Appendix 4D – Flow Tracker Brochure and Operating Manual
Standard Features

- Low-profile 2-D ADV water velocity sensor on 2m flexible cable (measure in depths down to 2cm (1 inch))
- Automatic discharge computation protocols (ISO/USGS mid-section, mean-section, and Japanese)
- Handheld keypad interface with real-time display
- Velocity methods: ISO, USGS, under ice, Kreps, 5-point, and multipoint
- Languages supported: English, Spanish, German, Italian, and French
- Recorder space: up to 64 discharge measurements or over 150,000 individual velocity samples
- Data Set Documentation: up to 20 values of time-stamped user comments including gauge height and rated flow
- QA/QC: automated data review and discharge uncertainty calculations
- Communication protocol: RS232
- Software: Windows software with diagnostic beam-check, recorder access, data visualization and customizable reports
- Compatible with FlowPack Velocity Indexing software
- Temperature sensor
- Hard plastic case

Optional Features

- 2-D/3-D ADV side-looking probe
- 3m flexible cable
- Deluxe SonTek two piece, top-setting wading rod kit (1.2m Metric or 4 ft English) including case and mounting brackets
- Wading rod mounting bracket for controller/keypad
- Offset mounting bracket for ADV probe

Specifications

- Velocity range: ±0.001 to 4.0 m/s (±0.003 to 13 ft/s)
- Velocity resolution: 0.0001 m/s
- Velocity accuracy: ±1% of measured velocity, ±0.25 cm/s
- Sampling volume location: 10 cm from center transducer
- Power supply: 8 AA batteries
- Typical battery life: 25+ hours continuous operation (alkaline batteries)
- Weight: 1.8 kg/4.0 lbs
- Probe width: 130 mm (5.1 inches)
- Handheld controller/keypad: temporarily submersible to 1m
- Operating temperature: -20 °C to 50 °C
- Storage temperature: -20 °C to 50 °C

SonTek/YSI, founded in 1992 and advancing environmental science in over 100 countries, manufactures affordable, reliable acoustic Doppler instrumentation for water velocity measurement in oceans, rivers, lakes, harbors, estuaries, and laboratories. Headquarters are located in San Diego, California. Additional information can be found at www.sontek.com. SonTek/YSI is an employee-owned company.

SonTek, ADV and FlowTracker are trademarks of SonTek/YSI Inc., San Diego, CA USA

The FlowTracker is made in the USA. FT Brochure 10/06, Rev. 4 - Oxford Group
FlowTracker in the Field

With rugged construction for any climate and a backlit display easily read during both day and night, the FlowTracker goes wherever you need it to go.

- Natural Streams
- Irrigation Canals
- Mining Channels
- Water Treatment
- Weirs/Flumes
- Storm Water
- Open Channels
- Lakes

The FlowTracker Advantage

It doesn’t matter if you are new to acoustic Doppler technology, or an old familiar friend, the FlowTracker provides unparalleled benefits you will only find with SonTek/YSI systems. Here is some of what sets the FlowTracker apart.

- Multi-language instrument and software (English, Spanish, French, Italian, and German)
- Proven velocity precision - accurate to as low as 0.001 m/s (0.003 ft/s) and up to 4.0 m/s (13 ft/s)
- Automatic discharge calculation - International techniques, including ISO and USGS standards
- Record changing gauge heights and rated flows, with comments in each measurement
- Automatic discharge uncertainty calculation to ISO standard

A FlowTracker First!

- Measure velocities in water as shallow as 2 cm (less than 1 inch)
- Keypad interface with real-time velocity and flow display
- Automatic quality control for accurate data collection
- Two or three dimensional velocity measurement
- Recorded data is shielded from power loss
- Lightweight, rugged, and waterproof
- No calibration required - ever!
- Built-in temperature sensor

FlowTracker Software Speaks Your Language

The FlowTracker comes with user-friendly, data analysis software that helps you produce attractive, customizable and professional reports in minutes. FlowTracker software also supports several languages, making it an ideal solution for international applications.

Example of FlowTracker discharge software and reports

Sound Principles. Good Advice.
Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for Operation of the SonTek® FlowTracker® Handheld ADV®

Version 1.0

Author – Tyler W. Burks, EOS FMU
Date – February 26, 2009

Reviewer – Mitch Wallace, EOS FMU
Date – March 30, 2009

QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date –

EAP058

APPROVED: June 24, 2009

Signatures on File
Please note that the Washington State Department of Ecology’s Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.
SOP Revision History

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Environmental Assessment Program

Standard Operating Procedure for Measuring Stream Discharge using the SonTek® FlowTracker® Handheld ADV®

Introduction

The SonTek® FlowTracker® Handheld Acoustic Doppler Velocimeter (FlowTracker) is the primary instrument used for measuring surface freshwater discharge in wadeable streams by the Environmental Assessment Program (EAP) Freshwater Monitoring Unit (FMU). The FlowTracker ADV operates at an acoustic frequency of 10 MHz and measures the phase change caused by the Doppler shift in acoustic frequency that occurs when a transmitted acoustic signal reflects off particles in the flow of water. The magnitude of the phase change is proportional to the flow velocity. In cooperation with the United States Geological Survey, SonTek/YSI Inc. adapted this previously lab-restricted technology for use by hydrographers in wadeable streams, via a Top-set wading rod.

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Freshwater Monitoring Unit (FMU) Standard Operating Procedure (SOP) for measuring stream discharge using the SonTek FlowTracker Handheld ADV.

1.2 The procedure for operation, maintenance, quality assurance, and data management for producing a surface water measurement with the FlowTracker is summarized in this document. The information hereafter is for quick reference and FMU relative supplementary information and is not a substitute for the SonTek FlowTracker Quick Start Guide, User’s Manual, or the more in-depth Technical Manual.

2.0 Applicability

2.1 This procedure is followed when conditions warrant a wading discharge measurement. Certain steps in this procedure (i.e. maintenance and quality assurance) can be followed out of sequence during periodic maintenance or office processing of a discharge measurement.

3.0 Definitions

3.1 Acoustic Doppler Velocimeter (ADV): An instrument that measures stream velocity by sensing the phase change caused by the Doppler shift in acoustic frequency that occurs when a transmitted acoustic signal reflects off particles in the flow.

3.2 Boundary: An underwater obstacle that impedes the transmission or receipt of the acoustic signal by the FlowTracker. The sampling range self-adjusts to some boundaries but may dramatically reduce recorded maximum velocity. The degree of interference is reported as the Boundary QC.
3.3 Cross-section: A vertical plane oriented perpendicular to the stream flow direction that extends from bank to bank and from the channel substrate to the water surface.

3.4 Discharge: The volume of water in a stream passing a given point at a given moment in time and is determined by measuring the stream channel cross sectional area and the water’s mean velocity at the site selected.

3.5 QA Thermistor: An analytical probe comprised of thermally sensitive resistors used to measure water temperature for quality assurance purposes.

3.6 Quality control (QC) data: In addition to velocity, the FlowTracker records several quality control parameters. These include signal-to-noise ratio (SNR), standard error of velocity, boundary adjustment, the number of spikes filtered from data, and velocity angle. For details about quality control data, see §8.1 of this document.

3.7 Signal-to-noise ratio (SNR): The ratio of the received acoustic signal strength to the ambient noise level. It is expressed in the logarithmic unit of decibels (dB), and is the most important quality control data for the FlowTracker. Without sufficient SNR, the FlowTracker cannot measure velocity.

3.8 Standard error of velocity (\( \sigma_V \)): A direct measure of the accuracy of the mean velocity data. \( \sigma_V \) is calculated by dividing the standard deviation of one-second samples by the square root of the number of samples.

4.0 Personnel Qualifications/Responsibilities

4.1 Personnel should possess knowledge of safely conducting discharge measurements by wading methods.

4.2 Anyone tasked to make a wading discharge measurement that has secured a FlowTracker from the FMU equipment pool.

5.0 Equipment, Reagents, and Supplies

5.1 2-D ADV Probe attached to FlowTracker Handheld Unit (Handheld Unit).
5.2 Top-Set Wading Rod with ADV Probe Mount and bubble level.
5.3 Mounting bracket for Handheld Unit.
5.4 Phillips-head screwdriver.
5.5 Discharge Measurement Notes Form (ECY 040-56 (Rev. 12/07)).
5.6 Personal Floatation Device.
5.7 Engineer’s Rule Measuring Tape (graduated in 10ths of feet to an appropriate length) and two stakes (or means to secure measuring tape).
5.8 Attire suitable for entering the stream.
5.9 RS-232 Communication Cable.
5.10 External Computer with SonTek Software installed (SonTek FlowTracker v2.11, SonUtils v4.00, and all versions of the manual).
5.11 Large container of turbid water (i.e. 5 gallon bucket or rectangular plastic tote).
6.0 Summary of Procedure

6.1 Instrument Assembly

6.1.1 Remove 2-D ADV Probe, Handheld Unit, Mounting Bracket, and screwdriver from the protective case.

6.1.2 Attach Mounting Bracket via thumbscrews to the two threaded holes on the back of the Handheld Unit.

6.1.3 Insert the Mounting Post of the ADV Probe into the ADV Probe Mount on the Top-Set Wading Rod; tighten the Phillips-head setscrew with the supplied screwdriver.

(SonTek/YSI, Inc., 2006)

6.1.4 Place the Mounting Bracket on the post extending from the top of the Top-Set Wading Rod; tighten the bracket using the black plastic-capped setscrew.

(SonTek/YSI, Inc., 2006)
6.2  **Pre-Measurement Diagnostics**: are performed both in the office and field environment in order to verify proper system function. *BeamCheck* is a SonTek diagnostic tool used to test and track the integrity of the ADV Probe in a controlled environment before the unit is taken to the measurement location. Additionally, there are procedures that are followed in the field before the measurement is started to assure system function.

6.2.1  *BeamCheck* is conducted prior to deployment for a typical weeklong field excursion, after an extended period of non-use, or potential damage to the FlowTracker is suspected.

6.2.1.1  Fill a container (five-gallon bucket or rectangular plastic tote) with at least 12 inches of water. This water must be turbid enough to reflect the transmitted acoustic pulses back to the receivers at the ADV Probe. If using tap water, add a handful of fine-grained dirt and stir into the container until suspended.

6.2.1.2  Connect the RS-232 Communication cable between an external computer and the threaded 5-pin connector to COM port at the base of the Handheld Unit.

6.2.1.3  Start up the external computer.

6.2.1.4  Turn the Handheld Unit on by holding down the yellow button on the keypad.

6.2.1.5  Run the *FlowTracker* software v2.11 (click **Start** | **Programs** | **SonTek Software** | **FlowTracker**).

6.2.1.6  Click **Connect to a FlowTracker**. Select the correct COM port and click **Connect**.

6.2.1.7  Click **BeamCheck**

6.2.1.8  Submerge ADV Probe in turbid water assuring that it is a minimum of 2 inches from the bottom of the container and ideally 8-12 inches from the edge of the container. It is important however that a boundary does exist.

6.2.1.9  In the upper right of the *BeamCheck* window, click **Averaging**.

6.2.1.10  Click **Start** then quickly click **Record**.

6.2.1.10.1  The software will log the *BeamCheck* session to a file.

6.2.1.10.2  Use the following file naming convention: FT*-YYYY-MM-DD.bmc. (*Depends on the EAP assigned number to that particular FlowTracker unit).

6.2.1.10.3  Save the file to the external computer for future archiving.

6.2.1.11  After recording a minimum of 20 pings click **Stop**.
6.2.11.1 The number of recorded pings is monitored in the upper left corner of the BeamCheck window.

6.2.11.2 The following diagram is an example of a near ideal Beam Check session:

![Beam Check Diagram]

6.2.11.3 Refer to SonTek/YSI FlowTracker Technical Manual (§6.5.5) for detailed explanation of the sample diagram. Refer to SonTek/YSI FlowTracker Technical Manual (§6.5.6) for assistance with diagnosing potential hardware problems using BeamCheck.

