

8.6 Syncing Field Collection Data from the iPad.

Once collection is completed and you are in an area with WiFi and connected to the internet, sync the map by returning to the “Maps” page and pressing the Sync button, see icon below. It is recommended that this is completed nightly and is the responsibility of the Field Data Collector. This action will load the field data to the EPA Geoplatform, where the GIS team can then manage the data.

9.0 NAVIGATION

Navigating using Collector of ArcGIS occurs by selecting the sample location in the map and tapping on the action button and select “Directions to here.” Routing information will be created based on the current location of the sampler.

10.0 CALIBRATION

There is no calibration requirement associated with this SOP.

11.0 MAINTENANCE

GPS maintenance must be performed by qualified GIS staff during the offseason as appropriate. This process involves firmware updates that are published by Apple and Esri. Hardware updates include visual and physical checks and the replacement of equipment as needed. Please report any equipment issues to the GIS team as soon as they are discovered.

12.0 WASTE MANAGEMENT & POLLUTION PREVENTION

Use of the GPS produces no waste. There are no waste management requirements associated with this SOP.

13.0 DATA & RECORDS MANAGEMENT

Once field data is synced, the remaining data and records management must be handled by qualified GIS staff. Any and all work related to data and records management should be processed and stored on the appropriate network location. After a field event, the File GeoDatabase (.gdb) and Comma Seperated Values file (.csv) are downloaded from the EPA Geoplatform and archived at the appropriate network location. Attribute values from the data collection event are to be forwarded to a data manager for processing and upload to the appropriate data management system. Any new sample locations, updates to current sample locations, or features collected are then added to the Regional GIS enterprise geodatabase and made available to Regional staff.

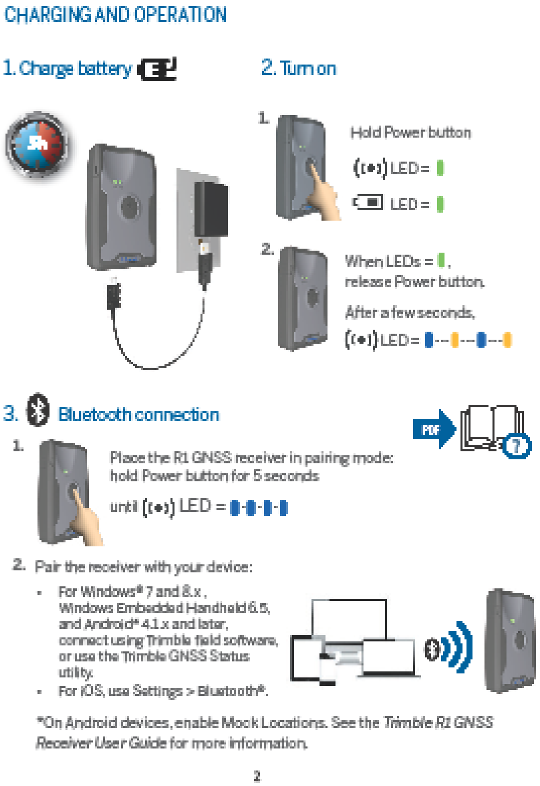
14.0 QUALITY CONTROL & QUALITY ASSURANCE

All data received by GIS staff from field personnel are reviewed under Regional GIS guidelines. Data received is reviewed for positional error using spot checking and review of field notes. Attribute information is reviewed for misspellings, inaccuracies, and operator error before being published. All data processing performed by a GIS staff member must be reviewed by another staff member to assure quality control.

15.0 REFERENCES

U.S. EPA, 2007. Guidance for the Preparation of Standard Operating Procedures (SOPs) for Quality-Related Documents. EPA QA/G-6, EPA/600/B-07/001. April 2007.

Link to the Trimble R1 GNSS Manual.



CHARGING AND OPERATION

1. Charge battery

2. Turn on

1. Hold Power button

(•) LED = 🟩

LED = 🟩

2. When LEDs = 🟩, release Power button.

After a few seconds,

(•) LED = 🟦---🟨---🟦---🟨

3. Bluetooth connection

1. Place the R1 GNSS receiver in pairing mode: hold Power button for 5 seconds

until (•) LED = 🟦-🟦-🟦-🟦

2. Pair the receiver with your device:

- For Windows® 7 and 8.x, Windows Embedded Handheld 6.5, and Android* 4.1.x and later, connect using Trimble field software, or use the Trimble GNSS Status utility.
- For iOS, use Settings > Bluetooth®.

*On Android devices, enable Mock Locations. See the *Trimble R1 GNSS Receiver User Guide* for more information.

2

QUICK START GUIDE

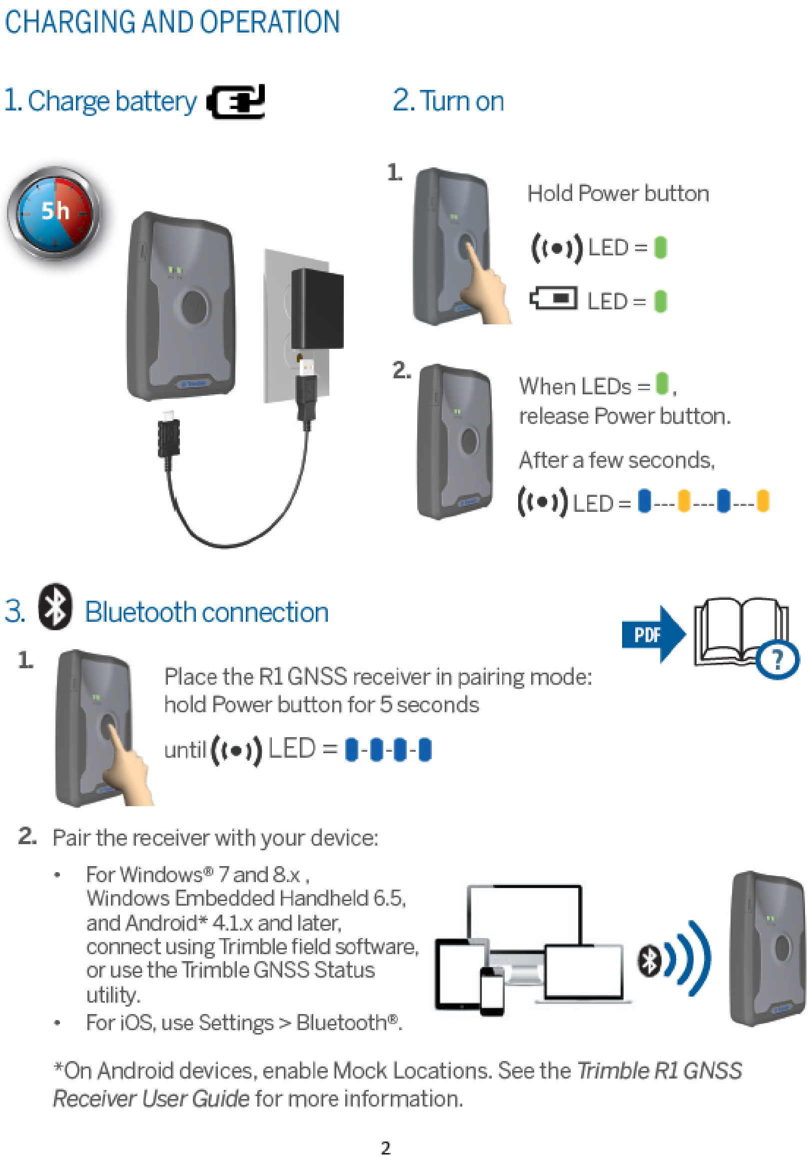
Trimble R1

GNSS RECEIVER

⚠ **CAUTION**: Please read the full user guide including all safety warnings, before operating this product.

TRANSFORMING THE WAY THE WORLD WORKS

Trimble.



CHARGING AND OPERATION

1. Charge battery

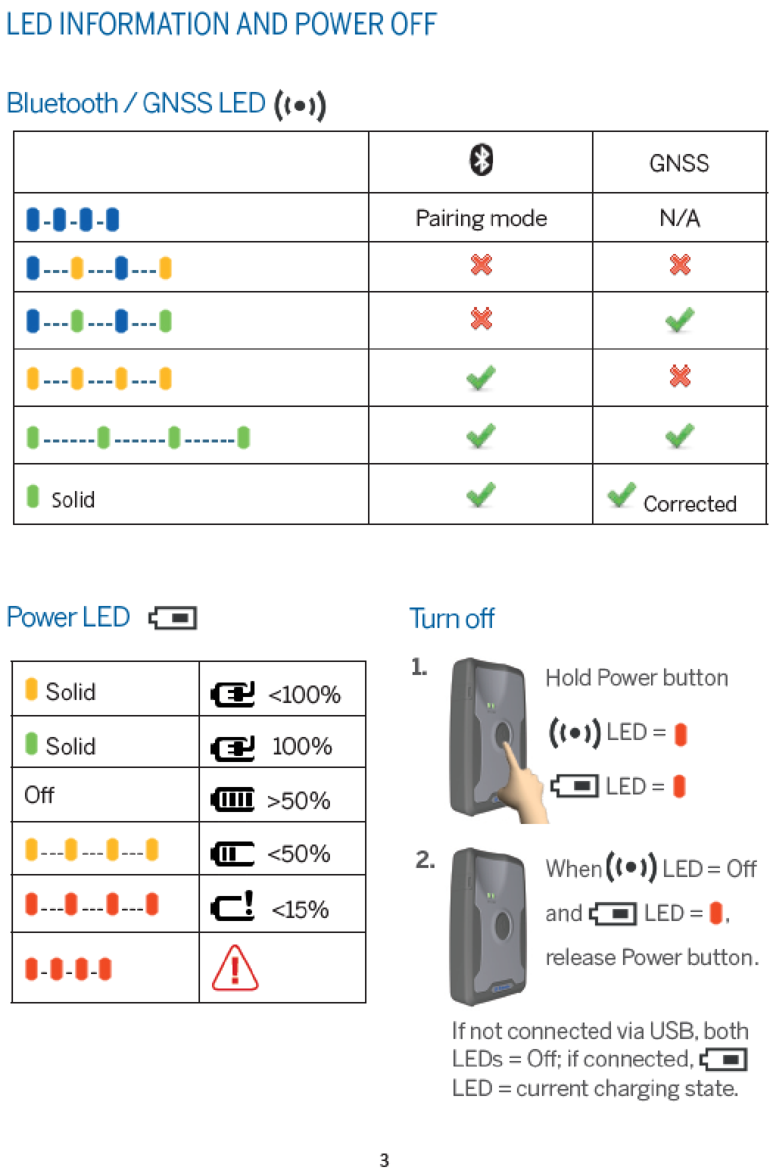
2. Turn on

1. Hold Power button
   ((•)) LED = 🟩
   LED = 🟩
2. When LEDs = 🟩, release Power button.
   After a few seconds,
   ((•)) LED = 🟦---🟨---🟦---🟨

3. Bluetooth connection

1. Place the R1 GNSS receiver in pairing mode: hold Power button for 5 seconds until ((•)) LED = 🟦-🟦-🟦-🟦
2. Pair the receiver with your device:
   - For Windows® 7 and 8.x, Windows Embedded Handheld 6.5, and Android* 4.1.x and later, connect using Trimble field software, or use the Trimble GNSS Status utility.
   - For iOS, use Settings > Bluetooth®.

