CHAPTER 13. CONTINUOUS WATER QUALITY MONITORING PROCEDURES

Overview of Continuous Water Quality Monitoring Program

The Continuous Water Quality Monitoring Program's purpose is to provide short and long term hourly water quality data in order to understand trends, treatments, changes, and extremes in water chemistry that would be difficult to observe through individual sampling efforts. Deployable meters (continuous monitors or sondes) generally collect the same parameters gathered during a typical WAB discrete water sample (pH, Temperature, Dissolved Oxygen, & Specific Conductance) but records these parameters at an set time interval (*e.g.,* hourly) for the duration of the deployment. Typical study subjects since the program's inception in 2005 include: delineating the efficacy of limestone treatments to acid deposition streams, quantification of daily pH and DO swings in Potomac drainage streams susceptible to periodic unexplained fish kills, recording treatment effects and pH extremes in acid mine drainage streams, studying specific conductance trends in streams affected by resource extraction, and exploratory monitoring of runoff effects. Other WVDEP divisions and State and Federal agencies are frequent cooperators in continuous monitoring efforts and are indispensable partners in collection of these data.

USEPA. 2014. Best Practices for Continuous Monitoring of Temperature and Flow in Wadeable Streams. Global Change Research Program, National Center for Environmental Assessment, Washington, DC. EPA/600/R-13/170. Available online at: http://www.fs.fed.us/rm/pubs_other/rmrs_2014_stamp_j001.pdf

Instructions for Establishing/Maintaining the Deployable Site (Including Setting up the Site, Site Documentation, and Guidelines for Completing the Forms)

The following is a description of how to establish continuous monitoring sites and use the Deployable Monitoring Form to record parameters of interest. Many of the procedures required to conduct this assessment have already been described in other Chapters of the SOP as detailed below:

CHAPTER 2. INSTRUCTIONS FOR ASSESSING THE STREAM SITE (INCLUDING SETTING UP THE SITE, SITE DOCUMENTATION, AND GUIDELINES FOR COMPLETING THE STREAM ASSESSMENT FORMS) Section C. Guidelines for Completing the Stream Assessment Forms on page 2-28

CHAPTER 3. WATER COLLECTION PROTOCOLS starting on page 3-1

CHAPTER 4. STREAM FLOW MEASUREMENT PROTOCOLS starting on page 4-1

Methods and Procedures

Section A. *Establishing a Site*

Site selection generally begins with a broad study location (*e.g.,* mouth of Sovern Run, or upstream of McClintock Run) or periodically with specific coordinates around which a site must be established. Site selection requires addressing several needs in order to obtain accurate data. A serviceable site should provide enough depth to completely cover the sonde (keeping potential changes in depth in mind), adequate flow to keep the sonde free of sediment and debris, a location for the sonde to blend into the surrounding substrate or be camouflaged into it, and a strong/properly positioned (with respect to depth, flow, and concealment) anchor point. Failure to meet these requirements subjects the data collected to preventable error and the equipment to theft or loss. Upon arrival at the location, the requirements above must be considered when determining the specific point to deploy the continuous monitor.

Part 1. Accessing Site

Since the Continuous Water Quality Monitoring Program generally has a measure of flexibility in establishing site locations, the majority of the sites should be safely accessible. However, in some cases, due to the remoteness of some sites or access points, travelling to the sample site may require strenuous hikes over difficult terrain; NOT DANGEROUS TERRAIN! If a difficult hike is necessary to get to a site, carefully consider the terrain and your personal ability and health to access the site. If you feel it is too difficult (*e.g.,* too far to hike) or dangerous (*e.g.,* steep banks) to get to the site, do not attempt it. Discuss it with other personnel who may be willing to try to get the site later**.**

WARNING: DO NOT NAVIGATE TO ANY ASSESSMENT SITE THAT PRESENTS A DANGEROUS SITUATION TO YOU OR ANOTHER TEAM MEMBER!

Part 2. Locating Established X-Site

When returning to an established site, GPS units should be primarily used to get into the general same stream reach (100 m) previously visited and to confirm the index latitude and longitude that is provided on the list for each index station. If the GPS coordinates and the given index coordinates differ by more than a couple of seconds, re-check your position.

IMPORTANT: ***You should make an attempt to get an exact match if possible. Let the GPS run for several minutes (5-10) before matching the latitude and longitude.***

Once the general stream reach has been located, the exact deployment location should be located by consulting the stream reach drawings from previous installations

Sampling teams should also consult other materials to ensure that they are at the correct location, including: Laptop GIS programs, topographic, county, and/or gazetteer maps, or previous visit photocopies which include directions to the site, hand-drawn maps, and photos.

NOTE: Topographic maps are recycled and older sites may appear on the topographic maps. Take extra care to make sure that you are targeting the correct site.

IMPORTANT: ***Be aware that the coordinates on the previous visit photocopy may be in a different datum. Nevertheless, the hand-drawn map from the previous visit photocopy will be very useful in locating the exact same X-site that was established during the previous visit. You should make an attempt to get an exact match to the previous visit's X-site.***

There may be sites where the GPS unit will not track satellites and thus confirmation of the X-site coordinates may not be immediately possible. If you are certain from the other materials provided that you are in the correct location, you may begin sampling and try getting the GPS unit to lock onto satellites 10-15 minutes later. Team members should collaborate in these instances and utilize their best professional judgment (BPJ) to decide where the X-site is located. In such a case, finely tuned map reading skills are important.

