

Standard Operation Procedure (SOP) #24

Using the FlowTracker2 and File Processing

Version 1.0 (March 19, 2025)

Change History

New Version #	Revision Date	Author	Changes Made	Reasons for Change	Previous Version #
1.0	3/19/2025	Theoden Struthers, Anne Farahi, Amanda McCutcheon, Glauco Puig-Santana	New SOP for using the SonTek YSI FlowTracker2 handheld ADV.		NA

Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision, changes made, and reason for the change along with the new version number.

Purpose

The purpose of this SOP is to describe the procedures for collecting and processing stream discharge data using the SonTek® YSI FlowTracker2 device and software. Data will be saved digitally onto the device upon collection in the field and will also be recorded onto the Stream Discharge Datasheet (see [SOP #23 Habitat Characterization at the Reach and Transect Scales](#) for a full version of the datasheet).

Introduction

Streamflow, or discharge, is defined as the volumetric rate of flow of water (volume per unit time) in an open channel or riparian area, including any sediment or other solids that may be dissolved or mixed with it. Streamflow in the PACN is expressed in Metric dimensions of cubic meters per second (m^3/s). Streamflow cannot be measured directly but must be computed from variables that can be measured directly, such as stream width, stream depth, and streamflow velocity. Even though streamflow is computed from measurements of other variables, the term “streamflow measurement” or “discharge measurement” is generally applied to the final result of the calculations.

Essentials

The SonTek/YSI FlowTracker2 handheld ADV® (Acoustic Doppler Velocimeter) is a designed wading discharge measurement device. Measuring discharge involves wading across the stream while taking measurements of water depth and velocity at different locations. The FlowTracker uses these measurements to calculate total discharge.

For additional instructions on device use, please see:

- [FlowTracker2 User's Manual](#), also available in the “[Reference](#)” folder in the [Streams Monitoring project workspace](#) on the PACN I&M SharePoint site¹.
- [SonTek FlowTracker2 Training](#) on YouTube.

Pre-Field

Gathering of Equipment Needed for field

1. FlowTracker2 handheld unit
2. Probe and communications/power connector cable
3. Two-part wading rod with J-style probe mounting bracket (ensure the bolt at the bottom is in place)
4. Handheld mounting bracket
5. 24 AA batteries (8 for unit plus 16 spare) and removable battery holder
6. Stream discharge datasheet printed on waterproof paper (Figure SOP 24.4), clipboard, and pencils
7. Transect tape (metric 30 m)

¹ PACN I&M SharePoint site, <https://doimspp.sharepoint.com/sites/nps-PWR-PACNIM> (last accessed 19 March 2025).



Figure SOP 24.1. FlowTracker2 handheld unit and its various components.



Figure SOP 24.2: FlowTracker2 keypad layout. Circled red is the left soft key, in yellow is the right soft key their functions are listed in the bottom banner of the FlowTracker2 screen in each menu. Circled in blue is the Enter key.

Testing FlowTracker

- Before beginning a new sampling trip, run systems diagnostics test using the BeamCheck® software. This software should show signal amplitude plots on top of each other. If not, it is possible the probe may be damaged. A complete description of BeamCheck is found in the [FlowTracker2 User's Manual](#).

Set Up Practice Before Out in the Field

1. Place batteries in the removable battery holder and install in FlowTracker2 handheld battery compartment. Press the power button and hold for a one second to ensure it turns on. Hold the power button for 4 seconds to turn off. After turning the FlowTracker2 off, remove the batteries from the unit.
2. Attach both parts of the wading rod.
3. Attach and secure mounting bracket on handheld unit. Attach mounting bracket to top of wading rod.
4. Secure probe in mounting bracket.

Set Parameters

Follow the steps below to set up parameters for the FlowTracker2:

1. Place batteries in the removable battery casing and install FlowTracker2 handheld battery compartment. Turn the FlowTracker2 on.
2. Navigate to device configuration and press the Enter key to enter the Device Configuration Menu (Figure SOP 24.3).

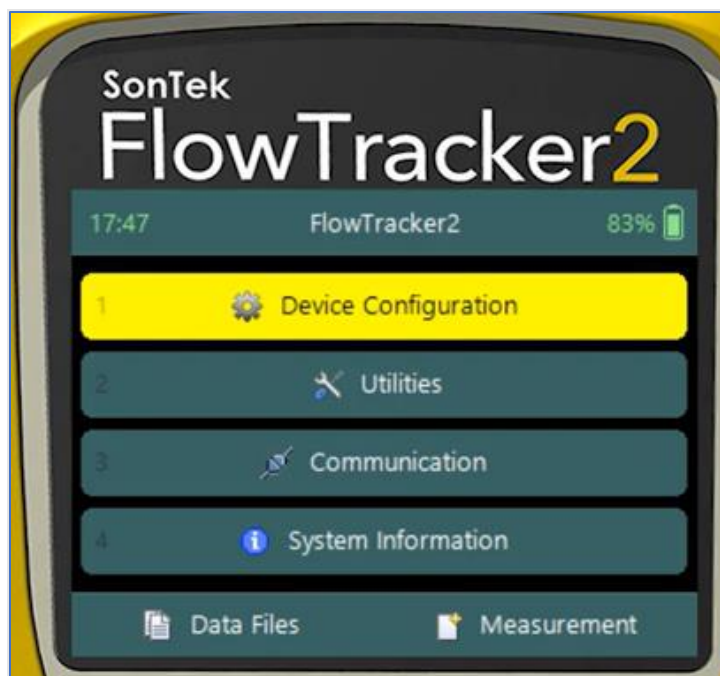


Figure SOP 24.3. FlowTracker2 Main Menu.

3. In the Device Configuration Menu, navigate to Discharge Templates and press the Enter key (Figure SOP 24.4, below).



Figure SOP 24.4. The FlowTracker2 device configuration menu.

4. Press the right soft key to make a new template and use the number pad to name the template “PARK Streams” where PARK is the four-letter park code for the sites you will be surveying

(e.g., HALE Streams, NPSA Streams, KALA Steams, or WAPA Streams). Then create the template.