*On Android devices, enable Mock Locations. See the *Trimble R1 GNSS Receiver User Guide* for more information.



LED INFORMATION AND POWER OFF

Bluetooth / GNSS LED ((•))

	ᛒ	GNSS
🟦-🟦-🟦-🟦	Pairing mode	N/A
🟦---🟨---🟦---🟨	✖	✖
🟦---🟩---🟦---🟩	✖	✓
🟨---🟨---🟨---🟨	✓	✖
🟩------🟩------🟩------🟩	✓	✓
🟩 Solid	✓	✓ Corrected

Power LED 🔋

🟨 Solid	🔌 <100%
🟩 Solid	🔌 100%
Off	🔋 >50%
🟨---🟨---🟨---🟨	🔋 <50%
🟥---🟥---🟥---🟥	🔋! <15%
🟥-🟥-🟥-🟥	⚠

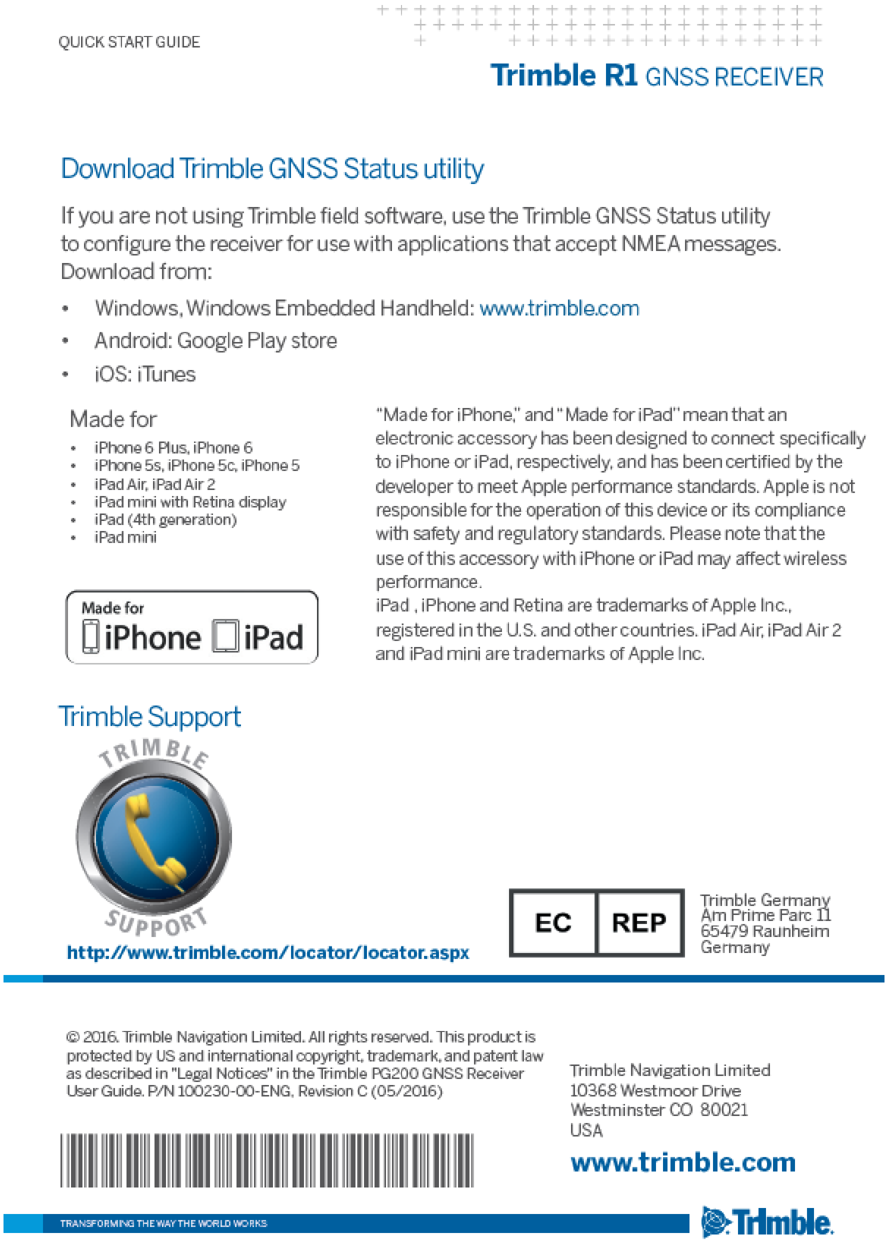
Turn off

1. Hold Power button
((•)) LED = 🟥
🔋 LED = 🟥

2. When ((•)) LED = Off
and 🔋 LED = 🟥,
release Power button.

If not connected via USB, both LEDs = Off; if connected, 🔋 LED = current charging state.

3



QUICK START GUIDE

Trimble R1 GNSS RECEIVER

Download Trimble GNSS Status utility

If you are not using Trimble field software, use the Trimble GNSS Status utility to configure the receiver for use with applications that accept NMEA messages. Download from:

- Windows, Windows Embedded Handheld: www.trimble.com
- Android: Google Play store
- iOS: iTunes

Made for

- iPhone 6 Plus, iPhone 6
- iPhone 5s, iPhone 5c, iPhone 5
- iPad Air, iPad Air 2
- iPad mini with Retina display
- iPad (4th generation)
- iPad mini

Made for iPhone iPad

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TRANSFORMING THE WAY THE WORLD WORKS

Trimble.

16-LAB-01.03
Laboratory Waste Management

Technical Approval: Scott C. Walker
PRINT NAME

SIGNATURE
Date: 4/23/2019

QA Management Approval: Holly J. Sprunger
PRINT NAME

SIGNATURE
Date: 4/29/19

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1.0 SOP Description

This standard operating procedure (SOP) describes the procedures and practices for safely collecting, storing, analyzing, and disposing of aqueous corrosive wastes. This procedure is applicable to the following aqueous waste streams analyzed by the Region 8 Environmental Services Assistance Team (ESAT): acidic instrument waste, acidic reagents (except standards), sample digestates, and samples preserved for analysis with acid. This procedure is also applicable to solid wastes such as soils, vegetation and biota samples.

Aqueous samples, digestates, reagents, and some instrument wastes contain small amounts of mineral acids. The presence of these acids causes the pH of the waste to be below 2, and hence, be defined as hazardous. In addition, these wastes may contain metal concentrations which exceed discharge standards.

Solid wastes may contain metal concentrations which exceed disposal standards. This waste must be properly labeled, contained and stored in accordance with all state and federal regulations, as well as laboratory requirements. This SOP includes the initiation of satellite waste containers, documentation accompanying the waste, and procedures for placing the waste in the designated waste storage area.

2.0 Acronyms and Definitions

Aqueous Corrosive Waste	An aqueous solution with a pH<2
CHP	Chemical Hygiene Plan
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
Evidentiary materials	Samples, sample containers and sample residuals
GHS	Globally Harmonized System for Classification and Labeling of Chemicals
HWTS	Hazardous Waste Tracking System
Satellite Waste Container	A container used to collect waste during generation (See 40 CFR 261.31)
Secondary Containment	A second level of containment ensuring no release if the initial containment fails.
SHEMP	Safety, Health and Environmental Management Program
SOP	Standard Operating Procedure
WCO	Waste Control Officer

3.0 Health and Safety

All pertinent procedures outlined in the United States Environmental Protection Agency (EPA) Region 8 Chemical Hygiene Plan (CHP) will be followed when handling wastes. The use of laboratory equipment and chemicals exposes the analyst to several potential hazards. Good laboratory technique and safety practices must be followed at all times.

Solutions classified as aqueous corrosive wastes normally contain percentage levels of mineral acids and can contain certain inorganic elements known to be hazardous. Avoid contact with water or wastewater samples. Gloves, protective eye wear and laboratory coats must be worn at all times when handling samples, reagents, or when in the vicinity of others handling these items.

4.0 Cautions

Prior to starting work that involves handling wastes, personnel should review the project plan safety requirements, analytical procedure safety requirements, and this waste management procedure.

Satellite waste containers must always be tightly capped when not in use. Satellite waste containers can weigh in excess of 50 pounds and should be lifted carefully.

When in doubt as to the proper procedure to follow, contact the EPA Health and Safety Officer for guidance. Personnel should minimize exposure to potential health hazards through the use of engineering and administrative controls, work practice procedures and practices, and proper protective equipment.

5.0 Personnel Qualifications

Personnel responsibilities for hazardous waste management at the EPA Region 8 laboratory are described in the Introduction/Executive Summary of the *Safety, Health and Environmental Management Program (SHEMP) Manual* (Section 2.2 Hazardous Waste Management).

Federal and state regulations require that employees who handle hazardous waste be provided with initial and annual training. Initial orientation and on-the-job training are provided to new ESAT employees within their first month of employment, and refresher training is provided on an annual basis thereafter. This training is designed to keep employees familiar with waste handling procedures in place at the Region 8 laboratory, along with applicable regulations. Training completion will be enforced by the supervisor and documented for each individual by the EPA Health and Safety Officer.

6.0 Equipment and Supplies

The Waste Control Officer (WCO) will assure that a supply of appropriate waste containers and labels are available for use. The WCO is responsible for maintaining control of all documentation of waste disposal.

Waste containers must be able to be tightly capped and both the container and the secondary containment must be chemically resistant to corrosive materials.

7.0 Satellite Waste Container Preparation

7.1 Labeling the Waste Container

The waste container will be properly labeled as appropriate. A Waste Container ID is assigned to the container by the person who initiates the container’s designation. The container ID will be written on the container with a Sharpie in such a location as to be easily seen.