After the X-site has been confirmed (or located via best professional judgment), establish the station.

IMPORTANT: ***Collect all physicochemical, water samples, and GPS coordinates at the X site.***

Part 3. Equipment

The items required for deploying the continuous monitor are pictured in ***Figure 13-1 below*** and include:

1. Protective Deployable Sonde Case and Cap
2. Deployable Water Quality Meter
3. Cable Cutters
4. Swaging Tool
5. Field Chemistry Multimeter (discrete meter)
6. Deployable Water Quality Meter Guard
7. 1/8” Galvanized Cable
8. 1/8” Ferrules (not pictured)

Figure 13-1. Items Required for Deploying the Continuous Monitor

Section B. *Site Documentation*

Part 1. Deployable Coordinates and Global Positioning Systems (GPS)

Basic guidance on how to use a GPS to document a site can be found in ***CHAPTER** 2**. Section B. Part 1. Coordinates and Global Positioning Systems (GPS) on page 2-20***.

Coordinates must be taken on the initial visit and on any subsequent visits during which the sonde is relocated. ***Table 2-2 on page 2-21*** outlines some typical frequency of GPS readings for various sample types.

Part 2. Deployable Photographic Documentation

Basic guidance on how to use a camera to document a site can be found in ***CHAPTER 2. Section B. Part 2. Photographic Documentation on page 2-24***.

Specifically for continuous monitoring, a minimum of the following are needed from each site to aid in relocating the site if necessary:

- View upstream from X site
- View downstream from X site
- Location of anchor point in wide angle picture with landmark (if available)

In addition, pictures of such items as the following may be useful:

- Surrounding bridges/roads
- Close-up of anchor point and sonde location
- Potential sources of error (sediment, sludge, precipitates) on or around sonde
- Waterfowl or other wildlife
- Scenic Views
- Field crews at work
- Distinctive views of target streams, buildings, industry or dams along target stream, or other water related pictures
- Pollution sources and features (*e.g.,* point and non-point sources, metal hydroxides, poorly constructed roads, feedlots, *etc*.)

All pertinent information about a photo should be recorded on the field sheet under the photography log section (***see Section C. Part 1. PAGE 4-Photography Log on page 12-16).***

Section C. *Form Completion*

This section is intended to provide information on interpreting each parameter as well as identifying the value(s) of resultant data. Most of the parameters and values on the Deployable Sonde Form have already been addressed in ***CHAPTER 2. Section C. Guidelines for Completing the Stream Assessment Forms found on page 2-28***.

The parameters that have already been addressed above will not be described here unless they vary in some way on the Deployable Sonde Form.

What is presented here explains what is found on the Deployable Sonde Form that is unique to Deployables and not found on other forms (*e.g.,* WAB, AWQN, TMDL-Initial Visit, TMDL-Secondary Visit, TMDL-Final Visit, TMDL-Source, and General WQ). The instructions on how to fill out the sections are the same unless otherwise stated.

Description of Deployable Sonde Form

The Deployable Sonde Form differs only slightly from other general water quality forms. There are two sections of the form that are unique. Instructions for completing those portions are as follows.

PAGE 1

For a description of parameters and values not seen below, ***see CHAPTER 2. Section C. Part 1. PAGE 1-Site Verification on page 2-30 for an example***.

Deployable Site Verification

Visit Type: At the top of PAGE 1 (***see Figure 13-2 below***) of the form, there is a check box to indicate the Visit Type that the sampler is performing. One or more boxes will need to be checked to show the purpose of the visit:

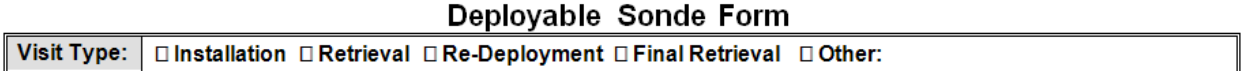

Figure 13-2. Example of the Deployable Visit Type on PAGE 1 of the Deployable Sonde Form

1. **Installation**
   The Installation box should be marked only when a deployable is being placed in a new location that has not previously been established as a deployable study site. It is not appropriate to check any other boxes during a sonde installation. An installation includes relocating the sonde within the general 100 m reach and should always be accompanied by a new drawing of the specific deployment location and new GPS coordinates.

2. **Retrieval**
   This box refers to any visit during which a previously installed deployable is being recovered for calibration, cleaning, downloading, *etc*. Even if the same sonde is returned to the stream for further data collection, it is still classified as a retrieval visit. Generally, this box is selected with the next one (Re-Deployment) also selected. The only time this would not be the case is when a subsequent trip will be made to deploy a fresh sonde or when the sonde is being temporarily pulled due to seasonal changes (*i.e.,* stream is too low or dry to deploy sonde for the next month) but will be redeployed when desired study conditions reoccur.

3. **Re-Deployment**
   The purpose of this box is to indicate any visit in which a fresh sonde is deployed to a previously established site. On many occasions this box will be indicated along with Retrieval box.

4. **Final Retrieval**
   Select this box if the visit is to terminate further foreseeable study at that location. No other boxes should be marked when this one is marked. This includes seasonal removals of equipment (*e.g.*, pulling the sonde for the winter months).