5. Ensure the settings match those below:

- Data Collection Settings:
 - Metric
 - Avg Time: 40 seconds
 - Salinity: 0
 - Temperature: Measured
 - Sound Speed: Calculated
 - Mounting Correction %: 0
- QC Settings:
 - SNR Threshold: 10
 - Std Error Threshold: 0.010
 - Spike Thresh: 10%
 - Velocity Angle for Warning: 20°
 - Tilt Angle for Warning: 5°
- Discharge Settings:
 - Discharge Equation: Mid Section
 - Discharge Uncertainty: IVE
 - Discharge Reference: Measured
 - Max Station Q for Caution: 5
 - Max Station Q for Warning: 10
 - Max Depth Change for Warning: 50
 - Max Spacing Change for Warning: 100
 - 0.6 Method Depth: 0.5
- Displayed Velocity Methods
 - 0.2/0.8/0.6 Methods: Yes
 - Kreps Methods: No
 - 5-Point Methods: No
 - 6-Point Methods: No
 - Vertical Velocity Curve: No

6. To change a displayed value, navigate to select that parameter using the Up/Down Keys. If the parameter value is numerical, then delete the previous entry using the backspace key and enter the new one. If the parameter is non-numerical then use the left and right keys to change it.

7. When you are finished, press the left soft key to return to the Template menu, then twice more to return to the main menu.

Field Collection

Site Selection

The first and most critical step in making an ADV measurement is selecting a site of desirable qualities. First, one must be able to wade comfortably in the stream, ideally no more than 1 m. Then look for a cross section with the following characteristics:

- A reasonably straight channel with streamlines parallel to each other; a stable streambed free of large rocks, weeds, and obstructions that would create eddies, slack water, and turbulence; and desirable measurement sections that are roughly parabolic, trapezoidal, or rectangular in shape. These conditions are obviously not always possible but remember these are the conditions in which the FlowTracker2 was developed. With that in mind, these are conditions that a hydrographer should seek in the field: a smooth, mirror-like water surface with steady, uniform, nonvarying flow conditions in the stream reach where the discharge measurement will be taken, essentially laminar flow.
- The velocities are, for the most part, greater than 0.15 m/s, and depths that are greater than about 0.15 m. These conditions are not always possible to find in the field.
- Avoid the effect of tributary and (or) intervening drainage area inflows between the measurement section and the control.

It is usually not possible to satisfy all these conditions. Select the best possible reach using these criteria above and then select a cross section.

When natural conditions for measuring are in the range considered undependable, modify the cross section, if practical, to provide acceptable conditions. Often it is possible in small streams to build dikes to cut off dead water and shallow flows in a cross section, or to improve the cross section by removing rocks and debris within the section and from the reach of stream immediately upstream from it. After modifying a cross section, allow the flow to stabilize before starting the discharge measurement.

Measurement of Width

The first measurement made in a discharge measurement is the determination of horizontal stream width in the cross section to be measured. Using a transect tape, extend the transect tape **across the width of the stream (perpendicular to the direction of flow)** and secure on either end of the stream with stakes, rocks, tree, etc. Record your LEW and REW (Note that LEW/REW stands for Left/Right Edge Water which is referenced by looking downstream). Subtract these amounts to obtain total width. The Stream width should then be divided by 21 to obtain the intervals of locations for velocity measurements that you will be using. Add/Subtract this interval to the REW/LEW (Depending on which side you are starting) to obtain the 1st location you will be collecting data sequentially until all

20 locations are done. These should be written in the datasheet and match what is inputted into the handheld.

For example, a transect tape measurement at the REW of 0.5 m and LEW of 5.4 m will have a stream width of 4.9 m (i.e., $5.4\text{ m} - 0.5\text{ m} = 4.9\text{ m}$). The stream width of 4.9 m divided by 21 will give you location intervals of 0.23 m (i.e., $4.9\text{ m} / 21 = 0.23\text{ m}$). Starting at the REW of 0.5 m the following location for the velocity measurement will be 0.73 m (i.e., $0.5\text{ m} + 0.23\text{ m} = 0.73\text{ m}$) on the transect tape followed by 0.96 m (i.e., $0.73\text{ m} + 0.23\text{ m} = 0.96\text{ m}$) and so on (i.e., previous measurement + interval measurement). These should be written down in the datasheet (Figure SOP 24.5, below).

STREAM DISCHARGE DATASHEET

Park:	Stream:	Site:	Date:
Flowtracker Operator:		Observer:	

Habitat Notes:					
Transect Location:		Wetted Channel Width (m): 4.9 m		Habitat Type (see codes below):	
Point	Tape Reading (m)	Depth (m)	Velocity (m/s)	Microhabitat (see codes below)	
				Type	Structure
LEW	5.4 m				
1	5.10 m				
2	4.87 m				
3	4.64 m				
4	4.41 m				
5	4.18 m				
6	3.95 m				
7	3.72 m				
8	3.49 m				
9	3.26 m				
10	3.03 m				
11	2.80 m				
12	2.57 m				
13	2.34 m				
14	2.11 m				
15	1.88 m				
16	1.65 m				
17	1.42 m				
18	1.19 m				
19	0.96 m				
20	0.73 m				
REW	0.5 m				
			Discharge (m³/s)	Error %	

Habitat Type: Abandoned Channel (AC), Backwater (BW), Boulder Riffle (BF), Cascade (CA), Chute (CH), Eddy (ED), Falls (FA), Glide (GL), Plunge-pool (PL), Pool (P), Rapid (RD), Riffle (RF), Run (RU), Sheet (SH), Not Applicable (NA)

Structure: Algal Mat (AM), Bedrock (BD), Filamentous Algae (FA), Leaf Pack (LP), Manmade Structure (MS), Rocks (cobble-to-boulder sized) (RK), Root Wad (RT), Vegetation (VG), Woody Debris (WD), No structure present (NONE), Sand (SD), Silt (ST)

PACN Stream Monitoring Protocol

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Figure SOP 24.5. An example of a datasheet with width measurements using the scenario listed above.

Positioning While Using FlowTracker

Stand in a position that least affects the velocity of the water passing the current meter (m) by facing the bank, with the water flowing against the side of your leg. Holding the wading rod in front of the transect tape, stand from 0.05 m downstream from the transect tape and 0.5 m or more downstream from the wading rod. Generally, place the wading rod ahead of and upstream from the hydrographer's body and feet.

Direction of Flow Measurements

Flow direction is also critical with respect to an ADV, since the ADV assumes a horizontal and perpendicular plane to the flow. The hydrographer must pay close attention to the flow angle reported by the FlowTracker. Always hold the wading rod (with FlowTracker2 attached) perpendicular to transect tape so that the probe is parallel to the transect tape and perpendicular to the flow while paying close attention to bubble level and ensure it is level while taking measurements. See Section 7 of the [FlowTracker2 User's Manual](#) for more information.