The Container ID will follow the YYMMDD-XXXX- # format where “XXXX” describes the laboratory room number and the “#” will be the number of the container generated on that particular day.

Affix an appropriate red and white hazardous label for containers used for suspected or known hazardous materials. Affix the proper GHS label for hazard communication warning of the presence of corrosives (pH<2) when the contents to be added to the container are known to be acidic.

7.2 Waste Container Inventory Log

The waste container inventory log will be initiated and placed next to the container.

This is an attached (or located in the near vicinity) hazardous waste container inventory log, listing the accumulated waste maintained by the generator(s).

The waste inventory sheet should include the container ID number and its date, description and amount of waste added, date of the addition, and the name of the person making each addition.

Note: The waste inventory sheet serves two important purposes. It guards against addition of incompatible chemicals to the container mix and allows packers to determine the correct classification of the waste for transport and disposal.

8.0 Waste Collection and Analysis

8.1 Waste Collection

Waste must be collected as near as possible to the point of generation and have secondary containment.

Containers must be kept closed except when waste is being added. When a container of waste is approximately 85% full, the waste inventory sheet must be signed, dated and entered into the inventory system by the WCO.

Waste containers that are full or otherwise ready for disposal will be transported to the F wing where the wastes are segregated by waste categories.

Each unit will be labeled with the start of accumulation date and, as appropriate, a “hazardous waste” or “non-hazardous waste” label.

8.2 Waste Analysis

8.2.1 Aqueous Waste

Aqueous waste containers will be sub-sampled. The waste inventory sheet will be filled out and transported to the waste storage area within 24 hours and must be clearly labeled as “Awaiting Analysis”.

Analysis of each aqueous waste container must be completed within 10 days. The results are then entered onto the waste inventory sheet.

8.2.2 Solid Waste

Solid wastes designated for disposal are collected in an approved container.

In lieu of analyzing the solids, the data collected during the analysis of the samples is used to indicate the level, if any, of metals concentration in the solid waste. In general, segregating the solids into LIMS workorder specific groups will make calculating the metals concentration less complicated.

A copy of the completed solid waste inventory sheet along with the raw data is provided to the WCO and the original is attached to the waste container.

9.0 Data Records and Management

Waste is tracked through the use of container labels, waste container logs, an in-house tracking system, physical inventories, hazardous waste shipping manifests, and certificates of disposal.

Data from waste container sheets for wastes generated in the laboratory is entered into the Hazardous Waste Tracking System (HWTS) bound green notebook by the WCO at the time of transport to the waste storage area.

10.0 Waste Minimization

Metals laden waste volumes are minimized by the use of a dedicated waste receptacle in which no other laboratory waste is placed.

Waste concentrations are minimized by judicious use of metals standard solutions and materials. In addition, ESAT chemists are working with field personnel to reduce the amount of excess sample collected.

11.0 References

EPA Region 8 Chemical Hygiene Plan, current version

EPA Region 8 Waste Management SOP, current version

EPA Region 8 Safety, Health and Environmental Management Program, current version

TechLaw Corporate Health and Safety Plan, current version

Document Change History

Revision No.	Status[1] (I, R, C)	Effective Date	Changes Made
0	I	01/17/07	Not applicable
1	R	03/29/16	Entire document reviewed and updated
2	R	07/20/17	Entire document reviewed and updated
3	R	04/23/19	Entire document reviewed and updated

[1] Status: I = Initial, R = Revision, or C = Cancelled

16-LAB-05.05
Sample Receipt, Custody, Storage, and LIMS Data Entry

Technical Approval: Scott C Walker
PRINT NAME

SIGNATURE
Date: 7/20/2017

QA Management Approval: Nikki Thomsen
PRINT NAME

SIGNATURE
Date: 07/20/17

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1.0 SOP Description

The purpose of this standard operating procedure (SOP) is to establish a safe, traceable, and consistent laboratory process for receiving, tracking, and storing of Environmental Services Assistant Team (ESAT) samples at the United States Environmental Protection Agency (EPA) Region 8 Laboratory. These may include surface waters, ground waters, soils, sediments, biological materials, and proficiency testing (PT) samples.

This SOP specifies the requirements for project definition, sample receipt, control, and record keeping by ESAT. The following objectives are defined in detail within this document:

1.1 EPA Project Definition – Prior to accepting client samples at the laboratory, an agreement between the EPA Task Order Project Officer (TOPO) and ESAT must be established in a Technical Direction Form (TDF). The TDF will detail the required analytical methods, target analytes, approximate quantity of samples, estimated receipt date, analytical quality control (QC) procedures, and data deliverables.

1.2 ESAT Project Definition – Following receipt of the TDF, ESAT personnel will create a project in the Laboratory Information Management System (LIMS) that defines the requirements detailed in the TDF.

Note: ESAT does not receive a TDF for PT samples; however, ESAT will still create a project in LIMS that defines the requirements of the PT provider and the National Environmental Laboratory Accreditation Conference (NELAC).

1.3 Sample Integrity Inspection

- Samples listed on the chain of custody (COC) are compared to the actual samples received in order to identify any discrepancies
- Samples and shipping coolers are inspected for leakage or breakage
- Temperature of the samples upon receipt is recorded
- Sample preservation is verified
- Any breach of the sample integrity will be noted and become a part of the project record
- A copy of the *Sample Receipt Form* – TLF-51.XX (current version) will be completed, which documents all of the parameters taken and any anomalies, if applicable.

1.4 COC Verification

- The COC establishes a traceable, legal record of the possession of the samples from sampling through analysis
- Laboratory personnel compares the sample identification as listed on the COC to the identification on the samples
- Identify any sample requiring analyses with short holding times and notify laboratory personnel of the sample arrival
- Note any and all discrepancies on the *Sample Receipt Form*, which becomes part of the project record
- Maintain sample custody by storing the samples in a locked cooler
- Track movement of the samples in and out of the cooler in a logbook

1.5 LIMS Sample Login – After completing sample receipt procedures, the samples are logged into the LIMS by utilizing the ESAT project definition and either an electronic XML file or by hand-entering sample information and any noted discrepancies from the *Sample Receipt Form*.

2.0 Acronyms

°C	Degrees Celsius
CHP	Chemical Hygiene Plan
COC	Chain of Custody
EDD	Electronic Data Deliverable
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
HSO	Health and Safety Officer
ID	Identification
IR	Infrared
LIMS	Laboratory Information Management System
NELAC	National Environmental Laboratory Accreditation Conference
PPE	Personal Protective Equipment
PT	Proficiency Testing
QA	Quality Assurance
QAO	Quality Assurance Officer
QC	Quality Control
SOP	Standard Operating Procedure
TDF	Technical Direction Form
TO	Task Order
TOPO	Task Order Project Officer

3.0 Health and Safety

3.1 The person receiving the samples ensures that the sample login area is clean and free of any potential contaminants prior to working in the area.

3.2 Proper personal protective equipment (PPE) is required for sample receipt, including a minimum of gloves, eye protection, and lab coat.

3.3 Leaking containers can pose a health risk due to the possible presence of acids and other toxic components making inhalation of toxic vapors a potential hazard.

- All coolers should be opened in a room with adequate ventilation
- If broken sample containers are present, additional PPE and engineering controls (e.g., chemical fume hood) may be required. If the use of spill cleanup material is necessary, the proper method of cleanup and disposal must be followed. Refer to the EPA Region 8 HSP-001, *Chemical Hygiene Plan* (CHP), current version.
- Assistance from the ESAT or EPA Health and Safety Officer (HSO) for proper handling and disposal procedures may be required

3.4 Sample receipt personnel must be familiar with the location of additional safety equipment.

- Spill and neutralizer equipment are available in the sample receipt area
- The eye wash station and safety shower in the sample receiving area should be

verified as unobstructed prior to unpacking the samples

4.0 Equipment and Supplies

- Calibrated and certified thermometers – Thermometers used for measuring sample storage cooler temperatures are calibrated annually under the supervision of the EPA laboratory Quality Assurance Officer (QAO) using a certified thermometer. An infrared (IR) temperature indicator is maintained and used by ESAT personnel for recording the temperature of the samples upon arrival.
- Wide-range pH paper (non-bleeding)
- Waste container (properly labeled according to the CHP)
- Promium ELEMENT LIMS for sample tracking and reporting
- Laboratory chemical fume hood for opening sample coolers
- Refrigerated and secured sample storage cooler kept at 4 ^{o}C

5.0 Personnel Qualifications and Responsibilities

5.1 ESAT Personnel

- The receiving and checking of incoming samples must be performed by an ESAT team member trained in the proper performance of this SOP
- The sample receiver must be familiar with interpreting COC documentation, performing pH determinations, and maintaining custody of samples
- Personnel receiving samples should have a baseline physical examination performed prior to receiving samples
- Some lifting of 30-50 pound coolers/containers may be required

5.2 EPA Personnel

- EPA personnel will periodically move coolers containing ESAT samples into the ESAT sample storage cooler
- EPA personnel will notify ESAT team members of the arrival of the samples

6.0 Cooler Receipt and Acceptance

6.1 Sample Integrity Inspection

6.1.1 Generally, samples are received through the main entrance of the laboratory via FedEx or delivery from the sampling contractor. Note the method of delivery on the *Sample Receipt Form*. This is indicated in the project later when the samples are logged into the LIMS.
6.1.2 Retrieve a sample cart, and move the coolers to the sample receipt area (E-115).
6.1.3 Examine the shipping coolers for any damage or leaks, and note their presence for inclusion into the project folder.
6.1.4 Open the cooler(s) while the cooler is located under the exhaust hood in the sample receipt area.
6.1.5 Remove the COC from the cooler.
6.1.6 On each page of the COC, sign the “Received” section and record the date and time of receipt.

Note: Whenever possible, the sampler or customer should be present during the *transition of the samples into ESAT custody, including opening of the coolers and cross-checking of information.*

6.1.7 Unpack the cooler, and use the COC to organize the samples on the work table in the sample receipt area.

- If any issues with sample integrity are observed (e.g., damage to the sample container, contamination, etc.), the analyst should note on the *Sample Receipt Form* and in the case narrative of the data package so that data users are aware that the sample may have been compromised.
- Any correspondence with and direction received from the TOPO regarding a compromised sample should be received in writing via email, and that email should be included in the data package.