6.2.12 Click File | Exit to close BeamCheck.

6.2.13 Click Disconnect.

6.2.14 Disconnect the RS-232 Communication cable from the Handheld Unit and external computer.

6.2.15 Press and hold the yellow power button on the Handheld Unit until the screen is blank.

6.2.16 Disassemble the FlowTracker and secure for departure.
6.2.2 *Field Diagnostics* are performed, with the instrument assembled, prior to each discharge measurement or periodically throughout the field excursion to confirm operation and capacity of the instrument.

6.2.2.1 The **Recorder Status** option checks the amount of space available on the 4-MB internal memory of the Handheld Unit.

6.2.2.1.1 Press and hold the yellow power button to turn on the unit.

6.2.2.1.2 Press **Enter** for the Main Menu

6.2.2.1.3 Press 2 to access System Functions

6.2.2.1.4 Press 2 to access Recorder Status

6.2.2.1.4.1 The number of files recorded and the maximum number of files available will be reported. On 4-MB of internal memory approximately 64 measurements can be conducted before the memory must be reformatted (erased).

6.2.2.1.5 Press **Enter** to return to the System Functions menu

6.2.2.1.6 If you have concerns regarding the amount of space available, Press 3 to Format Recorder.

6.2.2.1.6.1 Before the internal memory is erased be sure to download the data to an external computer, or confirm with others that the data has been properly archived. Once the memory is reformatted, the previous data is non-recoverable.

6.2.2.1.7 Press “1” “2” “3” and **Enter** to confirm your decision.

6.2.2.1.8 Press **Enter** after the format is complete to return to the System Functions menu. This process will take approximately 15-60+ seconds.

6.2.2.2 **Temperature Data** should be checked for accuracy because it is used for sound speed calculations and can affect velocity data.

6.2.2.2.1 Place the ADV Probe in the water that is to be measured.

6.2.2.2.2 From the **System Functions** menu Press 4 to access temperature data.

6.2.2.2.2.1 The temperature sensor is in the probe head and is accurate to ±0.1°C. The temperature recorded is used for automatic sound speed correction.

6.2.2.2.3 This temperature value should be compared to an independent measurement of water temperature (QA Thermistor) before a measurement is conducted. A difference of 5°C between the two values could result in an error of 2% in mean velocity determination.
6.2.2.2.4 Press Enter to return to the System Functions menu.

6.2.2.3 Battery Data should be checked prior to each measurement to confirm that there is capacity to complete the measurement.

6.2.2.3.1 From the System Functions menu Press 5 to access battery data.

6.2.2.3.1.1 The battery voltage and estimated remaining capacity (percent of total) based on voltage will be displayed for three battery types. In most cases, Alkaline or NiMH batteries are available.

6.2.2.3.1.2 Alkaline batteries have an average continuous running time of 25 hours, with a “drained” voltage of 7.0 V.

6.2.2.3.1.3 NiMH (1600mAh) batteries have an average continuous running time of 15 hours, with a “drained” voltage of 8.0V. If the alkaline voltage drops, below ≈ 8.0 V, the batteries should be changed. Batteries cannot be changed during a measurement without the possibility of losing data.

6.2.2.3.1.4 It is important to check the battery data at ambient temperature because capacity can vary greatly with environmental conditions.

6.2.2.3.2 Refer to SonTek/YSI FlowTracker Technical Manual (§7.2) for further information regarding the Handheld Unit Power Supply.

6.2.2.3.3 Press Enter to return to the System Functions menu.

6.2.2.3.4 The batteries are accessed from the back of the Handheld Unit.

6.2.2.3.4.1 Turn the system off by holding down the yellow power button.

6.2.2.3.4.1.1 Special Note: Each time the Handheld Unit is turned off, it is critical that you do so from the Main Menu. This ensures that all information is properly saved.

6.2.2.3.4.2 Remove the six screws holding the battery compartment lid to the main housing.

6.2.2.3.4.3 Remove the old batteries from the battery holder.

6.2.2.3.4.3.1 Place all discharged single-use alkaline batteries in a receptacle for proper recycling, or recharge NiMH batteries for later reuse.

6.2.2.3.4.4 Install the new batteries, matching the orientation shown on the battery holder.

6.2.2.3.4.5 Secure the battery compartment lid using the six screws.
6.2.2.3.4.6 Turn the system on and check the battery voltage level as described in §6.2.2.3.1 of this document.

6.2.2.3.4.6.1 New alkaline batteries will show approximately 12.0V, where NiMH will show approximately 10.5V.

6.2.2.4 Confirm the **System Clock** displays the correct date and time (PST).

6.2.2.4.1 From the System Functions menu Press 9 to access Set System Clock.

6.2.2.4.2 If time and date are accurate Press 0 to exit back to the System Functions menu.

6.2.2.4.2.1 Change Date if not accurate.

6.2.2.4.2.1.1 Press 1 to change Date.

6.2.2.4.2.1.2 Type date on keypad YYYY/MM/DD. Use “.” for “/.”

6.2.2.4.2.1.3 Press **Enter** to return to Set System Clock menu.

6.2.2.4.2.2 Change Time (PST) if not accurate.

6.2.2.4.2.2.1 Press 2 to change Time.

6.2.2.4.2.2.2 Type time on keypad HH:MM:SS. Use “.” for “:.”

6.2.2.4.2.2.3 Press **Enter** to apply the set time and return to the Set System Clock menu.

6.2.2.4.2.3 Press 0 to exit back to the System Functions menu.

6.2.2.4.3 Press 0 to exit back to the Main Menu.

6.3 **Setup Parameters** determine how the FlowTracker collects data and establishes quality control criteria. In most cases these settings will not vary from the USGS (Blanchard, 2007) recommended defaults. Instances of deviation will be mentioned below. It is however important to verify the setup parameters prior to deployment. (**Special Note:** Press **Enter** to scroll through the **Setup Parameters** menu)

6.3.1 The **Units System** defines the units used for display and output data.

6.3.1.1 From the Main Menu Press 1 to enter the **Setup Parameters** menu

6.3.1.2 Confirm that the Unit System is “English.”

6.3.1.2.1 To change, Press 1 from the **Setup Parameters** menu.
6.3.1.2.2 Press 1 to change the **Units System** to “English.”

6.3.2 The **Avg Time** (averaging time) option determines the period of sampling (in seconds) for data collection at each station.

6.3.2.1 The current averaging time will be displayed in parentheses to the right of **Avg Time**.

6.3.2.2 Confirm that the **Avg Time** is 40 seconds.

6.3.2.3 To change, Press 2 from the **Setup Parameters** menu.

6.3.2.3.1 In normal measuring conditions the averaging time is 40 seconds which conforms to EAP FMU and USGS standards.

6.3.2.3.2 In certain measurement conditions (Shedd, 2009) it is necessary to increase or decrease the averaging time. The desired time can be entered on the keypad during step 6.3.2.3.

6.3.3 The **Data Collection Mode** (**Mode**) option determines the procedure when collecting a series of measurement stations.

6.3.3.1 The current data collection mode will be displayed to the right of **Mode**.

6.3.3.2 Confirm that the **Mode** is set to “Discharge.”

6.3.3.3 To change, Press 3 from the Setup Parameters Menu.

6.3.3.4 Press 1 to set the mode to “Discharge”, or Press 2 to set the mode to “General.”

6.3.3.4.1 Typical discharge measurements require the **Mode** be set to “Discharge.”

6.3.3.4.2 The “General” mode is reserved for the storage of location and velocity information without discharge calculation. This mode will not be discussed further in this document. Refer to SonTek/YSI FlowTracker Technical Manual §4.2.2 for further information.

6.3.4 The **QC Settings** menu sets quality control criteria for discharge measurements. To access the **QC Settings** menu Press 4 from the Setup Parameters menu, this grants you access to multiple criteria.

6.3.4.1 Press 1 to set the **SNR Threshold**.

6.3.4.1.1 The **SNR Threshold** should be set to 10dB, which conforms to EAP FMU and USGS standards.

6.3.4.1.2 The optimal operating range is 10dB; however, the FlowTracker can operate properly at a ratio as low as 4dB. Below 4dB additional seeding material may be required to collect accurate data.
6.3.4.1.3 For additional information regarding the **SNR** refer to SonTek FlowTracker Technical Manual §1.4.2

6.3.4.2 Press 2 to set the **V Threshold** (Standard Error of Velocity Threshold).

6.3.4.2.1 The **V Threshold** should be set to 0.033 feet per second (ft/sec), which conforms to EAP FMU and USGS standards.

6.3.4.2.2 **V** is normally dominated by real variations in the flow and will vary depending on the measurement environment.

6.3.4.2.3 If the threshold is exceeded the observation can be repeated, with an adjustment of location in the cross section if desired. In certain measurement environments threshold exceedances are unavoidable.

6.3.4.2.4 For additional information regarding the **V** refer to SonTek FlowTracker Technical Manual §1.4.3

6.3.4.3 Press 3 to set the **Spike Threshold**.

6.3.4.3.1 The **Spike Threshold** should be set to 10%, which conforms to EAP FMU and USGS standards.

6.3.4.3.2 Spikes in velocity data are inherent in all acoustic Doppler velocity sensors. Spikes have many causes; but typically include: boundaries, highly aerated water, or acoustic anomalies.

6.3.4.3.3 A warning is given after a velocity observation if the percentage of spikes relative to the total number of points exceeds 10%. In the case of a 40 second averaging time this threshold would be 5 spikes.

6.3.4.3.4 If the threshold is exceeded the observation can be repeated, with an adjustment of location in the cross section if desired. In certain measurement environments threshold exceedances are unavoidable.

6.3.4.3.5 For additional information regarding the **Spike Threshold** refer to SonTek FlowTracker Technical Manual §1.4.5

6.3.4.4 Press 4 to set the **Max Velocity Angle**.

6.3.4.4.1 The **Max Velocity Angle** should be set to 20°, which conforms to EAP FMU and USGS standards.

6.3.4.4.2 Velocity angle is defined as the water flow direction relative to the FlowTracker’s X measurement component.
6.3.4.4.3 The following diagram by (Rehmel, 2007) illustrates the probe coordinate system relative to the channel cross section.

(Rehmel, 2007)

6.3.4.4 The FlowTracker’s ability to measure two components of velocity eliminates the requirement for the individual to measure and document flow angles at each station for later use in discharge computation of wading measurements.

6.3.4.5 If the threshold is exceeded the observation can be repeated, with an adjustment of location in the cross section if desired. If however a majority of the channel flow is beyond 20-30° in a single direction (positive or negative) a new location for the measurement cross section should be considered.

6.3.4.6 For additional information regarding the Max Velocity Angle refer to SonTek FlowTracker Technical Manual §1.4.6.

6.3.5 The Discharge Settings menu specifies settings for the discharge calculations and the quality control criteria used for Discharge measurements. To access the Discharge Settings menu Press 5 from the Setup Parameters menu.
6.3.5.1 From the **Discharge Settings** menu Press 1 to confirm the **Equation** used discharge calculation. The current equation used is in parentheses next to the word **Equation**.

6.3.5.1.1 The **Equation** should be set to **Mid Section**, which conforms to EAP FMU and USGS standards.

6.3.5.1.2 If the **Equation** differs Press 1 to set to the **Mid Section** method.

6.3.5.1.3 By selecting the **Mid Section** method this sets **Repeat Depth** and **Repeat Velocity** to “NO.” **Repeat Depth** and **Repeat Velocity** are only used in measurement methods non-standard to the EAP FMU and USGS.

6.3.5.2 From the **Discharge Settings** menu Press 4 to confirm the **Max Section Discharge**, which is the percentage of the total discharge allowed in each section.