5. **Other**
   Use this box when none of the above applies. The most common example would be a mid-deployment visit to the station to obtain an additional discrete sample to help later on with data correction (*e.g.,* Discrete Check).

PAGE 2

Discrete Sonde Info

This unique section of the Deployable Sonde Form is located at the top left of PAGE 2 (***see highlighted area in Figure 13-3 below***). It is similar to the regular Sonde Physiochemical Parameters section on other forms. However, the discrete sonde readings are recorded twice: 1) side-by-side with the deployable sonde at the time of retrieval and 2) side-by-side with the deployable sonde at the time of deployment of a new or serviced sonde. Since this will occur at two separate times, there is additional space to record the exact time of each reading.

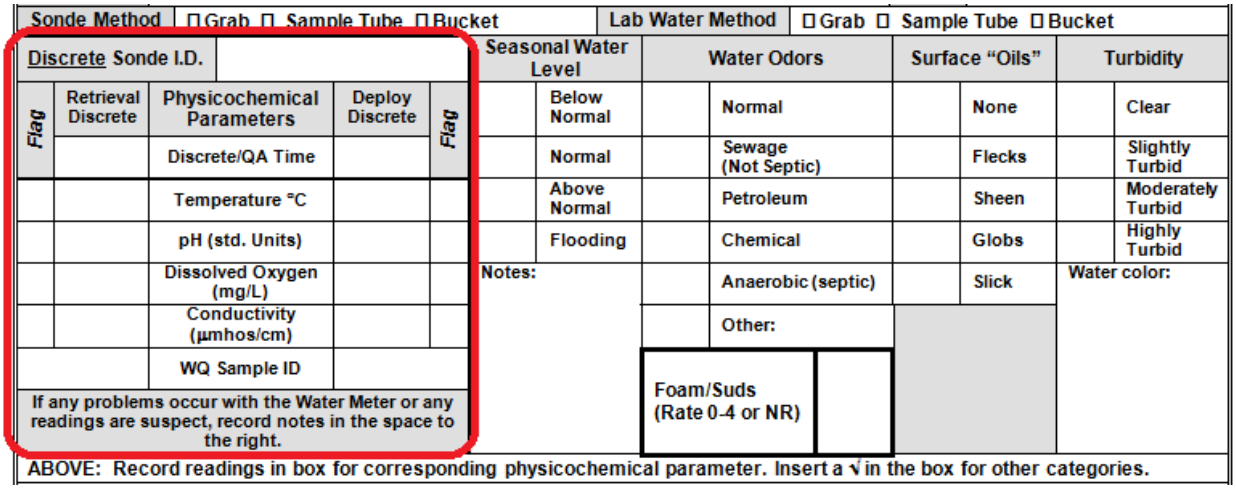

Figure 13-3. Example of the Discrete Sonde Info Section on the Top of PAGE 2 of the Deployable Sonde Form

Deployment Sonde Info

The other unique section of the Deployable Sonde Form is located at the bottom of PAGE 2 (***see Figure 13-4 below***). This portion of the form holds positional, programming, and Quality Control data about the deployable sonde.

Deployable Location	☐ Mid-Stream ☐ Bank (☐ Left ☐ Right) ☐ Thalweg (☐ Left ☐ Middle ☐ Right) ☐ Left Channel ☐ Right Channel ☐ Other:				
Flag	Retrieved Sonde	Physicochemical Parameters	Deployed Sonde	Flag	Target Deployment End Date
		Deployable Sonde ID			File Name
		Temperature °C			Deployable Notes & Comments:
		pH (std. Units)			
		Dissolved Oxygen (mg/L)			
		Conductivity (µmhos/cm)			
Rate the Following where 0=None, 1=Slight, 2=Moderate, 3=Heavy, 4=Extreme)					
Sediment on/in Sonde Case	0 1 2 3 4				
Biofilms on Sonde	0 1 2 3 4				
Metals/Precipitate on Sonde	0 1 2 3 4				

Figure 13-4. Example of the Deployment Info Section on the Bottom of PAGE 2 of the Deployable

Deployable Location: Indicate the cross-sectional location of the deployable sonde: 1) **Mid-Stream**, 2) **Bank** (**Left** or **Right**), 3) **Thalweg** (**Left**, **Middle**, or **Right**), 4) **Left Channel**, 5) **Right Channel**, 6) **Other** (please describe).

Deployable Sonde ID: Record the retrieved and deployed sonde instrument identification numbers. This is usually marked on the sonde with a black sharpie. If for some reason the sonde's instrument identification number is not apparent, then write down the WV Property Tag number (found on a blue tag) or the manufacturer's Serial Number on the instrument so that the proper identification number can be tracked down later and remarked onto the sonde.

Target Deployment End Date: An estimation of the next date the site will be visited for retrieval/redeployment/final retrieval (typically 30 days after deployment).

File Name: The name given to the file during programming that will be downloaded upon retrieval of the sonde. Make sure the file name matches exactly the programmed name to ensure future searches and cross checks will be less confusing and less subject to error.

Retrieved/Deployed Sonde Parameter Check: This space is for recording the side-by-side values for each of the physicochemical parameters indicated on the form from the retrieved and/or deployed sondes. This requires attaching the deployable sonde to a handheld display or laptop and gathering a discrete measurement from it at the same time as the discrete sonde side-by-side in-stream. This data should be paired with the

discrete sonde readings (***see highlighted area in Figure 13-3 on page 13-7)*** at the same exact time.