6.1.8 Temporarily place the ice or baggies filled with ice in the deep sink under the exhaust hood.

6.1.9 Using the IR thermometer, measure the temperature of the first unpacked sample. This temperature is recorded on the *Sample Receipt Form* and in LIMS.

6.1.10 Inspect each sample container for damage or leaking, and note any circumstance for inclusion in the project folder.

6.1.11 Verify the preservation of any samples that are indicated on the COC as having been preserved to a specific pH. Note the lot number(s) of the pH strips on the *Sample Receipt Form.*

6.1.12 Place a drop or two of sample on the pH indicator strip using a disposable pipet and compare strip to color scale that is provided on pH strip package to obtain sample pH.

6.1.13 If the sample is properly preserved, no further action is required.

6.1.14 Recap the sample container and proceed with the login procedure (see Section 7.0).

6.1.15 Improperly preserved samples must be preserved before placing into the storage cooler. Carefully note on the *Sample Receipt Form* which samples were not properly preserved.

6.2 COC Verification

6.2.1 The samples should be accompanied by a COC, sample identification (ID) tags, and custody seals.

- All information required on the forms and tags must be properly completed and legible.
- The sample ID tag information must be verified against the corresponding sample information provided on the COC.

6.2.2 In the case of COC discrepancies, the sample ID tag will be assumed as the true information, and the discrepancies must be clearly noted on the *Sample Receipt Form* and on the COC with the login personnel's initials and date.

- All COC discrepancies should be discussed in the *Sample Receipt Form* of the data package.
- If a COC discrepancy requires contact with the TOPO, this should also be discussed in the case narrative of the data package. If COC discrepancies are resolved verbally with the TOPO, an email should be sent to confirm the reconciliation of discrepancies, and a copy of the email should be included in the data package with the COC.

6.2.3 If the documentation is incomplete, the ESAT Contract Manager and TOPO must be notified of the discrepancy. The TOPO will decide if the process will continue.

6.2.4 After each sample is unpacked from the shipping container and the sampling information is verified, it is separated into various storage trays by analytical method.

6.2.5 The trays are labeled with a tag in a plastic shield with the following information: project name, LIMS work order number, due date, and requested analysis.

6.2.6 The labeled trays are then placed in walk-in cooler "A" and secured by locking the cooler with the provided padlock.

6.2.7 The trays are removed by the analyst prior to analysis. The analyst records the removal of the samples from the cooler in the logbook in the sample receipt area.

6.2.8 Empty the plastic bags filled with ice that were placed in the sink, and put the empty bags into the provided waste container in the sample receipt area.

7.0 Project Creation and Sample Entry in LIMS

7.1 Project Creation in LIMS

- Open the LIMS software
- In the Project Management dropdown menu, select "Projects"
- Highlight a similar project. Be sure to check that it has the required test codes.
- Select the "Copy" option
- Double click the "Superfund" client option
- Rename the project in the dialog window
- From the new project screen select "Edit"
- Put the TDF number in both the "Project Number" and "PO number" fields
- Select the "Project Manager" from the drop down menu
- Check that the default Electronic Data Deliverable (EDD) is "StdESATExel_rev1.exe"
- Enter the appropriate project name in the comments field
- If the test codes for the new project need to be changed, double click on "Test Codes" and select the correct test codes for the project from the drop down menu
- Save the project

7.2 Work Order Creation in LIMS

- From the "Sample Control" menu, select "Work Order"
- Select "Import" and select the file location of the XML/Scribe file from the drop down menu
- Click the "Import" button
- From the "Analysis" tab, match the appropriate test codes
- From the "Matrices" tab, match the sample preservatives
- From the "Container" tab, match the appropriate containers or select "Default"
- Click "Done" and the new work order screen will appear

7.3 Work Order Information Editing

- Select the work order from the dropdown menu and click "Edit"
- Select the project from the drop down menu in the top right corner
- The Project number and the PO number should match the TDF for the project
- In the "Submitted By" window, select the appropriate sampler from the drop down menu
- In the "SDG Identifier" window, type in the TDF number
- In the "Shipped By" window, select either "Walk-in" or" FedEx" from the drop down menu. If shipping was by Fed Ex, enter the tracking number in that window.

- Select the turn-around time to calculate the appropriate due date for the project
- Check the appropriate “Condition” boxes for the samples received and input the cooler temperature
- Ensure the Analysis Test Codes are accurate and add/delete as needed
- Save the work order

7.4 Editing Samples in the Work Order

- Click on the “Samples” tab and “Edit”
- Verify that the sample name, container, location, and comment (EPA Tag #) are correct
- In the “Report Matrix” drop down window, select the one listed on the COC
- In the “Sample Type” drop down window, select “Field Sample”
- In the “Sampled By” drop down window, select the one listed on the COC
- In the “Work Analysis” windows, the test codes may or may not be applied. If more tests are needed, click the “Work Analysis” tab to see all of the available test codes.
- Repeat sample entry/editing for all samples in the project
- Save the work order, and click the printer icon to print the sample information

7.5 Project Folder Creation

7.5.1 Master Project Folder

- Label a new folder with the work order number, project name, TDF number, and due date
- Place the original COC, TDF, and the Sample Receipt Form in the folder
- Place the LIMS printout of the samples entered in this folder
- Place any E-mail or other documents pertaining to the project in this folder
- All analytical data will be placed in this folder until final report generation

7.5.2 Analytical Folder

- On the LIMS computer, go to “Explore”
- Go to the “X” drive and click on “Metals_Data_Files”
- Select the appropriate year
- Go to “File”, “New”, “Folder”
- Name the new folder using the following format: Work Order_TDF Project Name (e.g., C606006_SC010 CalGulch June Monthly)
- Repeat the file creation sequence in “WetChem_Data_Files” if the project requires this type of analysis

7.5.3 Reporting Folder

- On an ESAT computer (not the LIMS computer), navigate to the appropriate Task Order (TO) folder on the network drive
- Click on “Analytical Reports” and then “Final Reports”
- Go to “File”, “New”, “Folder”
- Name the folder using the same convention as the Analytical Folder (Section 7.5.2)

8.0 Data and Records Management

- The sample checkout logbook is maintained by ESAT quality assurance (QA)/QC personnel
- Completed logbooks are archived and new ones provided when necessary
- EPA QA/QC personnel verify thermometer calibration and log cooler temperatures daily

- COC records, LIMS reports, and all other correspondence become part of the ESAT retained records data file
- All custody records and entries in the sample checkout logbook will be recorded in blue or black indelible ink
- When an entry error occurs, the author will draw a single line through the error, initial and date, and record the correct information. If the space is too small for further legible entries, either the next line will be used or the correction must be footnoted to ensure legibility of the correct entry
- Internal audits will be conducted periodically by the ESAT QAO or designee to verify the procedures outlined in this SOP are being performed
- Refrigerated cooler temperatures are checked and recorded daily according to EPA Region 8 SOP EQOP-805, *Monitoring Refrigerator and Cooler Temperatures*, current version

9.0 Waste Minimization

- The analyzed samples are separated for consolidation and disposal. Refer to ESAT SOP 16-LAB-01.XX, *Collection, Analysis and Disposal of Laboratory Waste*, current version.
- Plastic sample tag holders are reused, as are the washable trays, coolers, and carts. Sample containers are not reused due to high possibility of cross contamination.
- In order to minimize contamination of large volumes of liquids, compatible samples marked for disposal will be consolidated without further dilution
- Field coolers and some packing materials (e.g., foam, bubble wrap) can be cleaned, dried, and reused

10.0 References

EPA Region 8 Laboratory HSP-001, *Chemical Hygiene Plan*, current revision

EPA Region 8 Laboratory SOP EQOP-805, *Monitoring Refrigerator and Cooler Temperatures,* current revision

EPA Region 8 Laboratory SOP GENLP-808, *Sample Receipt and Custody*, current revision

ESAT Region 8 SOP 16-LAB-01.XX, *Collection, Analysis and Disposal of Laboratory Waste*, current revision

TechLaw Corporate Health and Safety Plan, current revision

Document Change History

Revision No.	**Status[1] (I, R, C)**	**Effective Date**	**Changes Made**
0	I	01/17/07	Not applicable
2	R	05/06/09	Entire document reviewed and updated (note that Revision 1 of this SOP was never finalized or approved, and therefore, not included in the document change history)
3	R	08/06/14	Entire document reviewed and updated
4	R	10/14/15	Entire document reviewed and updated
5	R	07/20/17	Entire document reviewed and updated

[1] Status: I = Initial, R= Revision, or C = Cancelled

U.S. EPA Region 8
Survey123 for ArcGIS

Region 8 Ecosystems Protection and Remediation

Program Support

Data Systems Unit

GIS

Version1.0

March 21, 2017

Date	Author	Version	Description
03/21/2017	Ryan Bahnfleth	1.0	Final

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CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standard approach for personnel to use a Global Positioning System (GPS) and the Survey123 application during field activities.

2.0 APPLICABILITY/SCOPE

This SOP is specifically intended for application by personnel who conduct field work using Survey123 for ArcGIS on an Apple iPad coupled with a Trimble R1 GNSS GPS receiver.

3.0 SUMMARY OF METHOD/PROCEDURE

This SOP covers the use of Survey123 for ArcGIS on an Apple iPad coupled with a Trimble R1 GNSS GPS receiver for field data collection. This SOP is based on Esri's (manufacturers') instructions.

4.0 PERSONNEL QUALIFICATIONS & RESPONSIBILITIES

Personnel who will be collecting data with the specified equipment should practice with the equipment before use. Additionally, personnel who conduct fieldwork should familiarize themselves with the standard health and safety practices associated with remedial clean-up operations.

5.0 ACRONYMS/DEFINITIONS

EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
SDE	Spatial Data Enterprise
SOP	Standard Operating Procedure

<u>Geographic Information System (GIS)</u>: A system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data.

<u>Global Positioning System (GPS)</u>: A navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

Survey123: Software used on iPad units that captures and stores spatial data and attributes of a sample location collected in the field.

Trimble: A private GPS Company that provides equipment and technical support, including the R1 GNSS GPS units and the Trimble GNSS Status application.