6.3.5.2.1 The **Max Section Discharge** should be set to **10%**, which conforms to EAP FMU and USGS standards.

6.3.5.2.2 The default **Max Section Discharge** is **10%**.

6.3.5.2.3 The operator is given an alert during the measurement if a **Rated** discharge is entered, or after the entire measurement is complete. For additional information regarding the **Max Section Discharge** refer to SonTek FlowTracker Technical Manual §1.4.7.

6.3.5.3 From the **Discharge Settings** menu Press 5 to confirm the **Max Depth Change** (default 50%), which is intended to alert the operator of potential depth entry errors.

6.3.5.3.1 If the entered depth differs from the previous or adjacent section by 50% the operator is alerted and prompted to re-enter or accept the value.

6.3.5.3.2 For additional information regarding the **Max Depth Change** refer to SonTek FlowTracker Technical Manual §1.4.8.

6.3.5.4 From the **Discharge Settings** menu Press 6 to confirm the **Max Location Change** (default 100%), which is intended to alert the operator of potential location entry errors.

6.3.5.4.1 With a setting of 100% an alert will be given to the operator if the station spacing changes by two-times or if a station is simply out of order. Stations can be entered out of order, however an alert is given to confirm the entry prior to sorting the location to the correct order.

6.3.5.4.2 For additional information regarding the **Max Location Change** refer to SonTek FlowTracker Technical Manual §1.4.9.

6.3.5.5 From the **Discharge Settings** menu Press 7 to confirm the discharge **Reference** value.
6.3.5.5.1 The discharge **Reference** value is used to compute percent discharge ($%Q$) at each station.

6.3.5.5.2 The operator has the option to compute $%Q$ using a **Rated** or **Measured** discharge.

6.3.5.5.3 **Rated** is the default option, however, if a value is not supplied the **Measured** discharge is used.

6.3.5.5.4 One benefit of entering a **Rated** discharge is that the operator is able to monitor the $%Q$ of each section as the measurement progresses; adding additional sections if necessary.

6.3.5.6 From the **Discharge Settings** menu Press 8 to select the **Methods Displayed**. This allows the operator to select the options available to measure mean velocity at a section.

6.3.5.6.1 The EAP FMU only uses a limited number of the total methods available. The unused methods can be turned off to reduce the number of methods toggled through during a measurement if a method change is required. **Special Note:** To the right of each method the word ON or OFF will be displayed.

6.3.5.6.2 Based on current techniques employed by the EAP FMU the following **Methods** should be toggled to the ON position: **2-6-8 Methods**, and **Multi Methods**.

6.3.5.6.3 Press 1 to toggle ON **2-6-8 Methods**.

6.3.5.6.4 Press 5 to toggle ON **Multi Methods**.

6.3.5.6.5 For additional information regarding the methods available for the measurement of mean velocity in a section refer to SonTek FlowTracker Technical Manual §5.2.4.

6.3.5.7 From the **Discharge Settings** menu Press 9 to confirm the **Uncertainty** calculation.

6.3.5.7.1 The **Uncertainty** calculation should be set to **Stats** (abbreviated from **Statistical**), which conforms to EAP FMU standards. The **Stats** calculation provides an estimate of measurement uncertainty for each discharge calculation.

6.3.5.7.2 In addition to an overall statistical uncertainty calculation uncertainty is split into the following components: accuracy, depth, velocity, and width.

6.3.5.7.3 The **Stats Uncertainty** calculation incorporates measurement uncertainty, natural stream conditions (e.g., different bottom types), and the assumption that depth and velocity change linearly between stations.

6.3.5.7.4 For detailed information regarding the **Stats Uncertainty** calculation refer to SonTek FlowTracker Technical Manual §5.2.5 and Appendix C.
6.3.6 **Salinity**

6.3.6.1 The salinity of the water being measured can affect the sound speed which is used for mean velocity determination.

6.3.6.2 Freshwater has a salinity of <0.5 ppt (parts per thousand) and seawater has a salinity of 35-50 ppt.

6.3.6.2.1 For the purposes of the EAP FMU, it is rare that the FlowTracker will be used in water with a salinity that will affect the sound speed. However, salinity may affect sound speed in estuary (brackish), or polluted waters.

6.3.6.2.2 **IMPORTANT:** When using the FlowTracker in salt water, a sacrificial zinc anode should be installed on the probe for corrosion protection.

6.3.6.3 It has been determined that an error of 12 ppt in salinity creates a 2% error in mean velocity.

6.3.6.4 From the **Setup Parameters Menu** press 6 to change the **Salinity** value (in ppt).

6.3.7 **Language**

6.3.7.1 The FlowTracker firmware can be operated in five different languages: English, French, German, Spanish, and Italian.

6.3.7.2 From the **Setup Parameters Menu** press 7 to change the **Language**.

6.3.7.3 Press 1 to set the firmware to **English**.

6.3.7.4 Consult the FlowTracker Technical Manual §2.4.7 if another language is desired.

6.4 **Discharge Measurement Procedure**

6.4.1 **Summary of Site Selection Criteria**

6.4.1.1 The first and often most critical step in determining the discharge of a watercourse is selecting a representative cross section. The following is a brief summary of site selection criteria that are specific to producing the best results with the SonTek FlowTracker. For a full description of measurement site selection criteria review (Shedd, 2009).

6.4.1.2 The channel is relatively straight for a distance (10-20 channel widths upstream and downstream of the measurement site) to provide uniform flow through the measuring section.

6.4.1.3 Streamflow is perpendicular to the measurement cross section and tagline.
6.4.1.4 The channel is free of obstructions (e.g., vegetation, woody debris, and variable substrate sizes) and excessive turbulence that create negative velocity, uneven velocity distribution across the measurement cross section, or that interfere with the acoustic signal.

6.4.1.4.1 In some cases, especially shallow streams with variable substrate sizes, minor channel modification may be necessary to improve a measurement site.

6.4.1.4.2 Modifications should be minor and conducted prior to the start of the flow measurement. Be mindful of the potential for salmonid redds during appropriate seasons.

6.4.1.5 The water to be measured has sufficient particulate matter (fine sediment, organics, and air) entrained to carry an acoustic signal.

6.4.2 Summary of the Mid-Section Method

6.4.2.1 The following is a brief summary of the mid-section method for determining stream discharge. A full explanation can be found in (Shedd, 2009).

6.4.2.2 The default method (§6.3.5.1) used by the FlowTracker for discharge calculation is the mid-section method. This discharge setting organizes the entered measurement information for the operator and applies the mid-section equation to the data to calculate discharge. Therefore, only working knowledge of the mid-section method is necessary.

6.4.2.3 In order to accurately define the area and mean velocity of the channel, the cross section is divided into multiple segments. A discharge measurement is the summation of the products of the partial areas of the stream cross section and their respective average velocities.

6.4.2.4 In the mid-section method of computing a discharge measurement, it is assumed that the velocity sample at each point represents the mean velocity in a rectangular subsection. The subsection area extends laterally from half the distance from the preceding observation point to half the distance to the next, and vertically from the water surface to the sounded depth (Buchanan and Somers, 1969; Rantz et al., 1982).

6.4.3 Data Collection Procedure

6.4.3.1 Assemble the FlowTracker as described in §6.1 of this document.

6.4.3.2 Select the cross-section location and stretch the tagline perpendicular to the prominent flow direction.

6.4.3.3 Begin filling out Discharge Measurement Notes Form (ECY 040-56 (Rev. 12/07)).
6.4.3.4 Read and record all primary, secondary, and auxiliary gage indices (where applicable).

6.4.3.5 Read and record water temperature for future comparison to both station data and the FlowTracker water temperature sensor.

6.4.3.6 Measurement Header Information

6.4.3.6.1 From the Main Menu Press 3 to Start Data Run

6.4.3.6.2 Press 1 to Name the data file.

6.4.3.6.2.1 Enter the station number (e.g., 45F110) using the keypad. It is similar to a touch-tone phone keypad, where numbers are displayed first then letters. Press the individual key multiple time to reach the desired number or letter.

6.4.3.6.2.2 Press Enter when finished.

6.4.3.6.3 Press 2 to add an extension to the Data File Name. The extension should consist of the 3-digit date as an identifier. Press Enter when finished.

6.4.3.6.4 Review the Data File Name, displayed in parentheses, for accuracy.

6.4.3.6.5 Press 9 to accept the Data File Name.

6.4.3.6.6 Press 1 to enter the Site name, this name will be imported during post-processing into the Hydstra database.

6.4.3.6.6.1 Enter the station number (e.g., 45F110) using the keypad. In this case the letters are displayed first, and then numbers. If a key is needed for a consecutive letter/number combination, wait for the cursor to move to the next space before pressing the keypad.

6.4.3.6.6.2 Press Enter when finished.

6.4.3.6.7 Press 2 to enter Operator Name (initials). Enter your initials using the keypad. In this case the letters are displayed first, and then numbers. Press Enter when finished.

6.4.3.7 Pre-measurement QC Data

6.4.3.7.1 Press 9 to Start.

6.4.3.7.2 Press 8 or QC Menu (in yellow text) to enter gage height, rated discharge, location, and site condition information. This button can be pressed at any point during the measurement to better document conditions throughout the site. For example, multiple entries of Height may be required during a rapidly changing stage. Up to 20 different entries can be added to each measurement file.
6.4.3.7.2.1 Press 1 to enter gage **Height** in feet. This value should be the most recent recorded observation of the primary gage index.

6.4.3.7.2.2 Press 2 to enter the **RatedQ** in ft$^3$/s. A current rating table is required to enter this information. This value is used for comparison to measured discharge both in %Q calculation during the measurement (aides in adjusting width spacing) and a quality control feature at the end of the measurement, showing departure from the current rating. Press **Enter** when finished.

6.4.3.7.2.3 Press 3 to enter the **Time** of the observation if it differs from the current time displayed. Press **Enter** when finished.

6.4.3.7.2.4 Press 4 to enter the **Location** of the observation on the tag line in feet. Press **Enter** when finished.

6.4.3.7.2.5 Press 5 to enter text **Comments** about the measurement cross section or a particular location in the cross section. The “-” button is used to put a space between words. It is advised that this feature only be used for limited text entry. Document additional notes on Discharge Measurement Note Sheet (ECY 040-56 (Rev. 12/07)). Press **Enter** when finished.

6.4.3.7.2.6 By pressing 6 or 7 you are able to navigate between specific observation entries.

6.4.3.7.2.7 Once you have completed pertinent entries press 0 to exit. This will either continue with the beginning of the measurement or return to the present measurement location.

6.4.3.7.3 The operator will next be prompted to **Run** or **Skip** the **Auto QC Test**. The **Auto QC Test** is essentially a field version of **BeamCheck**, but is particular to the present measurement environment. This information is stored with each discharge measurement file and is displayed on the discharge measurement summary.

6.4.3.7.3.1 It is a requirement of all EAP FMU members to conduct an **Auto QC Test** prior to each discharge measurement.

6.4.3.7.3.2 Press 1 to **Run Test**.

6.4.3.7.3.3 The operator will be prompted to put the FlowTracker probe in moving water, away from obstructions. It is suggested that the operator place the probe in a location within the cross section that is representative of the stream to be measured. Set the probe at the 6/10ths depth on the wading rod and Press **Enter**.

6.4.3.7.3.4 The FlowTracker will collect 20 pings and either report that “All Results are Good” or that the test completed with warnings.
6.4.3.7.3.5 If a warning exists Press 1 to **End Test** or Press 2 to **Repeat Test**. If the test is being repeated, move to a different place in the cross section free of potential boundary interference.

6.4.3.7.4 At this point of the procedure you are prompted to enter the **Starting Edge** of the cross section to be measured and will soon be collecting velocity data.

6.4.3.7.4.1 All discharge measurements conducted by EAP FMU members begin at the right edge of water (REW). However the default is the left edge.