Sediment in/on Sonde Case: Rate the amount of sediment inside or covering the sonde based on the following scale: **0-None, 1-Low, 2-Moderate, 3-High, 4-Extreme, or NR-Not Rated.** This is important to evaluate and note before disturbing the sonde during retrieval since sediment can clog the sonde ports and prevent accurate readings.

Biofilms on Sonde: Rate the amount of biofilms (*e.g.*, periphyton, algae, *etc*.) on the sonde based on the following scale: **0-None, 1-Low, 2-Moderate, 3-High, 4-Extreme, or NR-Not Rated.** This is important to concentrate on the individual sensors since biofilms can impede accurate measurements and cause drift in the readings.

Metals/Precipitate on Sonde: Rate the amount of metal hydroxides or other precipitates (*e.g.*, Iron Hydroxide, Calcite deposits, *etc*.) on the sonde based on the following scale: **0-None, 1-Low, 2-Moderate, 3-High, 4-Extreme, or NR-Not Rated.** This is important to concentrate on the individual sensors since these precipitates can impede accurate measurements and cause drift in the readings.

Deployable Notes & Comments: This space is for recording notes that pertain to any conditions observed when retrieving/deploying the meter that may be reflected in the data file such as extreme sediment in sonde case, biofilm on the sonde probes, or sonde washed out of water column upon retrieval. Describe any factors that might affect the accuracy of the data contained on the sonde or any possible explanations for differences in discrete and side by side measures.

Section D. *Deployable Sonde Operation (Calibration, Programing, and Downloading Protocols)*

Part 1. Sonde Calibration Procedures

The instructions below refer to ***Figure 3-3. Example of Sonde Calibration Log Sheet on page 3-5.***

> ***IMPORTANT: Since all of the readings being calibrated are temperature corrected, it is very important to use room temperature DI or distilled water and calibration solutions when available. The pH solutions can be corrected for using the graphs found on pages 3-19 to 3-21.***

YSI Deployables

YSI sondes may be calibrated using either a compatible YSI Display Unit or the computer via the YSI **Ecowatch software.** Refer to ***Section A. Water Quality Sondes & Sensors: Calibration, Routine Maintenance, & Use*** starting on ***page 3-1*** for instructions on the calibration of the YSI deployables using a compatible Display Unit.

Also note that the data ports on the YSI deployable sondes are protected by a gray plastic screw cap which must be removed before connecting the sonde to either a computer or display unit.

Refer to ***Part 2. Sonde Programming Procedures-YSI Deployables on page 13-14*** for directions on how to program the YSI sonde for deployment.

Hydrolab Deployables

Hydras 3LT software is required to operate Hydrolab brand sondes. If the software is not present, contact the help desk to request installation or use a computer that does have the program. **MAKE SURE THE PROBES ARE CLEAN BEFORE CALIBRATING THE SONDE.** Steps for programming the sonde for deployment are as follows:

1. Remove the rubberized cover over the data port and connect the sonde to the Hydrolab- USB adapter cable and plug into USB port of computer. When plugged in the sonde should emit a 1-2 second monotone beep signaling the unit is powering up. If this does not occur, replace the batteries and perform Step 1 again.

2. Initiate the **Hydras 3LT software** and it will automatically search for any connected sondes.

   NOTE: It is likely that the software will display in German, not English. Press F3 key to switch language to English.

   Upon locating the sonde, the port and sonde name/number will appear in the top box. To the right of this box are 3 gray buttons, select the middle **Operate Sonde** button.

3. Select the **Calibration tab** to open up the calibration interface. Eleven tabs will appear, begin calibration with the **SpCond [µS/cm] tab**. Make certain that calibration is done in µS/cm not mS/cm, as these tabs are adjacent to one another. Open the calibration cup and rinse the cup with DI or distilled water two times, watching the **Current Value** just below the tabs in the left corner ensuring that the values stay near 0, indicating a well rinsed probe. Empty the cup and dry the probes with a paper towel. Type 0 into the white **SpCond [µS/cm]** box above the Calibrate and Reset buttons. Record the **Current Value** as **Initial Sp Cond** on a Calibration Log Sheet and press the **Calibrate** button. Record the **Final Sp Cond** value from **Current Value**. Rinse the calibration cup two times with 1000 µS/cm standard solution and fill the cup above the stirring assembly with the standard. Type 1000 into the white **SpCond [µS/cm]** box above the Calibrate and Reset buttons. Record the **Current Value** as **Initial Sp Cond** on the Calibration Log Sheet and press the **Calibrate** button. Record the final value from **Current Value** on the Calibration Log Sheet as **Final Sp Cond**. Do not pour out standard solution, as it can be used to calibrate the next parameter.

NOTE: The Calibration Log Sheet does not have a location for the separate 0 and 1000 µS/cm initial and final calibration values. Record this on the sheet as 0/1000.

4. Press the **LDO% [Sat] tab**. Rinse the calibration cup 2 times with room temperature DI or Distilled Water. Shake the DI/DW water vigorously for 45 seconds in order to thoroughly aerate the liquid. Fill the calibration cup over the LDO probe and place the lid lightly back on the calibration cup. Let the LDO probe equilibrate for several minutes, or until readings in **Current Value** stabilize. Determine the Barometric Pressure (mmHg) from an YSI unit (which has a built in barometer) or a functioning Lab Barometer and enter the Barometric Pressure in the **LDO_BP [mmHg]** box. Record the **Current Value** as **Initial % Sat** and the **Atmospheric Pressure (mm Hg)** on the Calibration Log Sheet and press the **Calibrate** button. Record the final value from **Current Value** as **Final % Sat** on the Calibration Log Sheet. Empty the contents of the calibration cup.