6.0 EQUIPMENT & SUPPLIES

- Trimble R1 GNSS GPS unit and accessories
- Apple iPad and accessories
- LTI TruPulse™ 360 Laser RangeFinder
- TruPulse™ 200B/36B Cheat Notes card
- Tape measure
- Flags
- Computer and/or external hard drive and accessories

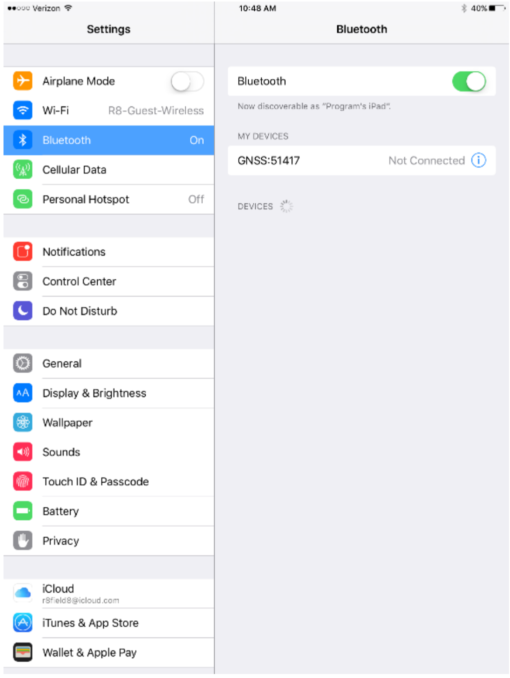
7.0 HEALTH & SAFETY CONSIDERATIONS

refer the applicable site-specific Health and Safety Plan (HASP) any time field work is conducted.

8.0 PROCEDURAL STEPS/EQUIPMENT OPERATION

8.1 Connecting the iPad to the Trimble GNSS Status app

To establish a Bluetooth connection between the iPad and the Trimble R1 GNSS receiver, open the iPad’s Settings App and tap on “Bluetooth” to enable a Bluetooth connection. Follow the printed Trimble instructions for enabling a Bluetooth connection for the Trimble R1 GNSS receiver that accompanied the GPS unit. Once enabled, the device will be listed in the “My Devices” window.

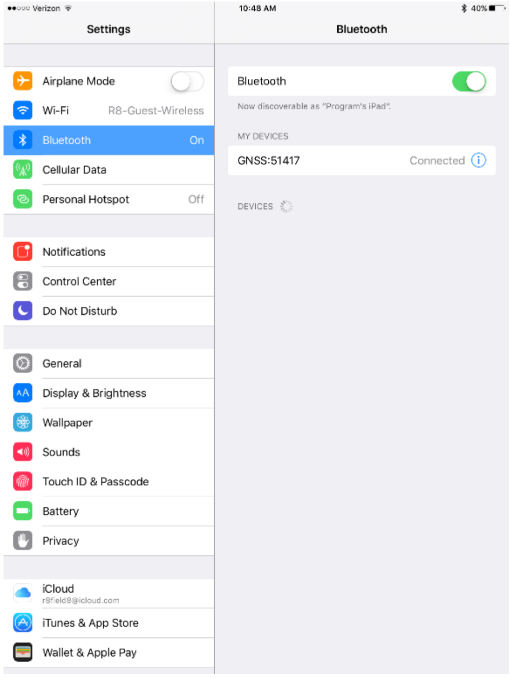


Bluetooth ●

Now discoverable as "Program's iPad".

MY DEVICES

GNSS:51417 Not Connected ⓘ



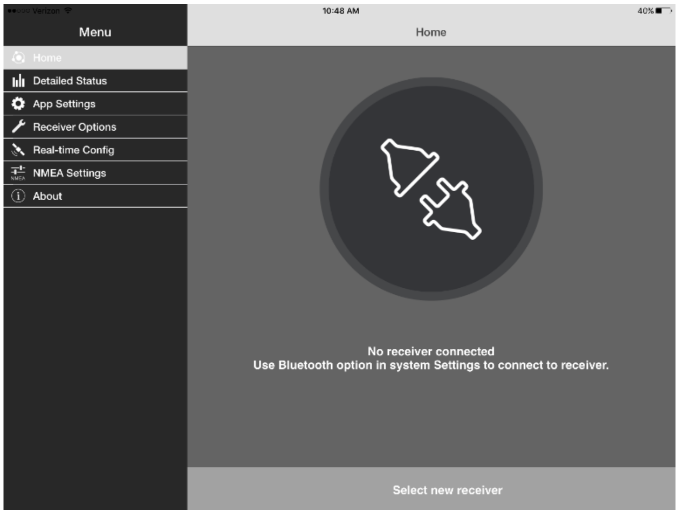
Bluetooth ●

Now discoverable as "Program's iPad".

MY DEVICES

GNSS:51417 Connected ⓘ

As shown in Figure 2, open the Trimble R1 GNSS Utility application to view satellite constellation and reported accuracy. It is recommended that you give the receiver 5-10 minutes on initial start up to lock in signals from satellites. To assist in locking onto satellites it is recommended that the user maintain an unobstructed view of the southern sky. Once a connection is established, you may now open the Survey123 application.

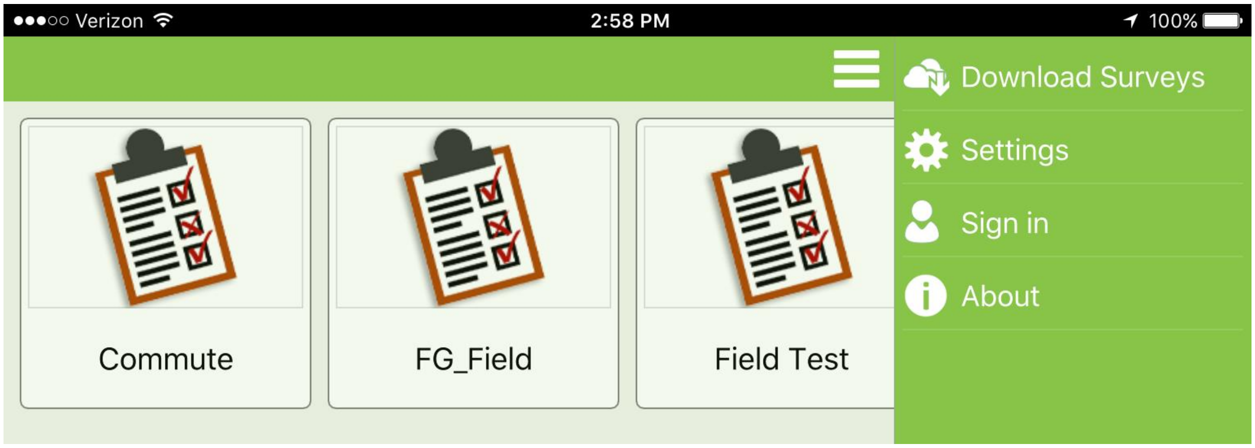


No receiver connected
Use Bluetooth option in system Settings to connect to receiver.

8.2 Survey123 for ArcGIS Application

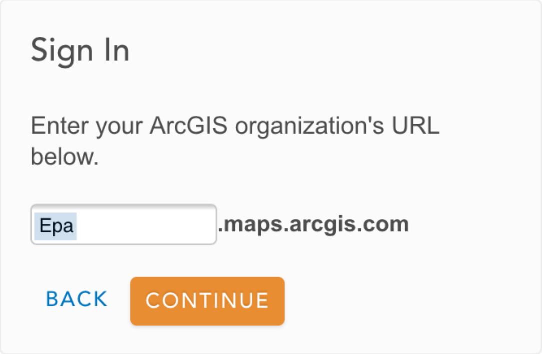
Begin by tapping on the Survey123 Application icon

Sign in by tapping on the upper right-hand corner of the screen and choose Sign in.



Choose to Sign in with your EPA Enterprise Account

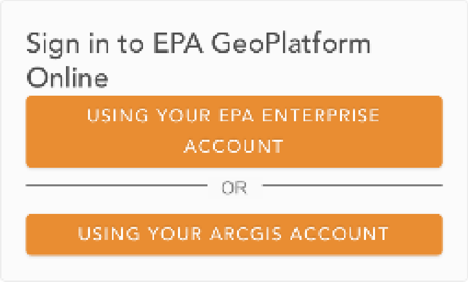
Type EPA to complete the url as epa.maps.arcgis.com



Sign In

Enter your ArcGIS organization's URL below.

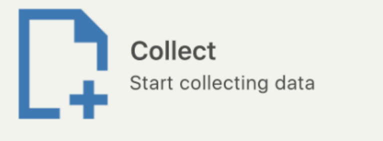
Epa .maps.arcgis.com


Sign in to EPA GeoPlatform Online

Sign in using Your ArcGIS Account. Use the device ID and Password specific to the iPad you are using.

After completing the Sign in, choose the project that you will be working on by tapping on the right hand corner and selecting Download Surveys. A list of surveys will appear, choose the appropriate survey for your field work and tap the following icon.

Once the Survey has downloaded tap on the survey and choose collect at the bottom of the screen.



Fill out the survey starting from the top to the bottom paying special attention to required fields which have a red asterisks *. Once your survey is completed, tap on the check mark to close that survey. Choose the Send Later option when in the field. When you have finished with collection for the day and you are in an area with WiFi and connected to the internet, send the completed surveys by returning to the Survey123 home page and pressing the Send Surveys Now option.

8.3 List of Fields to be Completed

Sample Area	Area of Location
Location ID	Sample Location unique identifier
Metals Analyses 1	Fill out each entry with separate Metals Analyses to obtain unique Sample # in report.
Sample ID 1	Unique sample number for reporting in Scribe

Metals Analyses 2	Fill out each entry with separate Metals Analyses to obtain unique Sample # in report.
Sample ID 2	Unique sample number for reporting in Scribe
Metals Analyses 3	Fill out each entry with separate Metals Analyses to obtain unique Sample # in report.
Sample ID 3	Unique sample number for reporting in Scribe
Sample Collection Type	Type of sample being collected. Select the appropriate radio button
Sample Matrix	Sample matrix to be collected
Date	Current date
Time	Current time
Environmental Conditions	Weather description, physical description of site, note anything that would adversely impact quality of measurement/sample
Form Author's Name	Who is completing this form?
Field Sampler's Name	Who is collecting the samples?
Water Quality Probe Barcode	Scan the Barcodes for this equipment
Flow Measurement Barcode	Scan the Barcodes for this equipment
TRM Bottle Lot Number	Scan the Barcode for this bottle
DM Bottle Lot Number	Scan the Barcode for this bottle
Alk/Anion Bottle Lot Number	Scan the Barcode for this bottle
Extra Field Equipment	Scan the Barcode
pH	ph reading as a number within the pH scale
Temperature	Degrees Celcius
Conductivity	Reading in µS/cm

Dissolved Oxygen	Reading in mg/L
ORP	Reading in mV
Flow Measurement	CFS or flume measurements. Not a required field
Remarks	Any further remarks concerning the sample location
Location	GPS reading of current location
Take Picture Upstream	Collect pictures upstream.
Take Picture Downstream	Collect pictures downstream.
Supplemental Picture	Include supplemental pictures as needed
Author's Signature	Sign this form to testify that all is truthful

9.0 CALIBRATION

There is no calibration requirement associated with this SOP.