6.4.3.7.4.2 Press **LEW/REW (#4)** to toggle between the edges, and set the starting edge to **REW**.

6.4.3.7.4.3 Press **Set Location** to enter the distance on the tagline for the starting **REW**. Press **Enter** when finished.

6.4.3.7.4.4 Some cases exist where the edge of the cross section has a depth (Shedd, 2009), e.g., at a bridge abutment.

6.4.3.7.4.5 Press **Set Depth** to enter the depth of water at the particular location on the tagline. Refer to (Shedd, 2009) for instructions on the use of a top-set wading rod. Press **Enter** when finished.

6.4.3.7.4.6 Press **Next Station (#2)** to continue the measurement.

6.4.3.7.4.7 The following sequence will occur at each successive location of the cross section. Generally, 25-30 observations per cross section are sufficient to define the natural variability of the channel. Narrow channels will have fewer observations due to the fact that spacing between observations is limited to 0.3 feet.

6.4.3.7.4.7.1 Press **Set Location** to enter the location on the tagline of the velocity observation. Press **Enter** when finished. The default observation spacing is one foot. Each successive observation sends you to the next point on the tagline based on the spacing of previous observations.

6.4.3.7.4.7.2 Press **Set Depth** to enter the depth of water at the observation point. Press **Enter** when finished. Each successive observation copies the depth of the previous point.

6.4.3.7.4.7.3 Depending on the depth of water at the observation point, the measurement method (§6.3.5.6) may differ in order to calculate mean velocity. To toggle between the various methods press **Method+**. The actual velocity observation depth (referenced from the bottom-up) is displayed in parentheses. This depth changes with method.

6.4.3.7.4.7.4 When all values are correctly set and the probe is located as desired, press **Measure** to start velocity data collection. Make sure you keep the probe’s X direction perpendicular to the tag line being used to define the stream cross section (see §6.3.4.4.3 of this document).
6.4.3.7.4.7.5 It is possible to recover if you mistakenly press Measure with an incorrect parameter or Method. Press Abort to terminate the measurement (or let the measurement finish), and press 2 to repeat the measurement. Until one measurement is accepted at a station, you have the ability to change all parameters. After one measurement has been accepted, Method can no longer be changed (although other parameters can still be changed).

6.4.3.7.4.7.6 An updating display (right) shows velocity and SNR data. Displayed values represent the running mean of data at that station.

6.4.3.7.4.7.7 Once the measurement time has elapsed, a series of quality control criteria warnings may be displayed, depending on the measurement environment. Below is a series of tables that describes the quality control warnings and recommend action. Sections in this table refer to the FlowTracker Technical Manual.

<table>
<thead>
<tr>
<th>Warning</th>
<th>QC Criteria</th>
<th>Description</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low SNR (§1.4.2)</td>
<td>None</td>
<td>SNR &lt; 4 dB</td>
<td>• Improve SNR (§8.6)</td>
</tr>
<tr>
<td>Beam SNR (§1.4.2)</td>
<td>SNR Threshold</td>
<td>Difference in SNR for any 2 beams is &gt; SNR Threshold.</td>
<td>• Look for underwater obstacles; repeat measurement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Check probe operation (§6.5).</td>
</tr>
<tr>
<td>SNR Variation (§1.4.2)</td>
<td>None</td>
<td>One-second SNR data varies more than expected during a measurement. May indicate underwater interference or a highly aerated environment.</td>
<td>• Look for underwater obstacles; repeat measurement.</td>
</tr>
<tr>
<td></td>
<td>SNR Threshold</td>
<td>SNR more than SNR Threshold different previous measurements; major change in measurement conditions.</td>
<td>• Look for underwater obstacles or other changes in river condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Repeat measurement</td>
</tr>
<tr>
<td>SNR Change (§1.4.2)</td>
<td>SNR Threshold</td>
<td>SNR threshold adjusted based on previous data and measured velocity. May indicate interference or a highly turbulent environment.</td>
<td>• Look for underwater obstacles or a change in conditions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Consider real turbulence levels in river.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Repeat measurement</td>
</tr>
<tr>
<td>High σV (§1.4.3)</td>
<td>σV Threshold</td>
<td>σV &gt; σV Threshold; adjusted based on previous data and measured velocity. May indicate interference or a highly turbulent environment.</td>
<td>• Look for underwater obstacles or a change in conditions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Consider real turbulence levels in river.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Repeat measurement</td>
</tr>
<tr>
<td>Bad Boundary QC (§1.4.4)</td>
<td>None</td>
<td>Boundary QC is FAIR or POOR. Indicates possible interference from underwater obstacles.</td>
<td>• Consider re-locating probe and repeating test.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Measurement can proceed if results are consistent.</td>
</tr>
<tr>
<td>High Spikes (§1.4.5)</td>
<td>Spike Threshold</td>
<td>Spikes &gt; Spike Threshold percent of samples. May indicate poor measurement conditions.</td>
<td>• Look for underwater obstacles or unusual conditions (e.g., aerated water).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Repeat measurement</td>
</tr>
</tbody>
</table>
6.4.3.7.4.7.8 Following the potential quality control warnings a summary of velocity and quality control data is shown. Below is an example of a summary screen.

<table>
<thead>
<tr>
<th>High Angle (§1.4.6)</th>
<th>Max Velocity Angle</th>
<th>Angle &gt; Max Velocity Angle. May only indicate non-ideal measurement environment.</th>
<th>• Consider if measured angle is realistic.</th>
<th>• Repeat measurement if needed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High %Q (§1.4.7)</td>
<td>Max Section Discharge</td>
<td>%Q &gt; Max Section Discharge. Station contains a large portion of the total discharge.</td>
<td>• Consider adding more stations.</td>
<td></td>
</tr>
<tr>
<td>Suspect Depth Value (§1.4.8)</td>
<td>Max Depth Change</td>
<td>Station depth differs from adjacent stations by more than Max Depth Change %. This may indicate a data entry problem.</td>
<td>• Verify station depth value.</td>
<td>• Re-enter if needed.</td>
</tr>
<tr>
<td>Suspect Location Value (§1.4.9)</td>
<td>Max Location Change</td>
<td>Spacing between stations has changed by more than Max Location Change %. This may indicate a data entry problem.</td>
<td>• Verify station location value.</td>
<td>• Re-enter if needed.</td>
</tr>
<tr>
<td>Location Out of Order / Location Outside Edge (§1.4.9)</td>
<td>None</td>
<td>Station location out of sequence or outside river edge. This may indicate a data entry problem.</td>
<td>• Verify station location value.</td>
<td>• Re-enter if needed.</td>
</tr>
</tbody>
</table>

6.4.3.7.4.7.9 Press 1 to **Accept** the data and move to the next station or location in the measurement series (e.g., advancing from the 2/10ths to 8/10ths observation depth). Record location, depth, and mean velocity in the Discharge Measurement Notes after each accepted observation.

6.4.3.7.4.7.10 Press 2 to **Repeat** the measurement, especially if quality control issues arise. When a measurement is repeated, data are not lost. However, you will no longer be able to view the *old* data from the keypad interface. The *old* data are still recorded. Later, the data can be extracted in the raw data file (*.dat) and the measurement summary file (*.sum), but not in the discharge summary file (*.dis).

6.4.3.7.4.7.11 Once a station is completed, the FlowTracker displays the next station. Location, depth, and method data for new stations are predicted using previous stations. If a multiple measurement method was used (e.g., 2/10ths and 8/10ths water depth), the next station will use the same method in the opposite order (i.e.; 8/10ths then 2/10ths depth).

6.4.3.7.4.7.12 Depending on the width and flow characteristics of the stream being measured, steps encompassed in §6.4.3.7.4.7 (through *7.10) will be repeated for approximately 25-30 locations across the cross section.
6.4.3.7.4.7.13 At the end of the cross section, or when an individual station is complete, the operator can review summary data for stations by pressing Next Station and Previous Station. Below is an example of summary information that is displayed.

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Depth</th>
<th>Velocity</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.6(0.54)</td>
<td>1.35</td>
<td>2.25</td>
<td>5°</td>
</tr>
</tbody>
</table>

6.4.3.7.4.7.14 After initial review of the collected data the operator has the option to return to a station and either delete or repeat the observation. This station can be navigated to by pressing Previous Station or Next Station.

6.4.3.7.4.7.15 Whether you are going to repeat or delete a completed station press Delete and the digits 1-2-3 to confirm.

6.4.3.7.4.7.16 If the operator must repeat or “redo” a station enter the location, depth, and measurement method of the station. Follow standard measurement procedures for that station. In most cases the operator will get a warning that the entered location is out of sequence. Press 1 to Accept Value, the new station data will automatically be sorted into the correct position so that discharge calculations are accurate. Data from a deleted station is not lost. However, you will no longer be able to view the old data from the keypad interface.

6.4.3.7.4.7.17 Once all measurement stations are completed press End Section. Depending on the measurement environment the operator is then presented with the summary of all data that has exceeded quality control criteria. Press Enter to review stations with quality control warnings.

6.4.3.7.4.7.18 After the review of stations, the operator has the option to either press 1 to end the section or to press 2 to not end the section. If quality control warnings exist and the measurement can be improved press 2 to return to the cross section for modification.

6.4.3.7.4.7.19 If the section is not ended the operator is returned to the last station. At this point press Set Location to add stations. If the operator is not advanced (Next Station) to the current last station of the measurement pressing Set Location will modify the location of the present station on the display. In order to avoid confusion advance to the last station before adding any additional stations.

6.4.3.7.4.7.20 Once satisfied press End Section, and then press 1 to end the collection of velocity observations.
6.4.3.7.4.7.21 Press QC Menu (§8) to enter the ending gage height from the primary gage index, and any additional observations as described in §6.4.3.7.2 of this document.

6.4.3.7.4.7.22 The operator will then be prompted to enter the ending (LEW) edge of water, enter the respective depth and location.

6.4.3.7.4.7.23 Press Calculate Disch. to finish the measurement. Below is an example of the final measurement summary screens that are displayed. Press Enter to advance through the multiple screens. While reviewing this information, populate the necessary fields of form ECY 040-56 (Rev. 12/07). It is also suggested that V Max, Depth Mean, SNR Mean, V Mean, and H₂O Temperature be written in the remarks portion of the form.

| TotalQ 44.234 cfs | Q Uncertainty 3.5% | Num Stations 27 |
| RatedQ 45.000 cfs | Largest Source | V Mean 1.43 ft/s |
| Difference -1.7% | Num Stations | V Max 2.21 ft/s |
| 0=Exit or Enter=More | 0=Exit or Enter=More | 0=Exit or Enter=More |
| Width 23.000 ft | Depth Mean 2.77 ft | SNR Mean 16.5 dB |
| Area 47.350 ft² | Depth Max 3.15 ft | 0=Exit or Enter=More |
| 0=Exit or Enter=More | 0=Exit or Enter=More | Temperature 61.2°F |
| Start Height 4.900 | File 555312.100 | Site Poudre River FC |
| End Height 5.000 | Mode: Discharge | Operator Billy Bob |
| Change 0.100 ft | 2001/06/25 14:24:15 | 0=Exit or Enter=More |
| 0=Exit or Enter=More |

6.4.3.7.4.7.24 Press 0 to Exit and return to the Main Menu. Once data collection is complete press and hold the yellow power button until the display goes dark, this must be done from the Main Menu otherwise there is a risk of losing data.

6.4.3.7.4.7.25 After each completed measurement disassemble the FlowTracker and return it to its protective case. Extra attention should be given to protecting the integrity of the sensor cable.

6.5 Discharge Measurement Processing

6.5.1 Discharge measurements conducted with the FlowTracker are processed using the software SonTek FlowTracker v2.11. For instructions on acquiring and installing this software refer to the SonTek FlowTracker Technical Manual §6.1.

6.5.2 Discharge measurement processing and software utilization requires connecting the FlowTracker to an external computer. Connect the RS-232 Communication cable between an external computer and the threaded 5-pin connector to the COM port at the base of the Handheld Unit.