5. Click the **pH [Units] tab**. The pH calibration is set up as a 2 point calibration; pH 7 will always be the first calibration standard followed by pH 10 or pH 4 depending on the expected pH range of the stream in which the sonde will be deployed. Use pH 10 buffer if the receiving stream is typically basic or use pH 4 if the stream is typically acidic. Rinse the calibration cup two times with pH 7 standard solution and fill the cup above the stirring assembly with the standard. Let the solution sit for approximately 2 minutes to allow for the temperature to adjust. Type 7 into the white **pH [Units]** box above the Calibrate and Reset buttons. Record the **Current Value** as **Initial pH (7)** on the Calibration Log Sheet and press the Calibrate button. Record the final value from **Current Value** on the Calibration Log Sheet as **Final pH (7)**. Rinse the calibration cup two times with pH 4 or 10 standard solution (select appropriate standard) and fill the cup above the stirring assembly. Type 4 or 10 into the white **pH [Units]** box above the Calibrate and Reset buttons. Record the **Current Value** as **Initial pH (4) or (10)** on the Calibration Log Sheet and press the **Calibrate** button. Record the final value from **Current Value** on the Calibration Log Sheet as **Final pH (4) or (10)**.

The sonde is now calibrated. Refer to ***Part 2. Sonde Programming Procedures-Hydrolab Deployables*** on ***page 13-15*** for directions on how to program the Hydrolab sonde for deployment.

Eureka Manta Deployables

Eureka Multiprobe Manager software is required to operate Eureka brand sondes, if the software is not present, contact the help desk to request installation or use a system that does have the program. **MAKE SURE THE PROBES ARE CLEAN BEFORE CALIBRATING THE SONDE**. Steps for calibrating the Manta sonde are as follows:

1. Remove the black plug from the end of the Manta by unscrewing the bolt and pulling the plug out, thus exposing the data port.

2. Connect the sonde to the Manta-USB adapter cable and plug into USB port of computer.

3. Initiate the **Multiprobe Manager software** and it will automatically search for any connected sondes. Upon locating the sonde the program will automatically start downloading the data from the currently running file name. (If there is no new data found on the probe, then a screen showing the current parameters will start cycling).

4. Click on the **Calibration** button, 3rd button down in the left column. The window will change to the **Calibration** window. In the middle of the window there will be a scroll down box with Sensor (parameters) list in the left column and Calibrate buttons running down the far right column.

5. Start the calibration by rinsing the probes with clean water. In the **scroll down** box, find the **Sensor DO %Sat** and click on the corresponding **Calibrate** button. The window will change to three line graphs of the real-time values for %Sat DO, Temperature, and Conductivity. Rinse the probes two times with room temperature DI/DW water. Shake the DI/DW water container vigorously for 45 seconds in order to thoroughly aerate the liquid then fill the calibration cup above the tip of the ODO probe. Replace the cap lightly on top of the calibration cup. Click on the **Start** button on the lower-left side of the window. The window will show refreshed line graphs of the above mentioned parameters. Enter the **Barometric Pressure (mmHg)** in the box below the line graphs. This can be determined from an YSI unit (which has a built in barometer) or a functioning lab barometer. Wait for the %Sat DO line graph to stabilize, record the %Sat DO value as **Initial % Sat** and the **Atmospheric Pressure (mm Hg)** on the Calibration Log Sheet. Click on the **Calibrate** button on the lower-left side of the window. The line graphs will refresh. Click the **Finish** button in the lower-left corner to return to the **Calibration** window. No final DO value is provided by program, must be recorded before clicking **Finish**.

6. In the **scroll down** box, find the **Sensor SC (us/cm)** (Specific Conductance) and click on the corresponding **Calibrate** button. This will initiate two line graphs of real-time values for Conductivity and Temperature. Rinse the calibration cup two times with DI or distilled water and fill until DI or distilled water is covering all probes. Specific Conductance should read less than 5 us/cm. Record the Specific Conductance value as the **Low End Check Sp Cond (μmhos/cm)** on the Calibration Log Sheet. If the value is greater than 5 us/cm, clean the probe with a wire brush and repeat the low-end check. If the probe still fails to read less than 5 us/cm, it is likely malfunctioning and will need to be sent to Eureka for maintenance. After completing a successful low end check, proceed with the calibration procedure. Empty the DI or distilled water and dry the probes with a

paper towel. Rinse the probes two times with 1,000 us/cm standard solution. Fill the calibration cup with standard solution ensuring all probes are fully covered. Click on the **Start** button on the lower-left side of the window. The window will show refreshed line graphs of the above mentioned parameters. Wait for the Specific Conductance line graph to stabilize, record the **Initial Specific Conductance** value as **Initial Sp Cond (μmhos/cm)** on the Calibration Log Sheet. Click on the **Calibrate** button on the lower-left side of the window. The line graphs will refresh, record the **Final Specific Conductance** value as **Final Sp Cond (μmhos/cm)** on the Calibration Log Sheet. Click the **Finish** button in the lower-left corner to return to the Calibration window.