10.0 MAINTENANCE

GPS maintenance must be performed by qualified GIS staff during the offseason as appropriate. This process involves firmware updates that are published by Apple and Esri. Hardware updates include visual and physical checks and the replacement of equipment as needed. Please report any equipment issues to the GIS team as soon as they are discovered.

11.0 WASTE MANAGEMENT & POLLUTION PREVENTION

Use of the GPS produces no waste. There are no waste management requirements associated with this SOP.

12.0 DATA & RECORDS MANAGEMENT

All data and records management must be handled by qualified GIS staff. Any and all work related to data and records management should be processed under the Regional S: drive, also known as the “SAN.” After a field event, the File GeoDatabase (.gdb) and Comma Separated Values file (.csv) are downloaded from the GeoPortal and are archived on the SAN. Attribute values from the data collection event are to be forwarded to a data manager for processing and upload to Scribe. Pictures are to be stored in accordance to the Site specific Data Management Plan. Any new sample locations, updates to current sample locations, or features collected are then added to the Regional GIS Spatial Data Enterprise (SDE) and made available to Regional staff.

13.0 QUALITY CONTROL & QUALITY ASSURANCE

All data received by GIS staff from field personnel are reviewed under Regional GIS guidelines. Data received is reviewed for positional error using spot checking and review of field notes. Attribute information is reviewed for misspellings, inaccuracies, and operator error before being published. All data processing performed by a GIS staff member must be reviewed by another qualified staff member to assure quality control.

14.0 REFERENCES

U.S. EPA, 2007. *Guidance for the Preparation of Standard Operating Procedures (SOPs) for Quality-Related Documents.* EPA QA/G-6, EPA/600/B-07/001. April 2007.

Attachment 2

Data Management Checklist

Data Management Checklist for the Red and Bonita Bulkhead Test Closure

The primary objective of this document is to ensure high-quality data is collected and properly backed up and stored in the proper locations outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado, and execution plan, as well as inform participants in the Red and Bonita Test Closure of the types of data being collected and their associated storage locations.

The following describes the data management plan specific to each type of data collected. All data described herein will be collected by MSI personnel on an EDCD and saved in the MSI Dropbox account to facilitate backing up of files immediately upon return to internet connectivity. Additional data redundancy will include uploading of raw data to EPA Sharepoint as well as regular backups of all data to the MSI server.

Draining Mines Data:

Types of data collected:

- Discharge
    - A discharge measurement will be collected weekly from the flume if available and calculated with the Ha measurement after the flume has been scraped and using the associated rating table.
    - If there is no flume, alternate discharge methods may be utilized to obtain the measurement.
    - Discharge data will be recorded on the (EDCD) and stored in the Excel master working document specific to each site.

- Water quality (pH, conductivity, temperature)
    - MSI will conduct weekly visits to the draining mines in the attached site list to collect water quality data. (Figure 1)
    - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site.

- Water Chemistry
    - 3 sampling events planned (Figure 1)

Water samples will be documented in Survey 123 according to the standard protocol. outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

-

Data Flowpaths:

1. Raw data is downloaded from instruments using an EDCD and saved to the MSI Dropbox account.
2. Raw data is uploaded upon return from the field to the following EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > Raw >Draining Mines > Site Specific Folder

3. MSI staff will QA/QC flow data to Level 2 and upload master working files and plots to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > QC'd >Draining Mines > Site Specific Folder
4. EPA will update the dashboard for participants to view.

Stream Gauge Data:

Types of data collected:

- Pressure transducer temperature, pressure, and depth data.
    - MSI will download pressure transducers weekly from select sites. (Figure 1)
- Discharge
    - A discharge measurement will be collected weekly from selected stream gage sites using a Hach flow meter or portable flume.
- Water quality (pH, conductivity, temperature)
    - MSI will conduct weekly visits to the selected stream gauges in the attached site list to collect water quality data. (Figure 1)
    - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site. (Figure 1)
- Water Chemistry
    - 3 sampling events planned (Figure 1)

Water samples will be documented in Survey 123 according to the standard protocol.
outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

- .

Data Flowpaths:

1. Raw data from pressure transducers is downloaded from instruments using an EDCD and into the MSI Dropbox account.
2. Raw data is uploaded upon return from the field to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > Raw >Stream Ga > Site Specific Folder
3. MSI staff will QA/QC pressure transducer depth data to Level 1 and upload master working files and plots to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > QC'd >Stream Gauges > Site Specific Folder
4. Water sampling data is recorded in the field utilizing Survey 123 according to the protocols outlined in the BPMD QAPP Rev 4_2020.
5. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.
6. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
7. EPA will update the dashboard for participants to view.

Dry Mines or Adits:

- Photographs
    - MSI personnel will document in Survey 123 with photographs verifying that there is no new discharge from dry mines or adits.
- Frequency of data collection
    - Weekly at selected sites (Figure 1)
- Collect a water sample if new flows are detected
    - Water samples will be documented in Survey 123 according to standard protocol.
- Water quality data will be collected if new flows are detected.

Data Flowpaths:

Water sampling or dry mine or adit data is recorded in the field utilizing Survey 123 according to the protocols outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

1. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.
2. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
3. EPA will update the dashboard for participants to view.

Seeps and Springs:

Types of data collected:

- Discharge
    - Discharge measurements will be collected utilizing a variety of methods if there is a quantifiable flow.
- Water quality (pH, conductivity, temperature)
    - MSI will conduct weekly visits to the selected seeps and springs in the attached site list to collect water quality data. (Figure 1)
    - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site. (Figure 1)
- Water Chemistry
    - 2 sampling events planned. (Figure 1)

Water samples or dry seeps will be documented in Survey 123 according to the standard protocol outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

Data Flowpaths:

Data is recorded in the field utilizing Survey 123 according to the protocols outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

1. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.

2. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
3. EPA will update the dashboard for participants to view.

Data Delivery Checklist Review Form

Event Site:
Event Date:
Deliverable Author:
TDF (Include TDF Line Item):
Sampling Group:
DCN:

FIELD DATA CHECKLIST

Field Data EDCD Data Completeness & Verification Process	**Correction Required?**				**Corr**
	No	**Yes**	**N/A**	**Comments**	**Initials**
Synced field data from EDCD tablet to the EPA Geoplatform by pressing the Sync button **within one week of the field event.**					
Field crew conducted completeness and error check on field data, (corrected errors, added missing data, ensured correct locational data) **within 15 days of sampling event.**					
EDCD EDD was transferred to QC folder for upload into Scribe.					
Data Team was notified that field data verification and completeness check was finished and field data was ready for upload into Scribe.					

Additional Comments:

GIS DATA CHECKLIST

EDCD Data Completeness & Verification Process	**Correction Required?**				**Corr**
	No	**Yes**	**N/A**	**Comments**	**Initials**
UNDOCUMENTED LOCATIONAL DATA GIS Locational Requirements - All field data will be required to provide vector data that will be submitted in geographic coordinate system, decimal degree units, and NAD83 datum. Special considerations will be given for indoor air samples, test blanks and some lab samples.					
Data Team alerted NEW locational latitude/longitude QC'd for upload into Scribe.					

Additional Comments:

ESAT EVENT DATA CHECKLIST

COC						**Com**
	No	**Yes**	**N/A**	**Comments**		**Initials**
Samples match provided COC.				**Issues:**		
				Corrections:		
Create eCOC from paper COC.				**Scribe COC:**	☐	
				Other:	☐	
eCOC Provided.						
Split out COC by Matrix						
Import Sample eCOC into Scribe.						

Additional Comments:

Field Data					**Com**
	No	**Yes**	**N/A**	**Comments**	**Initials**
After notification from field team, the QC'd Field Data EDD from the EDCD is imported into Scribe.					
Published project.					
Emailed noted individuals supplied by Data TOCOR.					
Lab Results					**Com**
	No	**Yes**	**N/A**	**Comments**	**Initials**
When Lab Results are analyzed and the data package has been QC'd,					
Lab Results Imported into Scribe.					
Totals or Dissolved update queries ran.					

Additional Comments:

Publishing Project					**Com**
	No	**Yes**	**N/A**	**Comments**	**Initials**
Project ran through R8_DMP Auditor.					
Correct Auditor Errors.					
Published project.					
Emailed noted individuals supplied by Data TOCOR.					
If new project, request Subscription from ERTSupport@epa.gov and forward to Project TOCOR and Data TOCOR.					

Additional Comments:

Standard Operating Procedures
TechLaw, Inc.
ESAT Region 8
Contract No.: EP-W-06-033

Document No.: FLD-04.00
Revision No.: 0
Revision Date: N/A
Page 1 of 24

Effective Date: 3/30/2012

Replaces SOP: N/A

Groundwater Sampling

APPROVED:

ESAT Region 8 QA Coordinator

06/06/12
Date

ESAT Region 8 Team Manager

6/6/12
Date

ESAT Region 8 Task Lead

7/10/12
Date

EPA Task Order Project Officer

6/8/12
Date

DCN: EP8-7-7061

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide field personnel a guideline for proper groundwater well sampling procedures. Each groundwater well is unique; therefore it is important that the site-specific Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) be thoroughly reviewed before deployment to the field.

2.0 SCOPE AND APPLICABILITY

The objective of this SOP is to provide general reference information on sampling of groundwater wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of groundwater contaminants (e.g., volatile and semi-volatile organic compounds, pesticides, metals, biological parameters).

These are standard operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the procedures employed should be documented and associated with the final report. Mention of trade names or commercial products does not constitute Techlaw, Inc. endorsement or recommendation for use.

3.0 SUMMARY OF METHOD

The method of either purge or non-purge sampling can be used in groundwater sampling. Non-purge sampling is preferred when sampling at low-flow. If sampling occurs when water flow is higher, it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump (peristaltic pump).

At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells in accordance with the Sample Equipment Decontamination SOP (FLD 02.00). Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments, and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some devices will affect the integrity of the sample. Sampling should occur in a progression from the least contaminated well to the most contaminated well, if this information is known.