6.5.3 Start up the external computer.

6.5.4 Turn the Handheld Unit on by holding down the yellow button on the keypad.
6.5.5 Run the FlowTracker software v2.11 (click **Start** | **Programs** | **SonTek Software** | **FlowTracker**). Below is the FlowTracker software start up window:

![FlowTracker software](image)

6.5.6 Click **Connect to a FlowTracker**. Select the correct COM port and click **Connect**. The operator will be notified if a connection was established. If a connection is not established a red circle will appear in the “connect to serial port” dialog box.

6.5.7 Each FlowTracker measurement is saved to a master file (*.wad), which is composed of many extractable file types that can be used in different settings. Each file type can be extracted at any time from the *.wad. **Important:** *FlowTracker* software does NOT prompt before overwriting the ASCII output files. Be sure any modified files, or files using the same file name, have been moved to a different folder before extracting the ASCII data.

6.5.7.1 From the main software window review the current file export settings.
6.5.7.2 For the proper export settings check the box next to the following three statements: “Show Discharge Summary Report,” “Export ASCII Discharge file (DIS),” and “Put Headers on ASCII files.”

6.5.7.3 “Show Discharge Summary Report” displays the final discharge calculation and measurement summary report in tabular and graphic form. This includes automatic quality control analysis to flag measurements that may include suspect data. Below is an example of a discharge summary report:
6.5.7.4 “Export ASCII Discharge file (DIS)” displays final discharge calculation data and overall measurement summary. The most widely used output file, especially for database integration. It also displays mean temperature, SNR, and flow angle of each vertical. In the instance that a data entry error was discovered prior to database import; this is the only file that is editable. See example below:
6.5.8 From the main software menu click on the “Program Settings” hyperlink. This dialog box allows the operator to specify the output units system, language settings, and (if desired) a fixed output directory for all ASCII output files. See the example below:

6.5.8.1 Set the Unit System and Language to **English**.

6.5.8.2 The *.dis file is electronically archived in the same location as the *.wad master file. Therefore, all files should be exported to the same directory as the master file.

6.5.8.3 It is suggested that an official Department of Ecology logo be placed on the discharge summary report header. Click **Browse** and navigate to H:\FLOWS\Instrumentation\SonTek_FlowTracker\Ecology Logo\LOGO_color_FT.jpg for the current pre-formatted logo.

6.5.8.4 Once satisfied with the Program Settings click **OK** to exit. These settings will now be valid for all measurements opened using the software.

6.5.9 While the FlowTracker is connected to an external computer the operator has access to the **Recorder** dialog box via a hyperlink. See an example of the Recorder dialog box below:
6.5.9.1 Completed discharge measurements are selected using several different methods. The operator can click one file to select it, hold Control or Shift and click a series of files, or click Select All to select all files on the recorder.

6.5.9.2 The default download rate for the Recorder is 57,600 baud. Faster or slower download rates are selectable depending on the external computer. If difficulty arises select a lower baud rate.

6.5.9.3 In most cases the operator will complete batch downloads of measurements. Later these processed measurements will be electronically archived to a gaging station specific directory. It is suggested that an intermediate Destination folder be established on a Department of Ecology (personal or network) drive in which all pre-processed discharge measurements be stored. Click Browse and navigate to this location.

6.5.9.4 Click Download to copy all the selected files to the specified folder. Note: A Cancel control will appear to let the operator abort the download process. Watch the status area at the bottom of the dialog box to view the download progress.

6.5.9.5 From the Recorder dialog box the operator can Format (erase) the internal memory of the FlowTracker, as discussed in §6.2.2.1.5 of this document. The previous discussion outlines how to Format the internal memory using the Keypad. The following steps outline how to Format the internal memory using the software.

6.5.9.5.1 Once it has been confirmed that all measurements have been properly downloaded and are in the proper directory click Format and then OK to confirm the decision to format/erase discharge measurements from the internal memory. As a reminder, once the measurements have been deleted from the FlowTracker’s internal memory the data is non-recoverable.

6.5.9.5.2 Depending on the number of measurements this process could take several minutes. When finished Close the Recorder dialog box and Disconnect the FlowTracker from the external computer.

6.5.9.6 An electronic and hard-copy archive of all FlowTracker discharge measurements is required by the EAP FMU. The following steps outline how to generate a hard-copy.

6.5.9.6.1 Run the FlowTracker software v2.11 (click Start | Programs | SonTek Software | FlowTracker).

6.5.9.6.2 Click the Open a FlowTracker file hyperlink. Browse to the particular discharge measurement that will be processed.
6.5.9.6.3 Prior to opening the *.wad file the file must be renamed. This file name is displayed on the Discharge Measurement Summary and is used to name subsequent export files, such as the *.dis. The name of the *.wad can be renamed by right-clicking on the measurement icon. The electronic file naming convention places station identification number, 4-digit year, 2-digit month, and 2-digit day; all separated by hyphen (e.g., 45F110-2007-07-26.wad).

6.5.9.6.4 Double-click on the measurement icon. This will load measurement data and display the Discharge Measurement Summary.

6.5.9.6.5 Review summary information for the measurement paying particular attention to the Discharge Uncertainty statistics, and Quality Control messages. This information is useful for evaluating the overall quality rating most the measurement. Also, assure that the information contained on the Discharge Measurement Notes Form (ECY 040-56 (Rev. 12/07)) and the Discharge Measurement Summary is consistent.

6.5.9.6.6 In the upper right corner of the Discharge Measurement Summary is the Print icon. Clicking this icon will bring up the print dialog box, which varies depending on the printer being used. In an effort to reduce paper consumption it is suggested that the printer be configured to print two color pages per double-sided sheet. The Discharge Measurement Summary is not editable therefore printing configuration is the only option for paper reduction.

6.5.9.7 Submit the printed Discharge Measurement Summary and the completed Discharge Measurement Notes form for peer review.

6.5.10 Located on the lower left corner of the main software screen are three hyperlinks to the three versions of the FlowTracker manual. These include the User’s Manual, Technical Manual, and Quick Start Guide all in *.pdf format.

7.0 Records Management

7.1 Recorded BeamCheck files are saved using the following file naming convention: FT*-YYYY-MM-DD.bmc. (*Depends on the EAP assigned number to that particular FlowTracker Handheld unit). BeamCheck files are archived on the EAP FMU shared server (H:\FLOWS\Instrumentation\SonTek_FlowTracker\BeamCheck\FT*).

7.2 Field data for discharge measurements are recorded on form ECY 040-56 (Rev. 12/07): Discharge Measurement Notes.

7.3 Master (*.wad) and auxiliary (*.dis) files are saved using the standard file naming convention, e.g., 45F110-2009-02-18.wad.

7.4 Both file types for each measurement are electronically archived on the EAP FMU shared server (H:\FLOWS\Projects), under the specific station name and water year in which the measurement was conducted.
7.5 Once returned from peer review (discussed in §8.7) the Discharge Measurement Summary and Discharge Measurement Notes and all original field discharge measurement notes are stored in central locations at Ecology Headquarters, Regional, and Field Offices.

7.6 A record of peer reviews of all discharge measurements is located in the EAP FMU shared server (H:\FLOWS\QAData).

8.0 Quality Control and Quality Assurance Section

8.1 The FlowTracker records quality control (QC) data with each measurement. QC parameters are automatically reviewed with each measurement and at the completion of a discharge cross section. Below is a summary table of QC parameters, all section hyperlinks are inactive, but, refer to the FlowTracker Technical Manual:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Expected Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNR</td>
<td>SNR is the most important QC parameter.</td>
<td>Ideally &gt; 10 dB</td>
</tr>
<tr>
<td></td>
<td>It measures the strength of the acoustic reflection from particles in the water.</td>
<td>Minimum ≥ 4 dB</td>
</tr>
<tr>
<td></td>
<td>Without sufficient SNR, the FlowTracker cannot measure velocity.</td>
<td></td>
</tr>
<tr>
<td>σV</td>
<td>σV (standard error of velocity) is a direct measure of the accuracy of velocity data.</td>
<td>Typically &lt; 0.01 m/s (0.03 ft/s). Higher in turbulent environment.</td>
</tr>
<tr>
<td></td>
<td>It includes the effects of turbulence in the river and instrument uncertainty.</td>
<td></td>
</tr>
<tr>
<td>Boundary QC</td>
<td>Boundary QC evaluates the measurement environment for interference from underwater obstacles.</td>
<td>BEST or GOOD</td>
</tr>
<tr>
<td></td>
<td>FAIR or POOR results may indicate significant interference from an underwater obstacle.</td>
<td></td>
</tr>
<tr>
<td>Spikes</td>
<td>Spikes in FlowTracker velocity data are removed using a spike filter. Some spikes are common and no cause for concern. Too many spikes indicate a problem in the measurement environment (e.g., interference from underwater obstacles or highly aerated water).</td>
<td>Typically &lt; 5% of total samples. Should be &lt; 10% of total samples.</td>
</tr>
<tr>
<td>Angle</td>
<td>Angle is the direction of the measured velocity relative to the FlowTracker X-axis. Used for discharge measurements only. A good site should have small velocity angles. Large angles may be unavoidable at some sites.</td>
<td>Ideally &lt; 20°</td>
</tr>
<tr>
<td>%Q</td>
<td>%Q is the percentage of the total discharge in a single measurement station. Most agencies have criteria for the maximum %Q.</td>
<td>Typical criteria: Ideally &lt; 5% Maximum &lt; 10%</td>
</tr>
</tbody>
</table>

8.2 If any value exceeds expected criteria, a warning is given. §6.4.3.7.4.7.7 of this document lists different QC warning messages and gives guidelines for interpreting these messages. All QC review criteria can be adjusted or disabled.

8.3 Avoidance of all QC warnings for a particular discharge measurement is difficult and strictly dependent on the stream environment available. However, the feedback given by the FlowTracker allows the operator to address potential QC issues at the measurement site. Addressing QC warnings at the measurement site may require modification of the measurement cross section, repeating velocity observations, adjusting the spacing of observations, adding observations to better define the channel, or choosing a different measurement cross section.
8.4 Upon completion of the measurement (Calc. Discharge) the FlowTracker reports a calculation of overall statistical discharge uncertainty and the largest contributing source. The Stats Uncertainty calculation incorporates measurement uncertainty, natural stream conditions (e.g., different bottom types), and the assumption that depth and velocity change linearly between stations. This uncertainty percentage should be used as guidance to assign a preliminary quality rating.

8.5 As a general guide, if the Overall Uncertainty of the discharge measurement is within two percent the measurement is considered excellent. If Overall Uncertainty is within five percent the quality of the measurement is good. An Overall Uncertainty between five and eight percent is considered fair. The measurement is regarded as poor if the Overall Uncertainty is greater than eight percent.

8.6 In addition to the discharge uncertainty statistics the relative amount of QC warnings incurred during the measurement should be considered. The operator should also consider factors such as cross-section quality, and flow conditions as part of the quality assignment.

8.7 Measurement Review

8.7.1 All FlowTracker measurements are peer reviewed. Reviewed materials include completed Discharge Measurement Notes and the Discharge Measurement Summary. Before review, the measurement is entered to the Hydstra Gaugings database.

8.7.2 The reviewer checks measurement notes to ensure proper measurement procedures were followed and the data reflects the assigned quality code. The Hydstra Gaugings database is checked to verify measurement statistics, stage height, quality assignments, and notes are entered correctly. After the Gaugings database is verified, the reviewer enters his or her initials in the check box provided.

8.7.3 The reviewer compares the Discharge Measurement Summary to the Discharge Measurement Notes to evaluate potential discrepancies of location, depth, and velocity. Measurements are also checked for the completion of the Auto QC Test and a review of QC warnings present. Though it is the decision of the Basin Lead, the reviewer may suggest an alternative quality rating for the measurement.