Obtaining Depth Using Wading Rod

Currently PACN is utilizing the metric rod for all flow tracking devices (Figure SOP 24.6, below). The thicker rod is divided into three different markings single line (0.02 m), double lines (0.1 m) and triple lines (0.5 m). To obtain the water depth place rod until it is flush with stream bottom and count up using the markings to the nearest 0.005 m (the last digit is rounded to 5 or 0). Alternatively, you could count down the rod starting at the triple lined 0.5 m mark and subtracting intervals from that measurement as you move down the rod.

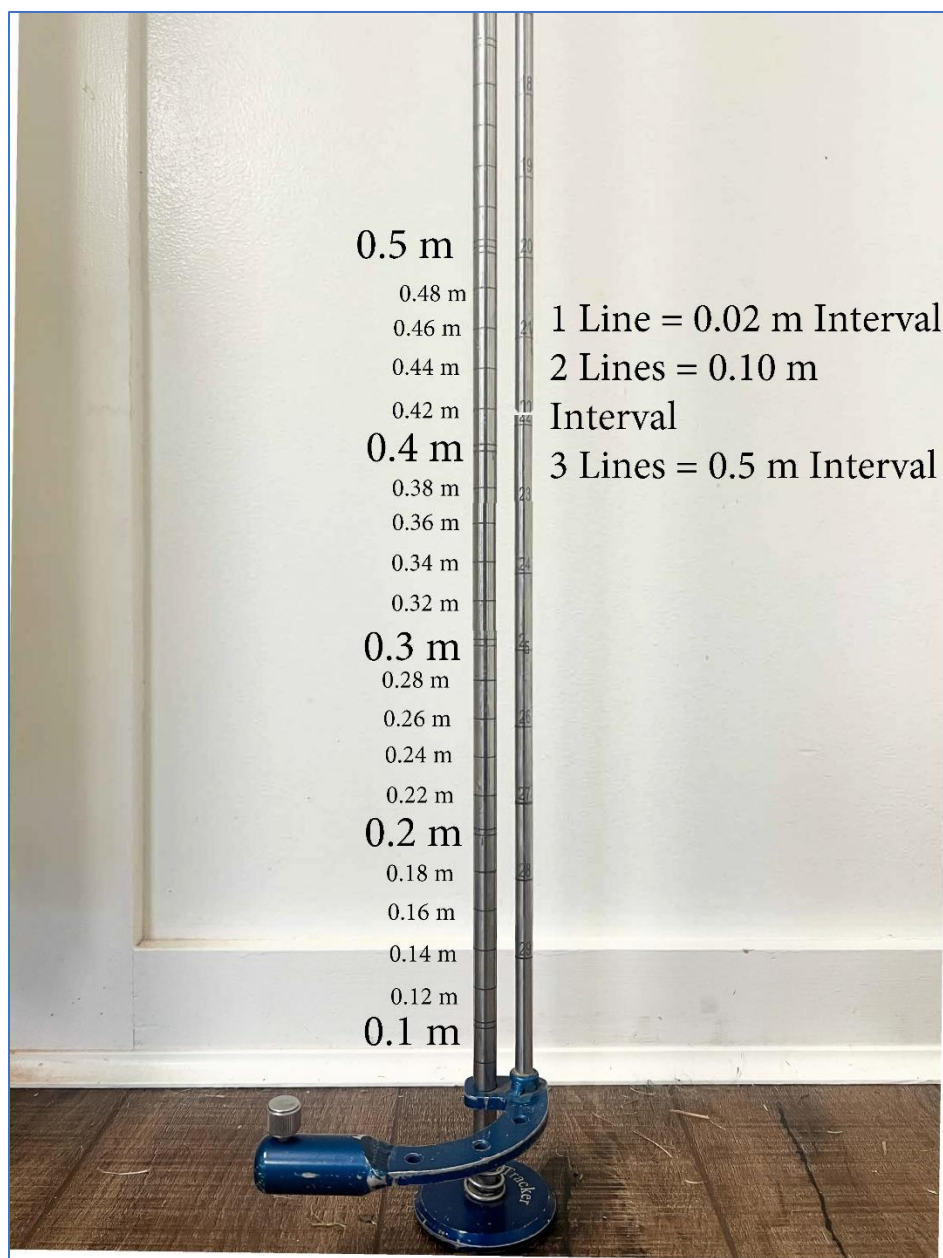


Figure SOP 24.6. The metric wading rod with measurements indicated. Single line markings indicate intervals of 0.02 m, double line markings indicate intervals of 0.1 m and triple line markings indicate intervals of 0.5 m.

The velocity is measured with having the probe at a determined depth from the bottom of the stream bed, so the thinner rod (holding the probe) needs to be adjusted accordingly. After inputting the depth measurement into the FlowTracker, the screen will display how you should align the markings on both rods (Figure SOP 24.7, below). To do this, press the handle and raise or lower the thin rod to align the number with appropriate depth.



Figure SOP 24.7. The top of the wading rod set to a depth of 0.16 m. When setting the depth, the number on the thin pole indicates the digit in the tenths place, and should align with the number on the handle, which indicates the hundredths place. For a depth of 0.16 m as shown above the 1 on the thin pole aligns with the 6 on the handle. If the depth were 0.26 m, the user would squeeze the handle and raise the thin pole such that the 2 on the pole would align with the 6 on the handle.

Measurement of Velocity Workflow

Setup and Calibration

1. Turn the FlowTracker2 on. Press the right soft key, under measurement.
2. Press the Enter key on *Discharge*.
3. Select the correct *Discharge Template* from the list. If you have not set up a template, go back to the section [Set Parameters](#).
4. Enter the *Site Number* and *Site Name* (they should be identical), and your initials into the *Operator* field, ensuring that the *Discharge Equation* displays “Mid-Section” (Figure SOP 24.8).

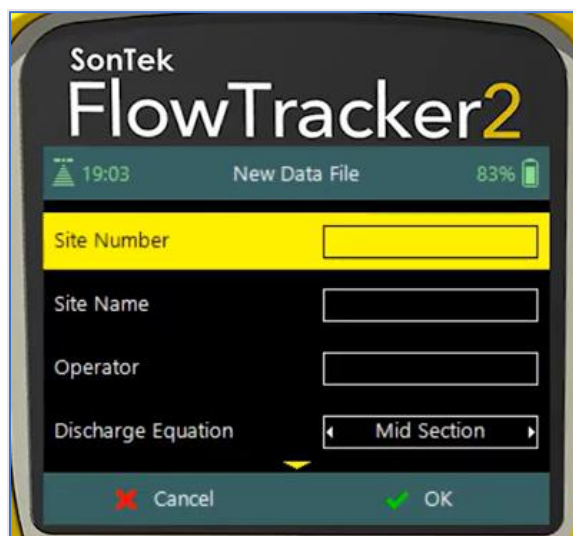


Figure SOP 24.8. FlowTracker2 Metadata Menu.