A growing concern over the past several years concerning low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part(s) per trillion levels. While the laboratory methods are extremely sensitive, closely controlled, and quality-assured, they cannot compensate for a poorly collected sample. The collection of each sample should attempt to be as highly developed and quality-assured as the analytical procedures.

4.0 ACRONYMS AND DEFINITIONS

EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
GFCI	Ground Fault Circuit Interrupter
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDW	Investigation Derived Waste
lbs/in	Pounds per inch
mL	Milliliter
NAPL	Non-Aqueous Phase Liquids
ORP	Oxidation Reduction Potential
OSHA	Occupation Safety and Health Administration
PID/FID	Photo Ionization Detection/Flame Ionization Detection
PVC	Polyvinylchloride
QAPP	Quality Assurance Project Plan
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
µm	Micrometer
VOA	Volatile Organic Analysis

Ground Fault Circuit Interrupter (GFCI): An electrical wiring device that disconnects a circuit whenever it detects that the electric current is not balanced between the energized conductor and the return neutral conductor.

Polyvinylchloride (PVC): A thermoplastic polymer commonly used for construction purposes.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Volatile Organic Analysis (VOA): A common type of analysis for groundwater sampling. The sample containers for this analysis are also referred to as “VOAs”.

5.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. Environmental Protection Agency (EPA) or Occupational Safety and Health Administration (OSHA) health and safety guidelines. Depending on the site-specific contaminates, more specific protective programs must be implemented prior to sampling the first well. The site-specific Health and Safety Plan (HASP) should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants (in both the vapor phase and liquid matrix) through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.

2. Pre-survey the well head-space with a Flame Ion Detection/Photo Ionization Detection prior to sampling

3. If monitoring results indicate organic constituents, sampling activities may be conducted at Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment

2. Use of pocket knives for cutting discharge hose

3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing

4. Slip, trip, and fall conditions as a result of pump discharge

5. Restricted mobility due to the use of protective clothing

6. Electrical shock associated with use of submersible pumps
   Note: Use a Ground Fault Circuit Interrupter (GFCI) or a copper grounding stake to avoid electrical shock

6.0 CAUTIONS

Refer to Section 5.0, “Health and Safety,” for cautions that should be considered while groundwater well sampling.

7.0 INTERFERENCES

7.1 General

The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Sample integrity can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample(s), or (2) by incorrect handling of the sample(s). There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

7.2 Purging

In a non-pumping well, the well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the groundwater. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in a~~n~~ non-representative sample. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the groundwater formation may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest. To safeguard against collecting non-representative and/or stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purged water should be containerized on-site or handled as specified in the site-specific SAP. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended in order to obtain a representative sample (unless low-flow or non-purge sampling techniques are used). In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data is to be used for enforcement actions, evacuation is recommended.

2. When purging with a pump (not a bailer), the pump should be set at the mid-point of the screened interval; or if the well is an open-rock well, it should be set at the desired sampling depth. When sampling a screened well, the sample should also be collected from the same depth as the pump.

3. The well should be sampled as soon as possible after purging.

4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument. Refer to the site-specific SAP or check with the analytical laboratory prior to sampling to ensure that sample collection meets analytical requirements.

5. For wells that can be pumped or bailed to low water levels with the equipment being used, the well should be evacuated and allowed to recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow and/or time does not allow, the well can be sampled after one evacuation.

7.3 Materials

Materials used for the construction of samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendencies of organics to leach in and out of certain materials make the selection of materials critical for trace analyses. The use of plastics, such as polyvinylchloride (PVC) or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come into contact with the sample. In highly contaminated wells, disposable equipment (i.e., sample tubing or polypropylene bailers) may be appropriate to avoid cross-contamination.

7.4 Advantages/Disadvantages of Purging Equipment

7.1.1 Bailers

Advantages:

- No power source needed
- Portable
- Inexpensive and can be dedicated and hung in a well, thereby reducing the chance of cross-contamination
- Minimal out-gassing of volatile organics while sample is in bailer (bailer must not be slammed into water column)
- Readily available
- Removes stagnant water first (when purging J-Casing volumes)
- Rapid, simple method for removing small volumes of purge water

Disadvantages:

- Time-consuming to flush a large well of stagnant water (if water volume is high)
- Transfer of sample may cause aeration
- Stoppers at the bottom of the bailer often leak thus the bailer must be brought to the surface rapidly
- If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve preventing the bailer from holding water
- Dropping bailer into the water can stir up contaminants

7.1.2 Submersible Pumps

Advantages:

- Portable and can be transported to several wells
- Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible, and samples can be collected from great depths (> 30 feet)
- Generally very reliable and does not require priming

Disadvantages:

- Potential for effects on analysis of trace organics
- Heavy and cumbersome to use, particularly in deeper wells
- Expensive
- Power source needed
- Sediment in water may cause problems with the pumps
- Decontamination between wells is necessary

7.1.3 Non-Contact Gas Bladder Pumps

Advantages:

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages:
- Difficult to clean, though dedicated tubing and bladder may be used
- Only useful to approximately 100 feet
- Relatively low pumping rates
- Requires air compressor or pressurized gas source and control box
- Supply of gas for operation, gas bottles and/or compressors are often difficult to obtain and are cumbersome

7.1.4 Peristaltic Suction Pumps

Advantages:
- Portable
- Inexpensive
- Readily available

Disadvantages:
- Restricted to areas with water levels within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics
- Pump must be primed and vacuum is often difficult to maintain during initial stages of pumping

7.1.5 Inertia Pumps

Advantages:
- Portable
- Inexpensive
- Readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages:
- Restricted to areas with water levels within 70 feet of the ground surface
- May be time consuming to purge wells with these manual pumps
- Labor intensive

8.0 PERSONNEL QUALIFICATIONS

All personnel conduction fieldwork for the Environmental Services Assistance Team (ESAT) must have following three forms of clearance: medical monitoring, respirator fit testing, and current OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hr training. In addition, it is beneficial for field personnel to have some prior experience with groundwater well sampling.

9.0 EQUIPMENT AND SUPPLIES

9.1 General

- Interface Probe
- Steel tape
- Transducer (optional)

- Airline
- Appropriate keys for well cap locks
- Steel brush
- Multirac or Photo Ionization Detection/Flame Ionization Detection (PID/FID) (whichever is most appropriate)
- Logbook
- Calculator
- Field data sheets and samples labels
- Chain of custody records and seals
- Sample containers
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, bolt cutters, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate health and safety gear/personal protective equipment
- 5-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non-phosphate soap
- Several brushes
- Pails or tubs
- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator as power source)

9.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line (enough to dedicate to each well)
- Sharp knife
- Aluminum foil (to wrap clean bailers if not already individually pre-wrapped)
- 5-gallon pail

9.3 Submersible Pump

- Pump(s)
- Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle - amp meter is useful
- 1" PVC coil tubing - enough to dedicate to each well
- Hose clamps
- Safety cable (in case main cable becomes detached)

- Wire strippers
- Electrical tape
- Teflon tape
- Winch, pulley or hoist
- Gasoline for generator/gas can
- Flow meter with gate valve
- 1" nipples and various plumbing (i.e., pipe connectors)
- Pump control box (if necessary)

9.4 Non-Gas Contact Bladder Pump

- Non-gas contact bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting(s)
- Toolbox supplements - to work with submersible pump
- Pump control box (if necessary)

9.5 Suction Pump (Peristaltic, Centrifugal, or Diaphragm)

- Pump
- 1" PVC coil tubing - enough to dedicate to each well
- Car Battery (or other power source)
- Toolbox
- Tube fittings
- Flow meter with gate valve

9.6 Inertia Pump

- Pump assembly

10.0 STANDARDS AND REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in SOP #FLD-02, Sampling Equipment Decontamination.

11.0 PROCEDURES

11.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e, diameter and depth of wells to be sampled, sampling analytes).

2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 milliliter (mL) glass sample vials with Teflon lined septa are ordered in sufficient numbers. Check sampling supplies; filed kit of

chlorine, preservatives, foam sleeves, and coolers. Due to the extreme levels at which volatile organics are detectable, cross-contamination and the introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross-contamination.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific HASP.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations followed by a GPS point (see GPS Trimble® GeoXT 2008 series SOP FLD 07.00).

11.2 Field Preparation

1. Start at the least contaminated well, if known and possible.

2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.

6. Lower water level measuring device or equivalent (i.e., interface probe) into well until water surface or Non-Aqueous Phase Liquids (NAPL) is encountered.

7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head. If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe which measures floating organics.

8. Measure total depth of well (at least twice to confirm measurement and determine presence or absence of NAPL) and record in site logbook or on field data sheet.

9. If casing volume method is used, calculate the volume of water in the well and the volume to be purged using the calculations in Section 12.0.

10. Select the appropriate purging and sampling equipment.

11. If residual chlorine is suspected (Volatile Organic Analysis [VOA] sampling only), use the Hach® Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

11.3 Purging Equipment and Operation

The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program as well as the hydro-geologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred. The media is considered stable when 3 measurements taken 1 minute apart indicate +/- 5% difference within the parameter.

However, monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

11.3.1 Bailers

Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

Purging with a bailer is best suited for shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more efficient.

11.3.1.1 Operation

Equipment required includes a clean, decontaminated bailer, Teflon or nylon line, a sharp knife, plastic sheeting, a 5-gallon bucket or pail of a known volume and a container for Investigation Derived Waste (IDW).

1. Determine the volume of water to be purged as described in Section 12.0.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with foreign materials.

3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.

6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site-specific SAP.

11.3.2 Submersible Pumps

The use of submersible pumps for sample collection is permissible provided they are constructed of suitable, non-contaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. Therefore, the use of submersible pumps in multiple well sampling programs should be carefully considered against other sampling mechanisms (e.g. bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump; however, submersible pumps may be the only practical sampling device for extremely deep wells (>300 feet of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use one of two types of power supplies: electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also utilize compressed gas (e g., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

11.3.2.1 Operation

1. Determine the volume of water to be purged as described in Section 12.0.

2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.

3. Assemble pump, hoses and safety cable, and lower the pump to the desired sampling interval. Make sure that a sufficient column of water is above the pump (running the pump without water may cause damage).

4. Attach a flow meter to the outlet hose to measure the volume of water purged.

5. Use a GFCI or ground the generator (if used) to avoid possible electric shock.

6. Attach a power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc. have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.