8.7.4 The reviewer enters the Overall discharge uncertainty, including the uncertainty in velocity and depth into the EAP FMU Quality Assurance Database (H:\FLOWS\QAData).

8.7.5 When the review is complete the reviewer initials the field note sheet in the space provided in the upper right corner and returns the submitted materials along with any written comments to the Basin Lead.
8.8 Troubleshooting

8.8.1 If problems persist and solutions cannot be found in this document consult the SonTek FlowTracker Technical Manual (particularly §8.7) for further assistance. If necessary contact SonTek at (858) 546-8327 or via e-mail at support@sontek.com.

8.8.2 BeamCheck is the same diagnostic tool that the manufacturer uses and is available to all users. BeamCheck methods are outlined in §6.2.1 of this document.

8.8.3 If SonTek is contacted via e-mail it is suggested that you send the *.wad file for the measurement in which difficulties were experienced and any previous *.bmc files for the FlowTracker that was used for the measurement. This may prevent the need to send the Handheld Unit to SonTek.

9.0 Safety

9.1 Personal Flotation Devices are required for persons working in or near bodies of water.

9.2 All EAP safety policies are followed and safety is always the top priority when operating this instrument.

9.3 In all measurement situations unsafe deployments that may result in injury to staff, loss or damage to equipment are not attempted. Refer to the EAP Safety Manual, pages 1-37 and 2-7 (EAP, 2009) for further information about working in and around streams.

9.4 Always consider the safety and traffic situations when measuring from a bridge and take appropriate actions including suspending the measurement if unsafe conditions exist. Consult the EAP Safety Manual, page 1-31 (EAP, 2009) for further guidance regarding bridge measurement safety.

9.5 Crossing the stream is done safely and in accordance with the guidelines for working in and around streams established in the EAP Safety Manual, page 1-37 (EAP, 2009).

10.0 References


10.10 SonTek/YSI, Inc., 2006. SonTek FlowTracker, version 2.11[program]. San Diego, California, SonTek/YSI, Inc.

10.11 Unless otherwise noted all photos and images used in this document courtesy of SonTek/YSI, Inc.
11.0 Appendices

Appendix A
Discharge Measurement Notes (ECY 040-56 (Rev. 12/07))

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Date</th>
<th>Name</th>
<th>Method</th>
<th>Meas. Dep.</th>
<th>Location</th>
<th>Type of Recorder</th>
<th>Calibration Prefix</th>
<th>Prop No.</th>
<th>Prop taken Y/N</th>
<th>Depth at control</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>01/01/2019</td>
<td>John Doe</td>
<td>weir</td>
<td>1.2 m</td>
<td>Left bank</td>
<td>FE-1</td>
<td>10000</td>
<td>123456</td>
<td>YES</td>
<td>1.5 m</td>
</tr>
<tr>
<td>02</td>
<td>01/02/2019</td>
<td>Jane Smith</td>
<td>weir</td>
<td>1.3 m</td>
<td>Right bank</td>
<td>FE-2</td>
<td>10001</td>
<td>654321</td>
<td>NO</td>
<td>2.0 m</td>
</tr>
</tbody>
</table>

**Graph:**

- **Axes:** Depth (m) vs. Velocity (m/s)
- **Data Points:** Various depth and velocity readings

**Notes:**
- Calibration:...
- Propagation time:...
- Depth at control:...

*STATE OF WASHINGTON*
*DEPARTMENT OF ECOLoGY*

*Measure No.*

*Check sheet*

*Copy of*...
Appendix 4E – Chain of Custody Forms
GROUNDWATER SAMPLES
**Groundwater Team**

**Chain of Custody & Sample Information Record**

Client: SARWQCB
Phone No. 951-963-4995

Project Name: Big Cyn Se Source Test
Project Location: Newport Beach, CA

**Sampler Information**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Date</th>
<th>Time</th>
<th># of Containers &amp; Preservatives</th>
<th>Sample Type</th>
<th>Analysis Requested</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCR - PIEZ - 141</td>
<td>6/21 10:55</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>DW</td>
</tr>
<tr>
<td>BCR - PIEZ - 626</td>
<td>6/21 11:30</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>DW</td>
</tr>
<tr>
<td>BCR - WEST - UNDER DRAHN</td>
<td>6/21 12:00</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>GW</td>
</tr>
<tr>
<td>BCR - EAST - UNDER DRAHN</td>
<td>6/21 11:55</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>GW</td>
</tr>
<tr>
<td>BCW - YACHST - HOA</td>
<td>6/21 12:25</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>GW</td>
</tr>
<tr>
<td>BCW - PLAT ST - HOA</td>
<td>6/21 12:35</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>GW</td>
</tr>
</tbody>
</table>

**Notes**
- Minerals = Chloride, Sulfate, Carbonate
- Metals = Ca, K, Mg, Na, Cd, Cu, Pb, Ni, Zn + Total Hardness
- Initial samples will be filtered by lab

**Sample Integrity Upon Receipt/Acceptance Criteria**

- Sample(s) Submitted on Ice? Yes / No
- Custody Seal(s) Intact? Yes / No
- Sample(s) Intact? Yes / No
- Temperature: °C / Cooler Blank

**Relinquished By (sign) / Print Name / Company**

<table>
<thead>
<tr>
<th>Relinquished By (sign)</th>
<th>Print Name / Company</th>
<th>Date / Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWJ Cailen</td>
<td>RWQCB</td>
<td>6/21/10 1445</td>
</tr>
</tbody>
</table>

**Received By (sign) / Print Name / Company**

<table>
<thead>
<tr>
<th>Received By (sign)</th>
<th>Print Name / Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Middelkamp</td>
<td>RWQCB</td>
</tr>
</tbody>
</table>

**Additional Reporting Requests**

- Include QC Data Package: Yes / No
- FAX Results: Yes / No
- Email Results: Yes / No
- State EDT: Yes / No

**Log in By/Date**

Lab No. 
Logged in By/Date: 
Page of 

Rev. 3/09
By submitting of samples the client agrees to all terms and conditions set forth in the quotation provided by the ASC project manager. If you are not familiar with the term and conditions associated with your project, please contact your ASC representative as soon as possible (425) 483-3300.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Bottle ID</th>
<th>Date and Time</th>
<th>Matrix</th>
<th>Volume</th>
<th>Preservative</th>
<th>Initials</th>
<th>Requested Analytes and Methods</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCR-PIEZ-I41</td>
<td>BCR-PIEZ-I41</td>
<td>6/21 1055</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Total Dissolved Se</td>
<td>Se Species</td>
</tr>
<tr>
<td>BCR-PIEZ-624</td>
<td>BCR-PIEZ-624</td>
<td>6/21 1130</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Total Dissolved Se</td>
<td>Se Species</td>
</tr>
<tr>
<td>BCR-WEST-UNDER</td>
<td>BCR-WEST-UNDER</td>
<td>6/21 1200</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Dissolved Se</td>
<td></td>
</tr>
<tr>
<td>BCR-EAST-Under</td>
<td>BCR-EAST-Under</td>
<td>6/21 1155</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Dissolved Se</td>
<td></td>
</tr>
<tr>
<td>BCW-YAHT ST-HOA</td>
<td>BCW-YAHT ST-HOA</td>
<td>6/21 1725</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Dissolved Se</td>
<td></td>
</tr>
<tr>
<td>BCW-PORT ST-HOA</td>
<td>BCW-PORT ST-HOA</td>
<td>6/21 1235</td>
<td>Water</td>
<td></td>
<td>NONE</td>
<td>(E)</td>
<td>Dissolved Se</td>
<td></td>
</tr>
</tbody>
</table>

Please account for each sample bottle as a separate line item for verification purposes.

*Matrix: Air, Freshwater (FW), seawater (SW), groundwater (GW), wastewater (WW), soil (SL), sediment (SD), tissue (TS), product (P), other (O)
SURFACE WATER SAMPLES
### Chain of Custody & Sample Information Record

<table>
<thead>
<tr>
<th>Client: SAUWQCS</th>
<th>Project Name: Big C.Y.M. Source Track</th>
<th>Project Location: Newport Beach, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone No. 951-782-4995</td>
<td>Turn Around Time: Routine 72 Hour Rush 48 Hour Rush 24 Hour Rush</td>
<td></td>
</tr>
<tr>
<td>Fax No. (951) 653-3351 • FAX (951) 653-1662</td>
<td>*Lab TAT Approval: By: *Additional Charges Apply</td>
<td></td>
</tr>
<tr>
<td>Contact: TERRELL REEDER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email: fredy@laboratories.ca.936</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sampler Information

- **Name:** T. REEDER - D. Vitale
- **Employer:** RW&G -
- **Signature:** GVitale

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCW-SB-MAIN (#1)</td>
<td>6/21</td>
<td>12:00</td>
</tr>
<tr>
<td>BCW-MB-MAIN (#2)</td>
<td>6/21</td>
<td>11:30</td>
</tr>
<tr>
<td>BCW-MB-MAIN (#2)</td>
<td>6/21</td>
<td>11:30</td>
</tr>
<tr>
<td>BCW- NB-MAIN (#5)</td>
<td>6/21</td>
<td>11:01</td>
</tr>
</tbody>
</table>

#### Analysis Requested

- **Sample Type:** Routine, Resample, Special
- **Analysis Requested:** Metals, Radionuclides, TIC, Spec.

#### Matrix

- DW = Drinking Water
- WW = Waste Water
- GW = Ground Water
- S = Soil
- SG = Sludge
- L = Liquid
- M = Miscellaneous
- SW = Surface Water

#### Notes

- *Samples for SW analyses to be sent over night to applied specialist*

#### Sample Integrity Upon Receipt

- Sample(s) Submitted on Ice: Yes
- Custody Seal(s) Intact: Yes
- Sample(s) Intact: Yes
- Temperature: 3°C

#### Lab Notes

- Lab No. TADD1234
- Page 1 of 6

---

Additional Reporting Requests

- Include QC Data Package: [ ] Yes [ ] No
- Email Results: [ ] Yes [ ] No
- FAX Results: [ ] Yes [ ] No
- State EDT: [ ] Yes [ ] No
- Include Source Number in Notes: [ ] Yes [ ] No

---

Rev. 6/07
# Chain of Custody & Sample Information Record

## Client Information

- **Client:** SARCOB
- **Phone No.:** 951-732-4415
- **Fax No.:**
- **Email:** treeder@waterboards.ca.gov

## Project Information

- **Project Name:** Big Yarn Source Water
- **Project Location:** Newport Beach, CA
- **Turn Around Time:** *Routine* *72 Hour Rush* *48 Hour Rush* *24 Hour Rush* 

## Sample Information

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Date/Time</th>
<th># of Containers</th>
<th>Matrix</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCGC - Lake 3 - WTR</td>
<td>6/21 1:55 pm</td>
<td>2</td>
<td>SW</td>
<td>Samples will be filtered in the laboratory</td>
</tr>
<tr>
<td>BCCE - Lake 3 - PA</td>
<td>6/21 1:55 pm</td>
<td>1</td>
<td>SW</td>
<td>TSS on particulate</td>
</tr>
<tr>
<td>BCSC - Lake 5 - WTR</td>
<td>6/21 1:53 pm</td>
<td>4</td>
<td>SW</td>
<td>Samples will be performed by ASC</td>
</tr>
<tr>
<td>BCCE - Outflow - WTR</td>
<td>6/21 2:40 pm</td>
<td>4</td>
<td>SW</td>
<td></td>
</tr>
<tr>
<td>BCCE - Outflow - PA</td>
<td>6/21 2:40 pm</td>
<td>1</td>
<td>SW</td>
<td></td>
</tr>
<tr>
<td>BCSCW-SB-HUNP WTR</td>
<td>6/21 5:50 pm</td>
<td>4</td>
<td>SW</td>
<td></td>
</tr>
<tr>
<td>BWW-SB-HUNP PA</td>
<td>6/21 5:50 pm</td>
<td>1</td>
<td>SW</td>
<td></td>
</tr>
</tbody>
</table>