5. Complete the *Automated BeamCheck* by submerging the probe into the water, perpendicular to the flow and follow the instructions on the LCD screen.

Data Collection

1. Click the left soft key to add your first station. Enter in the transect location of the left bank into the *Location* field and use the wading rods to measure the *Depth* of the water before ensuring that the *Station Type* displays “Left Bank”. Enter in a correction factor of “0.5” and click the right soft key to add the station.
2. Add your first point by pressing the left soft key once again to add a station, and input the new transect locations, and depths; but this time, ensure that the *Station Type* displays “Open Water” and change the correction factor to “1” before pressing the top right key to begin measuring (Figure SOP 24.9, below). Record the transect location and depth on the datasheet.

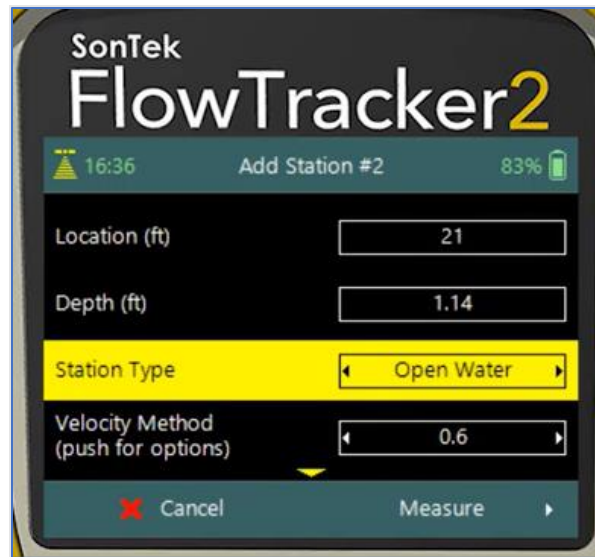


Figure SOP 24.9. FlowTracker2 Add Station Menu. Location and Depth are to be taken in meters (m), not in feet (ft).

3. At this point the FlowTracker2 will indicate how to line up the wading rod to position the probe at the correct depth. Match the diagram shown on the left side of the screen with your wading rod by gripping the handle and sliding the thin pole up or down so that the numbers align as on the diagram (Figure SOP 24.10).

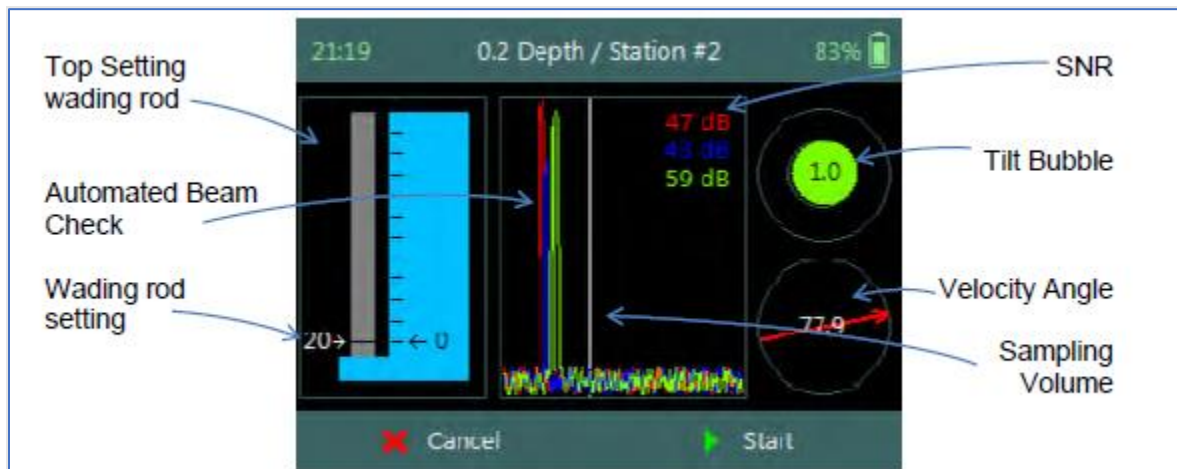


Figure SOP 24.10. The screen displayed when setting the fractional depth of the probe, including the wading rod setting, tilt bubble, and velocity angle.

4. You will also see two other readings on the right side of the screen, the top is the tilt bubble level, which indicates how level the probe is. Adjust the vertical angle of the pole such that the circle in the diagram is in the center. The reading below, the velocity angle, shows the angle at which the probe is facing in comparison to the flow.

5. Once both readings seem stable click the right soft key to start your reading. Keeping an eye on and adjust to the tilt bubble on screen as the reading is being taken to minimize error.
6. After each reading click the right soft key to confirm and accept the measurement, notate the discharge measurement for that station on the datasheet. If a critical error message is displayed (see [Error Messages](#) section below) then repeat the measurement.
7. Press the left soft key to add another station. The FlowTracker2 will automatically determine the location of your next station based on the interval between the left edge and the first point therefore the *Location* field will only need to be changed if an alternate point is sampled. Only the *Depth* will need to be updated by deleting the previous measurement with the backspace key and entering the new measurement.
8. Repeat Steps 2-7 for points 2-20 on the datasheet.
9. At the right edge, change the *Station Type* to “Right Bank” and change the correction factor to “0.5” before recording the *Depth*. Press the right soft key to indicate that you are done.

Troubleshooting

Press the right soft key and navigate to the *Discharge Measurement* menu then scroll down to see the % *Uncertainty* for the given discharge measurement. The goal is to bring the uncertainty to less than 10%. If your uncertainty is below 10% then continue to complete the measurement, if it is above 10% then additional points will need to be taken in order to bring the uncertainty down to an acceptable level. You can find spots to lower uncertainty visually using the color-coded bars on the data collection screen. The colors represent the station percentage of total discharge, station discharge less than 5% is ideal and colored green. 5-10% is yellow indicating that an additional station is required in the specific location, larger than 10% is colored red and not recommended. When choosing where to place your added stations, place them in between stations colored red or yellow. Continue this process until the Uncertainty is below 10%.