7. Collect and dispose of purge waters as specified in the site-specific SAP.

11.3.3 Non-Contact Gas Bladder Pumps

For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing. Teflon may also be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

11.3.3.1 Operation

1. Assemble the Teflon tubing, pump and charged control box.

2. The procedure for purging with a bladder pump is the same as for a submersible pump (Refer to Section 7.3.2.1).

3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

11.3.4 Suction Pumps

There are many different types of suction pumps. They include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross-contamination. Suction pumps require a power source of some kind to operate.

11.3.4.1 Operation

1. Assemble the pump, tubing, and power source, if necessary.

2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 11.3.2.1).

11.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump are manually operated. They are most appropriate to use when wells are too deep to bail by hand, are too shallow, too narrow, or inaccessible to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

11.3.5.1 Operation

1. Determine the volume of water to be purged as described in Section 12.0.

2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.

3. Assemble pump and lower to the appropriate depth in the well.

4. Begin pumping manually, discharging water into a 5-gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH, conductivity, etc. have stabilized).

5. Collect and dispose of purge waters as specified in the site-specific SAP.

11.4 Sampling Equipment and Operation

Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection.

The following sections detail factors to be taken into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

11.4.1 Bailers

The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

11.4.1.1 Operation

1. Surround the monitor well with clean plastic sheeting to prevent contamination of tubing. If using a bailer, insert a vial into the claim and assemble the unit.

2. Attach a line to a clean decontaminated bailer.

3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.

4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface, remove the bailer from the cable. Carefully open the GPI bailer unit and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate samples from the midstream sample.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated. See Section 11.7 for special considerations on VOA samples.

6. Begin slowly pouring from the bailer.

7. Filter and preserve samples as required by site-specific SAP.

8. Cap the sample container tightly and place pre-labeled sample container in a carrier.

9. Replace the well cap.

10. Log all samples in the site logbook and on field data sheets, and label all samples.

11. Package samples and complete necessary paperwork.

12. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

11.4.2 Submersible Pumps

Although it is recommended that samples not be collected with a submersible pump due to the reasons stated in Section 11.3.2, there are some situations where they may be used.

11.4.2.1 Operation

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.

2. Attach the gate valve to the hose (if not already fitted), and reduce flow of water to a manageable sampling rate.

3. Assemble the appropriate bottles.

4. If no gate valve is available, run the water down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place the pre-labeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets, and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. Upon completion, remove the pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

11.4.3 Non-Contact Gas Bladder Pumps

The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

11.4.3.1 Operation

1. Allow well to recharge after purging.

3. Assemble the appropriate bottles.

4. Turn the pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

5. Cap the sample container tightly and place pre-labeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on field data sheets, and label all samples.

8. Package samples and complete necessary paperwork.

9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.

10. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new, dedicated tubing and bladder or rigorously decontaminate the existing materials.

11. Non-filtered samples shall be collected directly from the outlet tubing into the sample bottle.

12. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build-up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

11.4.4 Suction Pumps

In view of the limitations of these type of pumps, they are not recommended for sampling purposes.

11.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer.

11.4.5.1 Operation

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Since these pumps are manually operated, the flow rate may be

regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.

4. Cap the sample container tightly and place pre-labeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets, and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

11.4.6 Sample Retrieval - Syringe

A limited number of commercial syringe type samplers are available (IEA, TIMCO, etc.) for groundwater sampling. These devices are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they operate with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe, if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials.

11.5 Filtering

For samples requiring filtering, such as dissolved metals analyses, the filter must be decontaminated prior to and between uses. Filters work by two methods. The first method is the barrel filter. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter media (PTFE or paper, etc. with minimum size 0.45 micrometer (µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 pounds per inch (lbs/in) by periodic pumping. The second filter method is the vacuum filter. A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain the entire sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

11.6 Post Operation

After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport groundwater samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

11.7 Special Considerations for VOA Sampling

The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample. When collecting duplicates, collect both samples within as close of an amount of time as possible.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not over tighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least 10 seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial (if sampling with a pre-preserved vial, discard vial and sample with a new vial; however, topping off the vial may be attempted if the vial has sufficient preservative).
5. Immediately place the vial in the protective foam sleeve and place into the cooler.

6. The holding time for VOAs is 14 days preserved, 7 days unpreserved. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4 degrees Celsius, but do not allow them to freeze.

12.0 DATA RECORDS AND MANAGEMENT

If it is necessary to calculate the volume of the well, utilize the following equation:

Well volume = nr^2h (cf) [Equation 1]
where:
n = pi
r = radius of monitoring well (feet)
h = height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (gal/ft) = 7.483 gal/ft [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2", 3", 4", or 6". If the monitor well diameter is known, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

v(gal/ft) = nr^2(cf) [Equation 2]
where:
n = pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft)

For a 2" diameter well, the volume per linear foot can be calculated as follows:

v(gal/ft) = nr^2(cf) [Equation 2]
3.14 (1/12 ft)^2 (7.48 gal/ft 3)
0.1632 gal/ft

Remember that if you have a 2" diameter well, you must convert this to the radius in feet to be able to use the equation.
The conversion factors for the common size monitor wells are as follows:

Well diameter	2"	3"	4"	6"
Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

If you utilize the conversion factors above, Equation 1 should be modified as follows:

Well volume = (h)(cf) [Equation 3]
where:
h = height of water column (feet)
cf = the conversion factor calculated from Equation 2. The well volume is typically tripled to determine the volume to be purged.

Additionally, water quality (pH, temperature, ORP, conductivity, and turbidity) and purge data should be recorded. Supplemental information such as well construction, screening interval, and casing diameter data should also be available and recorded in field notes.

13.0 QUALITY CONTROL AND ASSURANCE

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general quality assurance procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

3. The collection of equipment or rinsate blanks is recommended to evaluate potential for cross-contamination from the purging and/or sampling equipment.

4. Trip blanks are required if analytical parameters include VOAs.

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Attachment 2
Data Management Checklist

Data Management Checklist for the Red and Bonita Bulkhead Test Closure

The primary objective of this document is to ensure high-quality data is collected and properly backed up and stored in the proper locations outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado, and execution plan, as well as inform participants in the Red and Bonita Test Closure of the types of data being collected and their associated storage locations.

The following describes the data management plan specific to each type of data collected. All data described herein will be collected by MSI personnel on an EDCD and saved in the MSI Dropbox account to facilitate backing up of files immediately upon return to internet connectivity. Additional data redundancy will include uploading of raw data to EPA Sharepoint as well as regular backups of all data to the MSI server.

Draining Mines Data:

Types of data collected:

- Discharge
    - A discharge measurement will be collected weekly from the flume if available and calculated with the Ha measurement after the flume has been scraped and using the associated rating table.
    - If there is no flume, alternate discharge methods may be utilized to obtain the measurement.
    - Discharge data will be recorded on the (EDCD) and stored in the Excel master working document specific to each site.

- Water quality (pH, conductivity, temperature)
    - MSI will conduct weekly visits to the draining mines in the attached site list to collect water quality data. (Figure 1)
    - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site.

- Water Chemistry
    - 3 sampling events planned (Figure 1)

Water samples will be documented in Survey 123 according to the standard protocol. outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

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Data Flowpaths:

1. Raw data is downloaded from instruments using an EDCD and saved to the MSI Dropbox account.
2. Raw data is uploaded upon return from the field to the following EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > Raw >Draining Mines > Site Specific Folder

3. MSI staff will QA/QC flow data to Level 2 and upload master working files and plots to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > QC'd >Draining Mines > Site Specific Folder
4. EPA will update the dashboard for participants to view.

Stream Gauge Data:

Types of data collected:

- Pressure transducer temperature, pressure, and depth data.
    - MSI will download pressure transducers weekly from select sites. (Figure 1)
- Discharge
    - A discharge measurement will be collected weekly from selected stream gage sites using a Hach flow meter or portable flume.
- Water quality (pH, conductivity, temperature)
    - MSI will conduct weekly visits to the selected stream gauges in the attached site list to collect water quality data. (Figure 1)
    - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site. (Figure 1)
- Water Chemistry
    - 3 sampling events planned (Figure 1)

Water samples will be documented in Survey 123 according to the standard protocol.
outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining
District, San Juan County, Colorado.

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Data Flowpaths:

1. Raw data from pressure transducers is downloaded from instruments using an EDCD and into the MSI Dropbox account.
2. Raw data is uploaded upon return from the field to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > Raw >Stream Ga > Site Specific Folder
3. MSI staff will QA/QC pressure transducer depth data to Level 1 and upload master working files and plots to the EPA Sharepoint folder.
    a. Documents > Data Management team > 01 Data > MSI > QC'd >Stream Gauges > Site Specific Folder
4. Water sampling data is recorded in the field utilizing Survey 123 according to the protocols outlined in the BPMD QAPP Rev 4_2020.
5. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.
6. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
7. EPA will update the dashboard for participants to view.

Dry Mines or Adits:

- Photographs
  - MSI personnel will document in Survey 123 with photographs verifying that there is no new discharge from dry mines or adits.
- Frequency of data collection
  - Weekly at selected sites (Figure 1)
- Collect a water sample if new flows are detected
  - Water samples will be documented in Survey 123 according to standard protocol.
- Water quality data will be collected if new flows are detected.

Data Flowpaths:

Water sampling or dry mine or adit data is recorded in the field utilizing Survey 123 according to the protocols outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

1. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.
2. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
3. EPA will update the dashboard for participants to view.

Seeps and Springs:

Types of data collected:

- Discharge
  - Discharge measurements will be collected utilizing a variety of methods if there is a quantifiable flow.
- Water quality (pH, conductivity, temperature)
  - MSI will conduct weekly visits to the selected seeps and springs in the attached site list to collect water quality data. (Figure 1)
  - Water quality data will be recorded on the EDCD and stored in the Excel master working document specific to each site. (Figure 1)
- Water Chemistry
  - 2 sampling events planned. (Figure 1)

Water samples or dry seeps will be documented in Survey 123 according to the standard protocol outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

Data Flowpaths:

Data is recorded in the field utilizing Survey 123 according to the protocols outlined in the CDM Smith. 2020. Quality Assurance Project Plan, Bonita Peak Mining District, San Juan County, Colorado.

1. Upon return from the field Survey 123 data will be reviewed for accuracy and checked against the eCOC if samples were collected.

2. The data from the Survey 123 data will be sent to the Survey 123 online platform and will be available on the EPA ArcGIS website.
3. EPA will update the dashboard for participants to view.