## Additional Reporting Requests

- Include QC Data Package: [ ] Yes [ ] No
- FAX Results: [ ] Yes [ ] No
- Email Results: [ ] Yes [ ] No
- State EDT. [ ] Yes [ ] No

## Sampling Procedure

- **Name:** TERRY REEDER
- **Employer:** ESB
- **Signature:**

## Chain of Custody

- **Relinquished By:**
  - Signature: B.B. Byars
  - Date/Time: 6/22/10 3:00

## 906 Laboratories

- **Address:** 6100 Quail Valley Court Riverside, CA 92507
- **Phone:** (951) 653-3351 • FAX (951) 653-1662
- **Website:** www.babcocklabs.com

---

*For Lab Use Only*

- **Sample Integrity Upon Receipt/Acceptance Criteria:**
  - Sample(s) Submitted on Ice? [ ] Yes [ ] No
  - Custody Seal(s) Intact? [ ] Yes [ ] No [ ] NA
  - Sample(s) intact? [ ] Yes [ ] No
  - Temperature: [ ] Cooling Blank

## Additional Notes

- Lab No.:____________
- Logged in By/Date:____________
- Page of:__________________

Rev. 3/09
<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Bottle ID</th>
<th>Date and Time</th>
<th>Matrix</th>
<th>Volume</th>
<th>Preservative</th>
<th>Initials</th>
<th>Requested Analytes and Methods</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOW-NB-MAIN (#1)</td>
<td>BOW-NB-MAIN</td>
<td>6/21 1200</td>
<td>WATER</td>
<td></td>
<td>NONE</td>
<td>(ID)</td>
<td>Total Recoverable Se</td>
<td></td>
</tr>
<tr>
<td>BOW-NB-MAIN (#2)</td>
<td>BOW-NB-MAIN</td>
<td>6/21 1130</td>
<td>WATER</td>
<td></td>
<td>NONE</td>
<td>(ID)</td>
<td>Dissolved Se</td>
<td></td>
</tr>
<tr>
<td>BOW-NB-MAIN (#3)</td>
<td>BOW-NB-MAIN</td>
<td>6/21 1130</td>
<td>WATER</td>
<td></td>
<td>NONE</td>
<td>(ID)</td>
<td>Total Recoverable Se</td>
<td></td>
</tr>
</tbody>
</table>

Please account for each sample bottle as a separate line item for verification purposes.

Matrix: Air, Freshwater (FW), seawater (SW), groundwater (GW), wastewater (WW), soil (SL), sediment (SD), tissue (TS), product (P), other (O)

Rev 1.1 (April 2005)
PARTICULATES, SEDIMENT, ALGAE, & TISSUE SAMPLES
**Sample ID** | **Bottle ID** | **Date and Time** | **Matrix** | **Volume** | **Preservative** | **Initials** | **Requested Analytes and Methods** | **Comments**
---|---|---|---|---|---|---|---|---
BC02 - LK3-partic. | BC02-LK3 | 4/21 1228 | Water | 1/2 gal. | non | | Se in particulates; trace analytes to be completed on 0.5 gallon samples | 
EC5 - LK5-partic. | BC02-LK5 | 4/21 1228 | Water | 1/2 gal. | none | | Se in particulates; TSS; trace metals (Cu, Ni, Pb, Zn) in particulates | 
BC5 - Ounwco-partic. | BCP5-0unwco | 1/21 1440 | Water | 1/2 gal. | none | | | 
BNW-S8-HUNP-partic. | BNW-S8-HUNP | 6/21 1550 | Water | 1/2 gal. | none | | | 

**Relinquished by:** (sign) [Signature] (print) **Date/Time:** 4/22/06 1220 **Comments:** AAs provided appropriate duplicates for SWAMP QA/QC

**Relinquished by:** (sign) (print) **Date/Time:** **Comments:**

**Please account for each sample bottle as a separate line item for verification purposes.**

*Matrix: Air, Freshwater (FW), seawater (SW), groundwater (GW), wastewater (WW), soil (SL), sediment (SD), tissue (TS), product (P), other (O)*

Rev 1.1 (April 2005)

**PLEASE SEND INVOICE TO ESB**
**Institute for Integrated Research in Materials, Environments, and Society**


**CHAIN-OF-CUSTODY**

<table>
<thead>
<tr>
<th>Client Sample ID / Description</th>
<th>Sample Date</th>
<th>Sample Time</th>
<th>Sample Matrix</th>
<th>Container</th>
<th>Type</th>
<th>Requested Analyses</th>
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<tbody>
<tr>
<td>BC65-LK3-SED</td>
<td>6/21/10</td>
<td>11:40</td>
<td>SED</td>
<td>Glass</td>
<td>X</td>
<td>Trace Metals (CAs, GEs, etc.)</td>
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<td>% Solids</td>
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<td>6/21/10</td>
<td>10:42</td>
<td>ALG</td>
<td>Glass</td>
<td>X</td>
<td>% Lipids</td>
</tr>
<tr>
<td>BC65-LK5-FISH</td>
<td>6/21/10</td>
<td>10:42</td>
<td>FISH</td>
<td>Glass</td>
<td>X</td>
<td>Trace Metals (CAs, GEs, etc.)</td>
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<td>Glass</td>
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<td>% Lipids</td>
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<td>FISH</td>
<td>Glass</td>
<td>X</td>
<td>Trace Metals (CAs, GEs, etc.)</td>
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**Type of Ice used:**
- Yes
- Blue
- None

**Sample Preservative:**
- Yes
- No

**TURNAROUND TIME NEEDED:**

**COMMENTS:**

**RELINQUISHED BY**

**SIGNATURE:**

**DATE:**

**Print:**

**Company:**

**RECEIVED BY**

**SIGNATURE:**

**DATE:**

**Print:**

**Company:**

**TIME:**

**Referee:**

**Signature:**

**DATE:**

**Print:**

**Company:**

**TIME:**

**Project ID#**
### Institute for Integrated Research in Materials, Environments, and Society


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**CHAIN-OF-CUSTODY**

<table>
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<tr>
<th>Client Name</th>
<th>T. REEDER, SAWRACB</th>
<th>Address</th>
<th>3737 MAIN ST, STE 500</th>
<th>RIVERSIDE, CA 92501</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Contact Name</td>
<td>TERRI REEDER</td>
<td>Email Address</td>
<td><a href="mailto:treeder@waternbrds.ca.gov">treeder@waternbrds.ca.gov</a></td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td>951-782-4995</td>
<td></td>
<td></td>
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<td>Project Name/Number</td>
<td>Bio CYN SE Source Tracking</td>
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#### REQUESTED ANALYSES

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**RELINQUISHED BY**

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<tbody>
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| Comments: | |
| Print: | |
| Company: | |

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<tr>
<td>DATE:</td>
<td>6-21-10</td>
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<td>Company:</td>
<td>IIRMES</td>
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**Field Measurements (SampleType = FieldMeasure; Method = Field)**

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<tr>
<th>SampleType</th>
<th>Field Type</th>
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<th>Method</th>
<th>Instrument</th>
<th>Calib. Date</th>
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<td>pH</td>
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<tr>
<td>Sub/Surf/Bottom Ref</td>
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<td></td>
<td>Salinity (ppt)</td>
<td>Turbidity (ntu)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Samples Taken (# of containers filled) - Method = Water Grab**

Field Dup Yes / No: (SampleType = Grab / Integrated; Label_ID = FieldQA; create collection record upon data entry)

**Sample Type:** Grab / Integrated

**Collection Device:** Indiv bottle (by hand, by pole, by bucket); Teflon tubing; Kemmer; Pole & Beaker; Other

**Sub/Surface:**
- Depth Collected (m): 0-20m
- Bacteria
- Chla
- Toxins

**Notes:**
- Dissolved Mercury
- Total Metals
- Dissolved Metals
- Toxicity
Appendix 3E – Quality Assurance Report
Quality Assurance Report –

Analytical Results for the June 21, 2010 Big Canyon Watershed Sampling Event

Introduction

This summarizes the quality assurance procedures followed by the contract laboratories for the Big Canyon Watershed Sampling Project. The Project included the analyses of water, tissue, and sediment samples. The quality control samples were compared to the quality assurance procedures listed in the Big Canyon Watershed Preliminary Selenium Source Tracking Studies Big Canyon Country Club and Upstream Tributaries Scope of Work and Sampling and Analyses Plan (June 18, 2010). These procedures were taken from the Surface Water Ambient Monitoring Program quality assurance criteria (SWAMP, September 1, 2008). The quality control procedures were communicated to E.S. Babcock and Sons, Inc Environmental Laboratories via electronic mail directly to Lorenzo Rodriguez.

The main contract laboratory for this project was E.S. Babcock and Sons, Inc. Environmental Laboratories. Two other laboratories subcontracted with E.S. Babcock and Sons, Inc. Environmental Laboratories for some of the analyses. In all, three laboratories were involved in the analyses of the samples collected for this project: E.S. Babcock and Sons, Inc. Environmental Laboratories analyzed aqueous samples for cations, anions, total and dissolved organic carbon, total dissolved solids, and dissolved trace metals concentrations; IIRMES Laboratory based at California State University Long Beach analyzed the sediment and tissue samples for selenium and trace metals; and Applied Speciation and Consulting Laboratory analyzed the aqueous samples for total and dissolved selenium concentrations and selenium species, and the particulate samples for selenium and trace metal concentrations as well as total suspended solids.

The objectives of this study were the following:
1. Assess potential sources of selenium and flows upstream of the Big Canyon Country Club golf course.
2. Determine where and how selenium conversions are occurring upstream of the golf course.
3. Compare selenium concentrations and loads in the main tributaries of Big Canyon creek that enter and exit the BCCC golf course to the concentrations measured in 2009 by CH2MHill.
4. Determine selenium cycling and potential impacts to aquatic life in the golf course ponds and the Harbor View Nature Park.
5. Provide data to help build a conceptual model for selenium for the Big Canyon subwatershed.
6. Determine if preliminary estimates of potential sources of water and selenium (e.g., irrigation, leaking potable water lines) can be made based on general chemical parameters (i.e., use of Piper diagrams or Stiff plots).
7. Provide additional information that can be used in assessing potential selenium source controls and treatment options.
8. Collect data to aid in designing a long-term selenium monitoring and management program for the Big Canyon watershed.
9. Provide additional data that can be used to refine the Newport Bay watershed biodynamic model for the Big Canyon subwatershed.

Based on these objectives, the measurement quality objectives that are critical for this project are accuracy, precision, and completeness.

The samples that were collected consisted of 19 aqueous samples sent to E.S. Babcock and Sons, Inc. Environmental Laboratories for cation, anion, dissolved organic carbon, total organic carbon, total dissolved solids, and dissolved trace metals (Cd, Cu, Pb, Ni, and Zn) analyses. Fourteen (14) aqueous samples were sent to Applied Speciation and Consulting Laboratory for total and dissolved selenium and selenium speciation analyses. Four (4) of the surface water samples were filtered and the particulates (filtrate solids) were analyzed for total selenium and trace metals (Cd, Cu, Pb, Ni, and Zn) concentrations. Finally, 3 sediment and 11 tissue samples (algae, crayfish, mosquitofish, and African-clawed frogs) were sent to IIRMES Laboratory for analysis of total selenium and five trace metals (Cd, Cu, Pb, Ni, and Zn), as well as percent solids.

I. Accuracy:

1. Laboratory Control Samples (LCS)
   The SWAMP quality control criteria require that an LCS be analyzed for every 10 analytical runs with a recovery between 80% to 120%.

   Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:
   Cations - The cation analyses (calcium, magnesium, sodium, and potassium) in batch 0F28047-200.7 had LCS and LCS duplicate recoveries well within the 80%-120% recovery criteria.