Completing Measurements

1. Click the right soft key and select “Complete Measurement” (Figure SOP 24.11, below). Confirm using the right soft key once again and make a note of any [QC errors](#) on the datasheet, press the right soft key a second time.



Figure SOP 24.11. The Menu displayed before completing a FlowTracker2 measurement.

2. Scroll down using the down arrow and record the discharge measurement on the datasheet, as well as the uncertainty, then press the right soft key to indicate that you are complete.
3. Once the measurement is done, power off the FlowTracker2 and disassemble the wading rods outside of the water, making sure to remove the battery holder once the device is powered off to conserve charge.

Error Messages

The following are error messages/warnings that may appear after completing a measurement.

Although not all measurements will necessarily need to be fixed to maintain a % error of less than 10%, it is helpful to understand what each of these error messages mean. Errors **highlighted in red** are more critical than those that are not highlighted and therefore should be amended first in the case of a % error of greater than 10%.

- Approach Low SNR: This error occurs when water conditions are poor, and it is advised that you repeat the measurement or move to a slightly different location if this message is displayed.
- **Beam SNRs Not Similar:** This error message is most often caused because the beams are not seeing similar water quality. This is most often caused by obstacles in the water (rocks, leaves, plants, etc.) so if this error message is displayed check for and remove any obstacles near the probe, if the error persists then perform another beam check to calibrate the probe. This can be found by pressing the right soft key to click Menu in the “Data Collection” Screen and scrolling down to find “Automated Beam Check.”
- Boundary Interference: This error is most often caused by obstacles at or near the measurement location. It is advised that you check for and remove any obstacles near the probe or move to a different location.

- **High % Spikes:** This error occurs when there is highly variable flow, obstacles moving upstream, or the probe moves too much during data collection. In this case, check for obstacles upstream and repeat the measurement ensuring that the probe does not move during the measurement.
- **High Stn % Discharge:** This error occurs when there is high velocity at a station or when there is too much spacing between stations. If this error occurs add a station in between the current station and the previous station and notate it on the datasheet.
- **Large SNR Variation:** This error occurs when there is unusually high or low sediment load interfering with the probe, or if there are obstacles doing the same. Check the probe for obstacles before observing to see if there are any changes in the sediment load to determine if the warning is realistic.
- **Location Outside Edge:** This error occurs when the entered station location is outside of the edge location, in this case, re-enter the station location to correctly depict its location.
- **Low SNR:** This occurs when the SNR is below 4 dB which can be caused by clear water or very sediment-rich/poor water conditions. In this case perform an automated BeamCheck from the menu in the Data Collection screen.
- **Rod Angle > QC:** This error occurs when the wading rod is not vertical during measurement. In this case the measurement is to be repeated, ensuring that the rod is vertical using.
- **SNR Threshold Variation:** This error occurs when sudden changing of water conditions effects the probe. Check the probe for obstacles and to see if the warning is realistic.
- **Standard Error > QC:** This error occurs when the standard error of the measurement is greater than that of previous stations. If necessary to reduce the total % error of the discharge measurement, repeat measurement at a station with this error.
- **Station Order:** This error occurs when the station location is out of sequential order, ensure that this was on purpose and if not, correct the location field for the station.
- **Stn Spacing > QC:** This error is displayed when the distance between this station and the last station is too large, ensure that the station location was entered correctly.
- **Velocity Angle > QC:** This is displayed when the angle of flow at the station is not perpendicular to the probe. Repeat the measurement after adjusting the angle of the probe if necessary.
- **Water Depth > QC:** This occurs when the entered water depth is very different when compared to the previous station, simply ensure that the water depth was entered correctly.

Downloading and Processing Files

Equipment Needed:

- FlowTracker2 Software ([SonTek Software Downloads](#))
 - Micro-USB connector
1. Place batteries in removable battery holder and install in handheld FlowTracker battery compartment.
 2. Attach the micro-USB cable to base of handheld and attach USB serial port adapter to the serial port and plug the USB end to computer.
 3. Turn on FlowTracker2 handheld and navigate to the *Communications* menu from the Main Menu of the FlowTracker2, then open the FlowTracker2 software on your PC.
 4. In the software, click the “Device” button in the top-left corner (Figure SOP 24.12) then click the “USB” button to connect to the handheld (Figure SOP 24.13).

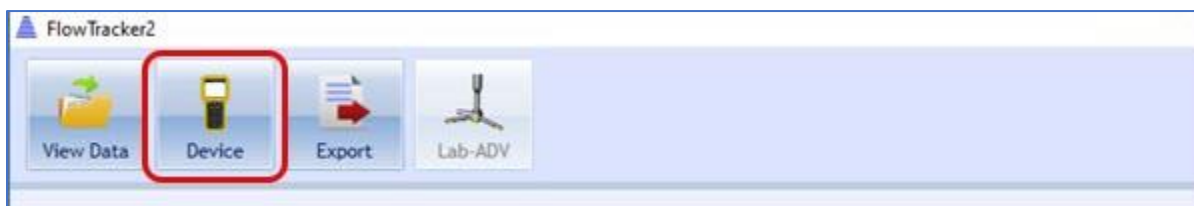


Figure SOP 24.12. The FlowTracker2 software menu. *View Data* is used to view FlowTracker2 files, *Device* is used to connect to the FlowTracker2 handheld, and *Export* is used to export edited FlowTracker2 files.

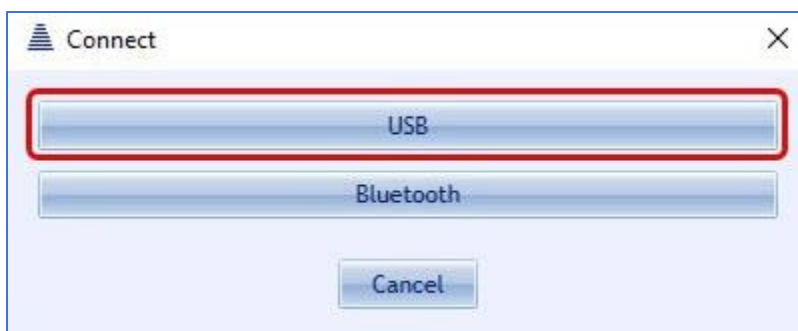


Figure SOP 24.13. The device menu in the FlowTracker2 software

- Once found, the files that are stored on the FlowTracker2 handheld will appear on screen. You can determine which files you would like to download by using different commands. A single click will select one file, holding down the **Shift** key on your keyboard and clicking will select a range of files, and holding down the **Ctrl** key and clicking will allow you to select and deselect multiple files individually. Once the files that you would like to download are selected, you may click the “Download” button found in the upper menu on the right (Figure SOP 24.14).