7. In the **scroll down** box, find the **Sensor pH** and click on the corresponding **Calibrate** button. The two line graphs of the real-time values for pH and Temperature will appear. Rinse the probes twice with pH 7 buffer and fill the calibration cup above all the probes. Click on the **Start** button on the lower-left side of the window. Refreshed line graphs will initiate. Just below the line graphs enter pH 7 into the **pH value** box. Once the pH line graph stabilizes record the **Initial pH value** as **Initial pH (7)** on the Calibration Log Sheet. Click on the **Calibrate** button on the lower-left side of the window. The line graphs will refresh, record the **Final pH value** as **Final pH (7)** on the Calibration Log Sheet. A window will prompt that the next pH solution should be added. Use pH 10 buffer if the receiving stream is typically basic or use pH 4 if the stream is typically acidic. Rinse the probes two times with appropriate pH buffer and fill the calibration cup. Click on the **Start** button on the lower-left side of the window. Refreshed line graphs will appear. Below the line graphs enter the **pH value of the buffer** used. Once the pH line graph stabilizes record the **Initial pH value** as **Initial pH (4) or (10)** on the Calibration Log Sheet. Click on the **Calibrate** button on the lower-left side of the window. The line graphs will refresh, record the **Final pH value** as **Final pH (4) or (10)** on the Calibration Log Sheet. The next window will present three buttons. Click on the **Calibrate** button to end 2 point calibration, **Continue** and repeat the process used for the other two buffers to perform a 3 point calibration (2 point calibration is the preferred method). Record the **Sensor Response Factor** on the Calibration Log Sheet. Click the **Finish** button in the lower-left corner to return to the Calibration window.

The sonde is now calibrated. Replace the plug with the end with the hole toward the circle and replace the screw (this is the logging off position) or continue to ***Part 2. Sonde Programming Procedures-Eureka Manta Deployables on page 13-17*** for directions on how to program the Eureka sonde for deployment.

HOBO - Temperature/Light Intensity & Temperature/Conductivity Loggers

HOBO (from Onset Comp.) data loggers do not require calibration. Therefore, it is especially important to have a complete set of discrete readings to attempt to document any potential drift. Proceed to ***Part 2. Sonde Programming Procedures-HOBO Temperature/Conductivity*** & Temperature/Light Intensity Loggers on ***page 13-18***.

Part 2. Sonde Programming Procedures

General

All sondes are typically programmed for hourly deployment for a minimum of 30 days. It is advisable to program the meter to run for at least as long as the battery will sustain data collection (around 90 days for YSI and 60 days for Hydrolab). In the event that water level or other priorities prevent timely retrieval of the meter from the site, data will continue to be collected until retrieval is possible. Upon initiating a program, the current date and time need to be verified as correct and the site name must be set up. Site names need to be unique to the site location with the date of the data file within the name. For example, Sovern Run for deployment on May 03, 2010 would be **SOVR0510** for an YSI and **Sovern Run 05032010** for a Hydrolab, HOBO, or Manta. It is important to attempt to maintain the same site name, changing the date only for subsequent deployments. This assists in maintaining neat and orderly collections of data files. Water quality parameters need to be checked to ensure that the file will collect data for all desired parameters using the correct units. Additionally, the programmer must ensure that all previous programs have been terminated before initiating a new file. Some brands will allow multiple files to record concurrently, leading to potential confusion during data analysis.

YSI Deployables

Ecowatch software is required to operate YSI brand sondes, if the software is not present, contact the help desk to request installation or use a system that has the program installed. Steps for programming the sonde for deployment are as follows:

1. Connect the sonde to the YSI-USB adapter cable and plug into USB port of computer.

2. Open the **Ecowatch software** (if not already open). Single-click the **Sonde Icon** (6 over from the left) on the top bar. A **Select COM Port** window will open, select the **port the USB is connected to** and click the **OK** button. This will open the **Sonde Programming Window**. If this window does not open, no connection is occurring and the issue likely lies with the adapter cable.

3. Within the Sonde Programming Window, a # sign or prompt should be present in the top left hand corner. Type **menu** beside the # sign to begin programming. This will bring up the **Main Programming Menu.**

4. Select **4** from the Main Menu to bring up the **Status Screen**. Check that the date and time are correct. To edit these, select **2** for **Date** or **3** for **Time** and type in the correct value then **press enter**. Also ensure that the Battery volts are above 5.7 (always deploy a sonde with new batteries) and that Logging is inactive. When all changes have been completed, type **0** or **press escape** to go

backwards to the **Main Menu** (these commands will always take you backwards in any menu screen).

5. Type **1** at the Main Menu to enter the **Run Setup Screen**. Type **2** for **Unattended Sample**. This will bring initiate the **Unattended Setup Screen**. Check that **1-Interval** is set to the correct logging interval, typically **01:00:00 or 1 hour**. The start date and start time default to the day of programming and the beginning of the next hour (for hourly logging). Logging can be postponed by changing these dates/times in the same manner as in the Status Screen (2 for Date; 3 for Time). Postponing the start of logging is advisable if the sondes will not be deployed immediately (within the next 24-48 hours) as it will save some battery life. Check **4** for **Duration days** to ensure that the period of deployment is covered plus a window to allow the sonde to continue recording if it is not retrieved when scheduled. Most sondes are set at 90 days.