   Anions - The anion analyses (nitrate as nitrogen) in batches 0F22033, 0F22054, sulfate and chloride in batch 0F23051, total alkalinity, hydroxide, carbonate, and bicarbonate in batch 0F29015, total alkalinity, hydroxide, carbonate, and bicarbonate in batch 0G01015 had LCS recoveries within the 80%-120% criteria.
Solids – The total dissolved solids in batch 0F25017 and total suspended solids from batch 0F28032 had LCS recoveries within the 80%-120% criteria. SWAMP does not require analyses of LCS for solids or organics.

Organics – The LCS for dissolved organic carbon in batch 0F25037 and in batch 0F30005 and the two LCS for total organic carbon in batch 0F30004 had recoveries within the SWAMP criteria.

Metals – The LCS and LCS duplicate for batch 0F24025 have recoveries within the SWAMP criteria.

**Analyses by Applied Speciation and Consulting Laboratory:**
Total Metals and Selenium speciation - LCS information was not reported.

**Analyses by IIRMES Laboratory:**
Sediment analyses - LCS information was not reported.
Tissue analyses - LCS information was not reported.

### 2. Certified Reference Material (CRM)

**Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:**
None were used for the water chemistry samples analyzed by E.S. Babcock and Sons, Inc Environmental Laboratories.

**Analyses by Applied Speciation and Consulting Laboratory:**
Total and Dissolved Selenium, Selenium Species, and Trace Metals – all the CRM recoveries were within the SWAMP criteria of 80%-120%.

**Analyses by IIRMES Laboratory:**
Tissue analyses - all the CRM recoveries were within the SWAMP criteria of 80%-120%.

### 3. Blanks
The SWAMP criteria for blanks require these to be less than the reporting limit for the target analyte.

**Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:**
Cations - The blanks for cation analyses (sodium, potassium) in batch 0F28047-200.7 were below the reporting limit.

Anions – The blanks for anion analyses (nitrate as nitrogen) in batches 0F22033, 0F22054, sulfate and chloride in batch 0F23051, total alkalinity,

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1 SWAMP does not require analyses of LCS for solids or organics.
hydroxide, carbonate, bicarbonate in batch 0F29015, total alkalinity, hydroxide, carbonate, bicarbonate in batch 0G01015 were below the reporting limit.

**Solids** - The total dissolved solids blank in batch 0F25017 and the total suspended solids blank in batch 0F28032 were below the reporting limit.

**Organic Compounds** – The blanks, one for dissolved organic carbon in batch 0F25037, and one in batch 0F30005 and two for total organic carbon in batch 0F30004 were below the reporting limit.

**Metals** – Three blank samples were analyzed for trace metals (cadmium, copper, lead, nickel, and zinc) in batch 0F24025-200.8. These blanks were below the reporting limit. One of the blanks, however, showed zinc at a concentration (0.983 µg/L) very close to the reporting limit (1 µg/L). A subsequent blank (batch 0G09022 and EPA Method 1638) for this trace metal was analyzed showing a zinc concentration below the reporting limit. Copper results in the blanks were all reported as below the reporting limit, but were closer to the reporting limit than they should have been; however, the copper results in the samples collected at Big Canyon were much higher than the reporting limit and higher than the detections in the blanks.

**Analyses by Applied Speciation and Consulting Laboratory:**
- **Total and Dissolved Selenium, Selenium Species, Trace Metals, Total Suspended Solids** – Four preparation blanks were conducted for these analyses. According to the laboratory, the reporting limit for the trace metals analyses is 0.4 µg/L. Except for the zinc preparation blank, all the metal preparation blanks had detections below the reporting limit. The zinc detections in the preparation blanks ranged between 1.2 µg/L to 3.2 µg/L with a mean of 1.8 µg/L and a standard deviation of 0.9. The zinc results in the various samples ranged between 2.1 µg/L to 7.5 µg/L. The high detected concentrations in zinc in the preparation blanks indicate that the sample results will be biased high due to possible zinc contamination.

**Analyses by IIRMES Laboratory:**
- **Tissue analyses** – The detections in the blanks were below the reporting limit.
- **Sediment analyses** – The detections in the blanks were below the reporting limit.
II. Precision:

1. **Matrix Spikes (MS)**

   The SWAMP criteria require that one MS and one MSD sample be analyzed per constituent and that the recovery should be within 80%-120% with an RPD less than 25%.

**Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:**

- **Cations** - Contrary to SWAMP guidelines, two distinct MS samples were analyzed instead of an MS and MSD. One of the MS for the cation analyses (calcium, magnesium, sodium, and potassium) in batch 0F28047-200.7 had MS recoveries within the SWAMP criteria. The second MS for cation analyses (for only sodium, and potassium) in batch 0F28047-200.7 had MS recoveries within the SWAMP criteria. The calcium and magnesium analyses for the second MS, on the other hand, were outside the criteria with low recoveries of 64.3% and 70% respectively. This could be due to the fact that the spike concentration was too low (22.1 mg/L).

- **Anions** - Two MS were analyzed for the anion analysis (nitrate as nitrogen) in batches 0F22033, 0F22054, and sulfate and chloride in batch 0F23051. All MS had recoveries within the SWAMP criteria.

- **Solids** – MS were not analyzed.

- **Organics** – The recovery for MS for dissolved organic carbon in batch 0F25037 was not reported and is presumed to be outside the SWAMP criteria. The recoveries for the dissolved organic carbon in batch 0F30005 and for total organic carbon in batch 0F30004 were within the SWAMP criteria.

- **Metals** – Two MS were analyzed for batch 0F24025. Except for the recovery for zinc, the recoveries for the trace metals in batch 0F24025 meet the SWAMP criteria. The zinc recovery was 75.5%.

**Analyses by Applied Speciation and Consulting Laboratory:**

- **Total and Dissolved Selenium, Selenium Species, and Trace Metals Analyses** – The MS for the selenium, selenium species, and all of the trace metals had recoveries within the SWAMP criteria.

**Analyses by IIRMES Laboratory:**

- **Sediment and Tissue Analyses** – For sediment, none were analyzed. Laboratory blank spikes were used to determine precision. These laboratory blank spikes had recoveries within the SWAMP criteria. For tissue, all results were within the SWAMP criteria.
2. Matrix Spike Duplicates (MSD)

The SWAMP criteria for MSD are 80%-120% recovery and relative percent difference (RPD) less than 25%.

**Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:**

*Cations* - Contrary to the SWAMP criteria, MSD were not analyzed for the cation samples.

*Anions* - The MSD analyzed for the anion samples (nitrate as nitrogen) in batches 0F22033, 0F22054, and sulfate and chloride in batch 0F23051 were within the SWAMP recovery and RPD criteria.

*Solsids* – MSD were not analyzed.

*Organics* – The recovery for the MSD for dissolved organic carbon in batch 0F25037 was not reported and presumed to be outside of the SWAMP criteria; the recoveries for dissolved organic carbon in batch 0F30005 and for total organic carbon in batch 0F30004 were within the SWAMP criteria. The RPD for batches 0F25037, 0F30005 (dissolved organic carbon) and 0F30004 (total organic carbon) were reported to be within the SWAMP criteria.

**Analyses by Applied Speciation and Consulting Laboratory:**

*Total and Dissolved Selenium, Selenium Species, and Trace Metals* – The MSD and RPD for selenium, selenium species, and all of the metals had recoveries within the SWAMP criteria.

**Analyses by IIRMES Laboratory:**

*Tissue analyses* – The MS and MSD were within the SWAMP criteria. 
*Sediment analyses* – MSD were not analyzed. In lieu of the MSD, the laboratory ran two blank spikes which had recoveries ranging from 84% to 98% in one laboratory blank spike and 82% to 97% in the second. The preferable indicators of precision are MS and MSD because they indicate the ability to detect the spiked concentrations in the sample matrix. The laboratory spikes analyses were performed on aqueous media which is very different from the sediment matrix in the samples collected from Big Canyon.

3. Laboratory Duplicates

The SWAMP criteria for laboratory duplicates state that these should be done per 20 samples, or per analytical batch, with an RPD less than 25%.
Analyses by E.S. Babcock and Sons, Inc. Environmental Laboratories:

Anions - The duplicates for the anion analyses (total alkalinity, hydroxide, carbonate, and bicarbonate) in batch 0F29015, one of the duplicates for total alkalinity, hydroxide, carbonate and bicarbonate in batch 0G01015 were within the RPD criteria. Two duplicates were analyzed for batch 0G01015. The RPD for carbonate from one the duplicates was 40% and this does not meet the SWAMP criteria for this analyte.

Solids – The one duplicate analyzed for total dissolved solids in batch 0F25017 met the RPD criteria; both duplicates analyzed for total suspended solids in batch 0F28032 met the RPD criteria.

Analyses by Applied Speciation and Consulting Laboratory:

Total Selenium, Selenium Species, and Trace Metals – The duplicates for the metals had RPD within the SWAMP criteria.

Analyses by IIRMES Laboratory:

Sediment and Tissue analyses – The duplicates had RPD within the SWAMP criteria.

4. Relative Percent Difference (RPD) between the LCS and LCS Duplicate

The cation analyses (calcium, magnesium, sodium, and potassium) performed by E.S. Babcock and Sons, Inc. Environmental Laboratories in batch 0F28047-200.7 had LCS and LCS duplicate RPD within acceptable limits (less than 25%).

The LCS and LCS duplicates were not performed on the data by either Applied Speciation and Consulting or the IIRMES Laboratories.

III. Completeness

The completeness requirement of 90% was met.

IV. Conclusion

The quality assurance procedures (SWAMP QA procedures) stipulated for this project were not completely followed.

For example, the target reporting limits used by the E.S. Babcock and Sons were higher than the SWAMP recommended reporting limits. However, the analytes in the samples were found in high enough concentrations that “non-detect” data was kept to a minimum. Lead, carbonate and hydroxide were the only analytes found below the laboratory’s reporting limit.
In addition, MSD analyses were not conducted for the metals, solids, and cation analyses performed by E.S. Babcock and Sons.

The MS recovery for zinc was low in one of the batches analyzed by E.S. Babcock and Sons, Inc. Environmental Laboratories.

The hard copy reports from E.S. Babcock and Sons, Inc Environmental Laboratories did not specify which samples correspond to which quality assurance batch.

The high detected concentrations of zinc in the preparation blanks used by Applied Speciation and Consulting indicate that the sample results will be biased high due to possible zinc contamination.

Data that should not be used for the project’s intended purpose because it did not meet all the precision criteria:

- Zinc data from the analyses performed by Applied Speciation and Consulting Laboratory should not be used. The detections in the preparation blank indicate that this data is biased high and did not meet the accuracy criteria.

Data that may be used for the project’s intended purpose because it met all the quality assurance criteria:

- Except for the zinc data that was analyzed by Applied Speciation and Consulting Laboratory, all the trace metals data may be used.
- The total suspended solids analyses performed by Applied Speciation and Consulting can be used.
- The total dissolved solids data from the analyses performed by E.S. Babcock and Sons, Inc Environmental Laboratories may be used.

Data that should be used with caution (in that it may be used for the project’s objective number 6 because it is a preliminary analyses not a regulatory one) because it met most of the quality assurance criteria:

- Cations, total alkalinity, hydroxide, carbonate and bicarbonate, dissolved organic carbon, total organic carbon and dissolved organic carbon, and metals data from the analyses performed by E.S. Babcock and Sons, Inc Environmental Laboratories. This data may be used for preliminary assessment purposes and to design future sampling activities, but may not be used to determine compliance with water quality criteria because of poor precision.
- The sediment data from IIRMES Laboratory lacked MS and MSD but the precision criterion was somewhat met from the two laboratory blank spike analyses. The laboratory blank consisted of laboratory blank water and is not a perfect surrogate for the matrix in the samples but serves to illustrate that the laboratory, at a minimum, is capable of detecting the metals at the spiked concentrations.