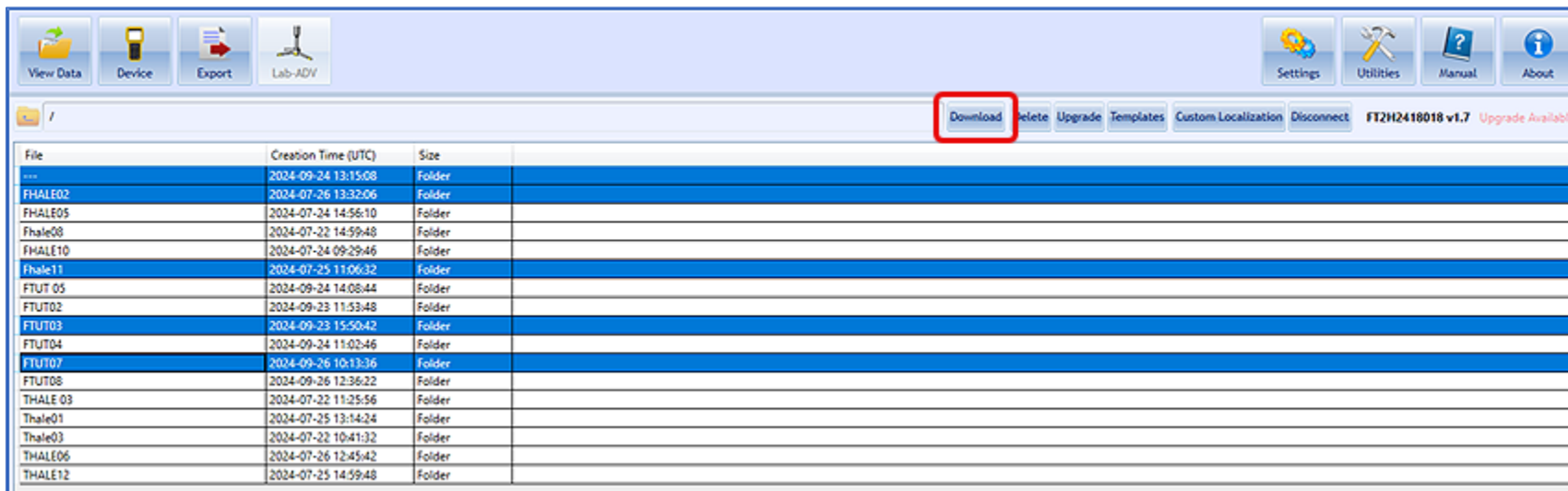


Figure SOP 24.14. This screen shows the files stored on the FlowTracker2 handheld. Selected files are highlighted in blue and will be downloaded when the “Download” button (circled in red) is clicked.

6. Save the raw (.ft) files onto the user's local workspace (e.g., C:\Users\UserName\OneDrive - DOI\06b_fw_animals_streams\Data\Flowtracker_Data\[YEAR]²\[PARK]³\Raw).
7. Once the FlowTracker2 files are downloaded, disconnect the FlowTracker2 handheld by clicking the “Disconnect” button on the far right.
8. To open files click the “View Data” button in the top-left of your screen and navigate to the folder you saved your FlowTracker2 files in Step 6. Select a file to open and a summary of the discharge measurement will appear on your screen.
9. Data can be reviewed and edited and once it is satisfactory, click the *Summary* tab at the far right of the selection above the data (Figure SOP 24.15). From here click the button that says “Save PDF of summary” in order to open a PDF of the summary in your browser. Save this PDF with the naming convention, “TransectName.pdf” (e.g., FHALE02.pdf).

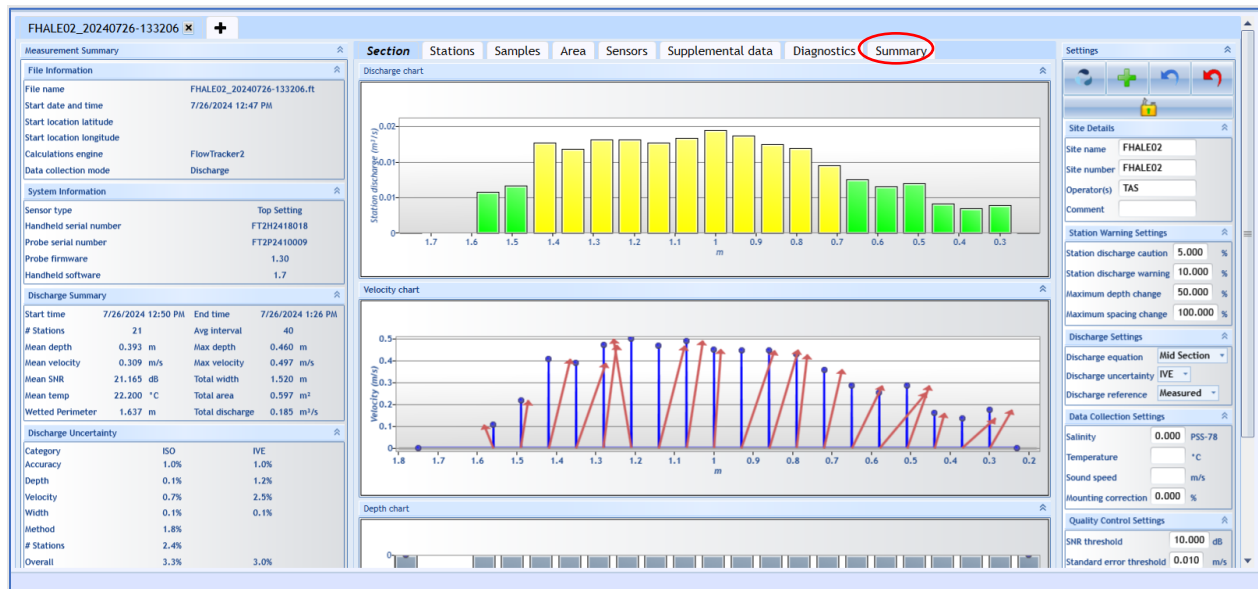


Figure SOP 24.15. A FlowTracker2 software summary. The Summary tab from which the PDF is saved is circled.

10. Once done processing, upload both the raw and processed (PDF) files from the user's local workstation to SharePoint –
 - Upload RAW files to “Raw” folder for the appropriate park and year which are subfolders within the “[Flowtracker Data](#)” folder in SharePoint (Figure SOP 24.16, below).