6. Type **5** and **enter a file name** according to the naming convention described in the section above, then press enter. YSI sondes only allow 8 characters for this field. North Fork of Cranberry River 7/12/10 would need to be recognizable in 4 characters with 4 characters for the date: NFCR0710. Type **6** then **enter the same site designation** and **press enter**. Check that lines 5 and 6 read the same, both in caps.

> ***IMPORTANT:*** ***If you are deploying at the first of the month and anticipate redeploying at the end of the same month, you will need to amend the file name in some manner so that you can distinguish the two files. For example, if you are deploying into the North Fork of Cranberry River on 7/1/11 and 7/31/11 you may use NFCR0711 for the first deployment in July and either NFC0711B (B for the second deployment) or NFCR0811 (indicating August, the next day).***

7. Type **C – Start logging** to initiate the logging program. This will initiate the Start logging screen asking for a confirmation, type **1** to **begin the program**. The **Logging Screen** will open, where all parameters should be read to ensure no errors exist and the program has a start and end time/date.

8. Type **0** two times to return to the **Main Menu**. Type **4** to enter the **Status Screen**, review all entries again paying particular attention to line 7-Logging, it should read “Active.” If it does not, the program has not been initiated correctly. Check that Step 7 was completed correctly, if so, return to Step 4 and redo the entire programming process. When complete, disconnect the sonde and screw the end cap back on the meter and it is ready for deployment.

Hydrolab Deployables

Hydras 3LT software is required to operate Hydrolab brand sondes, if it is not installed on the computer to be used, contact the help desk to request installation or use a

system that does have the program. Steps for programming the sonde for deployment are as follows:

1. Remove the rubberized cover over the data port and connect the sonde to the Hydrolab-USB adapter cable and plug into USB port of computer. When plugged in the sonde should emit a 1-2 second monotone beep signaling the unit is powering up. If this does not occur, replace the batteries and perform Step 1 again.

2. Initiate the **Hydras 3LT software** and it will automatically search for any connected sondes. Upon locating the sonde, the port, and sonde name/number will appear in the top box. To the right of this box are 3 gray buttons, select the middle **Operate Sonde** button.

3. A second, multi-tabbed Hydrolab window will appear with the System tap selected. Check the date and time to ensure they are accurate. If inaccuracies exist, use the **Set clock to PC** button or **Set clock manually** button to remedy the problem(s). Click the **Log Files tab** at the top of the window.

4. Hydrolab sondes only hold 4 log programs at a time. In order to start a new log a check must be performed to determine if any free space exists for a new program. Click the **drop down** box at the top of the screen beside the Log File text and count the number of files listed. If four are there, highlight one (preferably the oldest) of the files then press the **Delete** button at the bottom of the window. If a free spot exists a new log file can be created. **Make sure that the file has definitely already been downloaded before deleting it.**

5. Click the **Create** button at the bottom of the window. An **Enter new file name** box will appear, **fill in the file name** according to the naming convention outlined in the ***General*** section on ***page 13-14*** and click the OK button.

6. Enter the **Start Logging** and **Stop Logging** date and times using the boxes in the middle of the window. Be sure to make all of the times on the hour and to set the **deployment period** for at least 60 days so data will continue to be gathered if a sonde is not retrieved in exactly 30 days.

7. Set the **logging interval**, typically 01:00:00 or one hour. Make the sensor and circulator **warm up** 2 minutes and **uncheck the Audio check** box beside circulator warm-up.

8. The bottom portion of the box covers parameter selection. Each project has different parameter needs, but in general, you want to gather every parameter of pertinence that can be accurately measured. This doesn't include unit conversions. The basic set of parameters that should be gathered for a typical Hydrolab deployment are: Temp (C), pH, SpCond (µs/cm), LDO%, LDO (mg/L) and Internal Battery (Volts & %). **Select the parameters** by highlighting them in

the box and clicking the **add** button. Any inadvertent additions are easily removed by highlighting and clicking the **Delete** button. *Be sure to use the SpCond (µs/cm) and not the SpCond (mS/cm), as the latter will round any values to whole numbers, leaving valuable data unrecorded.* Check the Parameters in Log File box and ensure they are correct.

9. Click the **Save Settings** button at the top right of the window. Read over all logging program information and click the **Enable** button at the bottom of the window to initiate the program. Check the Status line (third line down with a blue count down until start box beside it) and ensure it says "Enabled." When complete, disconnect the sonde and place the rubberized cover over the data port and it is ready for deployment.

Eureka Manta Deployables

Eureka Multiprobe Manager software is required to operate Manta brand sondes, if it is not installed on the computer to be used, contact the help desk to request installation or use a system that does have the program. Steps for programming the sonde for deployment are as follows:

1. Remove the black plug from the end of the Manta by unscrewing the bolt and pulling the plug out, thus exposing the data port.

2. Connect the sonde to the Manta-USB adapter cable and plug into USB port of computer.

3. Initiate the **Multiprobe Manager software** and it will automatically search for any connected sondes. Upon locating the sonde the program will automatically start downloading the data from the currently running file name. If there is no new data found on the probe, then a screen showing the current parameters will start cycling.

4. Once the file has been downloaded, the program will automatically show the **Logged Data page** in the window. This window contains a list of all the downloaded files from that sonde.