² [YEAR] = 4-digit year (e.g., 2024, 2025, etc.)

³ [PARK] = 4-letter park code (e.g., HALE, KALA, NPSA, WAPA)

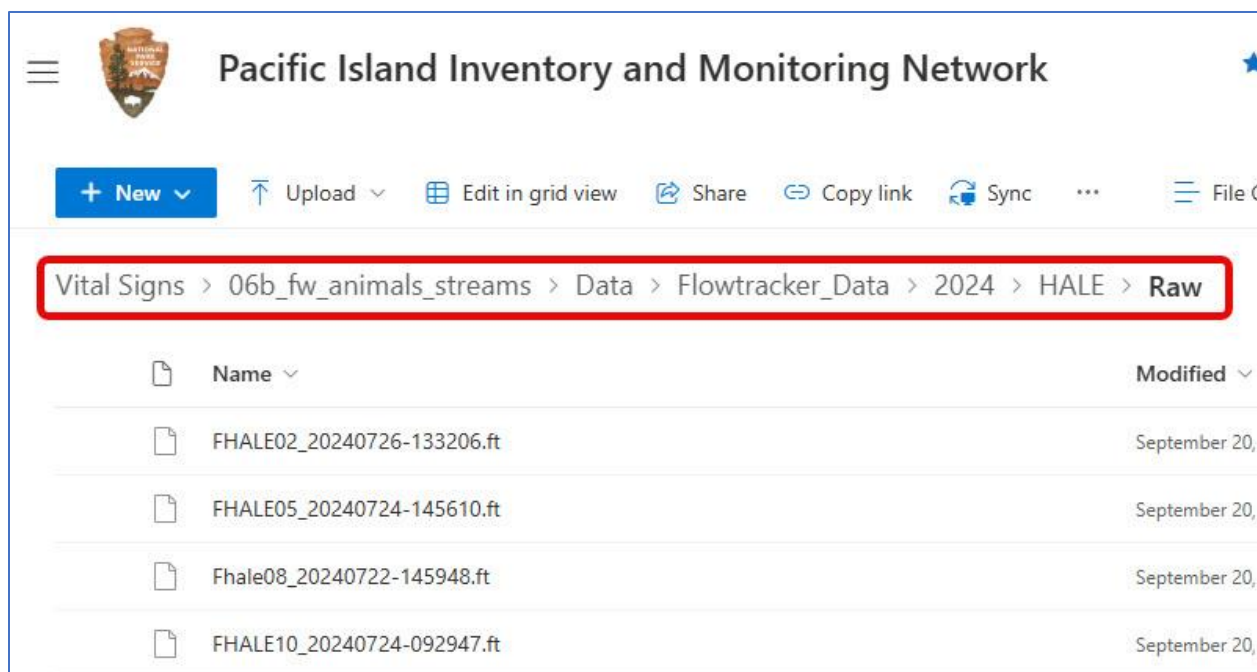


Figure SOP 24.16. Example of where to save raw FlowTracker files in SharePoint for 2024 HALE data.

- Upload Processed PDF files to “PDFs” folder for the appropriate park and year which are subfolders within the “[Flowtracker Data](#)” folder in SharePoint (Figure SOP 24.17).

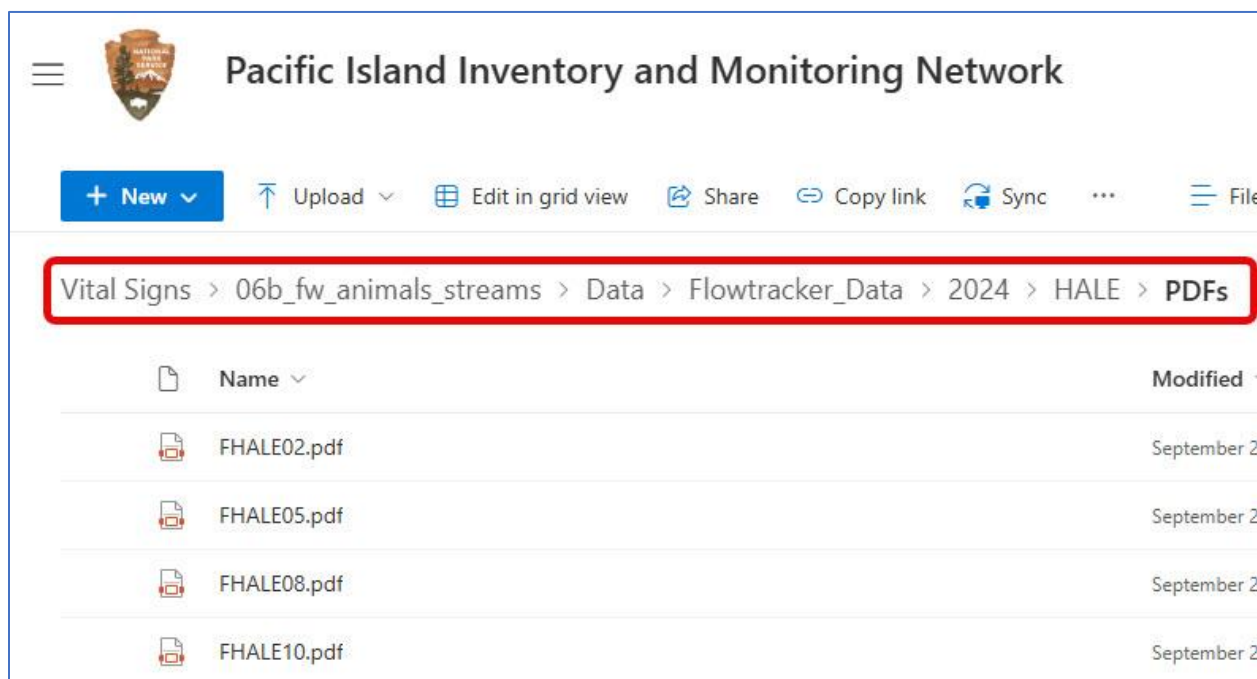


Figure SOP 24.17. Example of where to save processed PDF FlowTracker file in SharePoint for 2024 HALE data.

Additional Information

Additional information below is copied directly from [Discharge Measurements at Gaging Stations](#) (Turnipseed & Sauer, 2010).

Acoustic Doppler Velocimeter (ADV)

The SonTek/YSI FlowTracker2 handheld ADV is a wading discharge measurement device. The FlowTracker2 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. The magnitude of the phase change is proportional to the flow velocity. The phase difference can be positive or negative, allowing ADVs to measure positive and negative velocities. The FlowTracker2 measures the velocity at a rate of approximately 10 MHz, averages the data, and records 1-second velocity-vector data. The FlowTracker2 measures velocities with a range as low as 0.001 m/s (0.003 ft/s) and up to 4.5 m/s (15 ft/s).

The FlowTracker2 probe is mounted to a standard top-setting wading rod with a special offset-mounting bracket. This bracket is designed to locate the FlowTracker2 probe at the front of the wading rod, with the sampling volume about 2 in. (5 cm) to the right of the wading rod. Although the probe is inserted into the flow, the sampling volume is about 4 in. (10 cm) away from all physical parts of the probe, to minimize flow disturbance in the sampling volume.

FlowTrackers have several unique data-processing requirements because of their method of operation and some of the inherent limitations of the acoustic Doppler measurement technique. Unlike mechanical meters that use the momentum of the water to turn a propeller and directly measure the velocity of the water, the FlowTracker2 does not measure the velocity of the water. The FlowTracker2 measures the velocity of particles (sediment, small organisms, and bubbles) suspended in the flow, if these particles travel at the same velocity as the water. Therefore, the quality of the measurement is dependent on the presence of particles within the sampling volume that reflect a transmitted signal. The FlowTracker2 records the signal-to-noise ratio (SNR), standard error of velocity (based on 1-second data), angle of the measured flow (relative to the x-axis of the FlowTracker2 probe), number of filtered velocity spikes, and a boundary quality-control flag. These velocity and quality-assurance data may be used to evaluate the measurement conditions. Few similar quality-assurance data are available for Price current-meter measurements.

Although a FlowTracker2 can measure within about 1.2 in. (3 cm) of a boundary, the velocity measurement might be affected by acoustic interference when the sampling volume is close to boundaries or underwater objects, even when the sampling volume is not directly on or past the boundary. At the start of each velocity measurement, if the probe detects nearby acoustic boundaries that could cause interference with the velocity measurement, a boundary adjustment is automatically made. The boundary adjustment attempts to overcome the possible interference by reducing the lag times of the acoustic signals transmitted by the

FlowTracker2, causing a reduction of the velocity range that can be measured. Any changes are noted in the boundary quality-control flag. Because the sampling volume is located about 4 in. (10 cm) from the transmitting transducer it can be difficult to ascertain the precise location of the sampling volume. If the sampling volume is on or past a boundary, the velocity data will be erroneous. Be careful to avoid boundaries while making measurements in depths less than 3.54 in. (9 cm), especially in channels with irregular bottoms.

Spikes in velocity data occur with any acoustic Doppler velocity sensor such as the FlowTracker. Spikes may have a variety of causes (for example, large particles in the flow, air bubbles, or acoustic anomalies). Velocity data from each FlowTracker2 measurement are evaluated to look for spikes. The FlowTracker2 spike filter is a variation on a method called “Tukey’s Outlier.” In this method, a histogram of each velocity component is calculated. The FlowTracker2 determines the lower quartile (Q1; 25 percent of samples are less than this value), the upper quartile (Q3; 75 percent of samples are less than this value), and the interquartile range ($IQR = Q3 - Q1$). If the IQR is less than 0.015 m/s (0.049 ft/s), IQR is set to A 0.015 m/s (0.049 ft/s). Any value less than ($Q1 - 2 * IQR$) or greater than ($Q3 + 2 * IQR$) is considered a spike and is not used for mean-velocity calculations.

The FlowTracker2 measures magnitude and direction of velocity. The operator must keep the wading rod perpendicular to the tag line so that the pulse generated by the transmitter is parallel to the tag line, regardless of flow direction. To compute discharge, the FlowTracker2 uses the component of velocity perpendicular to the transmitting transducer and reports the flow angle from the FlowTracker’s x-axis as a quality-control value. A flow angle measured by the FlowTracker2 may be the result of flow that is not perpendicular to the tag line, or a wading rod that is not being held perpendicular to the tag line (operator error). Flow angles of less than 20 degrees with small variations between verticals are not unusual. Large fluctuations of flow angles between verticals, however, may indicate a poorly measured cross section. If there is angular flow, and the wading rod is oriented with the flow, the velocity used and resulting discharge would be biased high. If the flow is truly perpendicular to the cross section, but the wading rod is erroneously held at an angle, the velocity and resulting discharge would be biased low. To avoid possible errors in the measured velocities, it is important that the operator always carefully and accurately aligns the wading rod.

Signal-to-Noise Ratio (SNR)

Adequate signal-to-noise ratio is needed to obtain an accurate measurement of the flow velocity. SNR is a measure of the strength of the reflected acoustic signal relative to the ambient noise level of the instrument. SNR is a function of the concentration and size distribution of the particles that reflect the acoustic signal. SNR is recorded for each beam with each 1-second sample. The manufacturer states that optimal SNR is 10 decibels (dB) or above (SonTek/YSI, 2002). USGS policy is that a FlowTracker2 should not be used for measuring discharge if the SNR for any single beam is less than 4 dB.

Speed of Sound

The accuracy of hydroacoustic instruments like the FlowTracker2 is dependent on an accurate speed of sound. The speed of sound is primarily a function of the temperature and salinity of the water. The FlowTracker2 has a built-in temperature sensor. To verify that the temperature sensor is working correctly, take an independent water-temperature measurement prior to each discharge measurement. If the FlowTracker2 has been stored in an environment with a different ambient temperature from the water, the probe may need to be placed in the water for a period of time, allowing it to equilibrate with the water temperature. A 5°F error in temperature will result in approximately a 1-percent bias in the measured velocity. The speed of sound is also sensitive to salinity. A 5-part-per-thousand error in salinity would result in an approximate velocity bias of 1 percent, when used in saline environments like estuaries; therefore, the operator needs to measure the salinity and input the value into the FlowTracker.

Maintenance and Care

Although the built-in QCTest is reliable for detecting issues, a BeamCheck stores more system performance data and still may be needed to evaluate the unit in more detail when there is a potential issue.

QCTests and BeamChecks

- Perform a QCTest and store it with each measurement. When a QCTest is completed as part of a measurement, it will print out on the measurement summary.
- Complete a QCTest in flowing water with the sample volume away from any boundaries.
- Perform a BeamCheck if you notice any anomalies in the QCTest. Any failures in a QCTest require a BeamCheck.
- Perform a BeamCheck after any possible physical damage (drop, and so forth), firmware upgrade, or repair.

Literature Cited

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