5. To set up a new logging profile, click on the **Logging Profile** button, 4th from the left at the bottom of the window. This will open the Logging Profile Window. Type the filename of the new data set in the box under the **Description Box** according to the naming convention outlined in the ***General*** section on ***page 13-14***. Next, make sure the **Reading Interval** box is set to 1 hour and the **Warm-up** box is set for 2 minutes. Finally, click the **Set Profile** button to save the changes of the new file name.

6. Now, click on the **Calibration** button, 3rd button down in the left column. This will open the **Calibration** window. On the lower-left corner of the window, there will

be an area titled Real-time Clock. Within this area, click the button that reads **Sync w/ PC**. This will change the time on the sonde to that of the computer to which the sonde is connected.

7. Close the program and disconnect the cord from the sonde. Replace the plug with the end with the hole toward the circle and replace the screw (this is the logging off position). In order to **initiate the program**, remove the screw and turn/slide the black plug to the line and away from the circle (logging on position). Check for the **orange and green lights** on the board inside the meter to begin flashing alternately. Once the flashing occurs, **replace the screw** into the plug in its new position and the sonde is ready for deployment.

HOBO Temperature/Conductivity & Temperature/Light Intensity Loggers

HOBOware Pro software is required to operate HOBO brand loggers, if it is not installed on the computer to be used, contact the help desk to request installation or use a system/setup that does have the program. Steps for programming the sonde for deployment are as follows:

1. Connect the HOBO Optic USB Base Station or Pendant Coupler to the USB port of the computer.

2. Initiate the **HOBOware Pro software** and click the **Launch Device Icon**, located in the top left of the window under **File**. If a file is currently running it must be stopped and readout or any currently recording file and its corresponding data will be erased.

3. A **Launch Logger** window will appear. Ensure that the battery state is adequate for the deployment. **Type the Site name and deployment date** in the description box according to the naming convention outlined in the ***General*** section on ***page 13-14*** (*e.g.,* Coal Fk 031411).

4. Check all appropriate parameters to be collected in the **Channels to Log** box.

    a. For Temperature/Conductivity loggers choose: Conductivity Low Range, Full Range, and Temperature.

    b. For Temperature/Light Intensity loggers choose: Temperature and Battery Power Remaining. The WAB does not typically collect light intensity data.

5. Under logging interval, use the boxes to enter the **interval between logging events or data points**. One hour is the default interval to be employed unless another interval is specified for the project.

6. Within the **Launch Options** box, select the start time, ensuring that initiation of the program will occur before the meter is installed into the stream and will not

run for multiple days before deployment if possible. **All files should start on the hour.**

7. Click the **Launch** button in the lower right hand corner to initiate program.

> ***IMPORTANT: Do not unplug logger until program upload is complete.***

The lower left-hand section of screen will show "Launch Successful" when it is safe to remove from base station. When the HOBOware PRO window returns to normal, it is safe to unplug the sonde and it is ready for deployment.

Part 3. Sonde Downloading Procedures

General

Downloading is typically a simple process, and will even occur automatically in some deployable brands upon connection to a computer running the appropriate software. Several things must be considered when retrieving data from the sondes. If no file or an attenuated file is on the retrieved meter, this must be noted on the field form with the probable cause of the data loss (water leakage into battery compartment, dead battery, critical sonde failure, *etc*.). Also, the program must be terminated to prevent further readings to be added to the file, creating potential confusion during data analysis. To prevent loss of data or confusion over file location, upon return from the field, the data file must then be placed on the network as soon at the following location:

Q:\WATER RESOURCES\WAB\DEPLOYABLE DATA\Raw Data

Files should also be left on the sondes until removal is required for new data collection programs (lack of memory space on the sonde). This ensures that for a short period of time any lost files can be retrieved from their sonde of origin.

YSI Deployables

Ecowatch software is required to operate YSI brand sondes, if it is not installed on the computer to be used, contact the help desk to request installation or use a system that has the program installed. Steps for downloading data from the sonde are as follows:

1. Perform Steps 1-4 from ***Part 2. Sonde Programming Procedures-YSI Deployables*** section on ***page 13-14***.

2. Type **1** at the **Main Menu** to enter the **Run Setup Screen. Type 2** for **Unattended Sample**. This will bring initiate the **Logging Screen**. Type B – Stop Logging to terminate the program then confirm by typing **1** on the **Stop Logging?** screen. Type **0** two times to return to the **Main Menu**.

3. Type **3** to enter the **File Menu**. Type **2** to enter the **Upload Menu**. Type the number/letter corresponding to the file to be downloaded. The most recent files

are at the bottom of the list. The number to the right of the filename is the number of data points on the file. An hourly file for 30 days should be in the range of 700-750 data points. Any apparent data loss should be documented on the field form.

4. After selecting the file to be downloaded, the **Time Window Screen** shows the start and end date/time of the logged file. Note any errors on the field form, then type **1-Proceed** to bring up the **File Type** screen. Type **1-PC6000** to initiate the download.

5. When the download completes, type **0** to return to the **Main Menu**. When complete, disconnect the sonde and screw the end cap back on the meter and it is ready for calibration and reassignment. Files are automatically downloaded to ***C:\Ecowatch\Data*** folder on the computer.

Hydrolab Deployables

Hydras 3LT software is required to operate Hydrolab brand sondes, if it is not installed on the computer to be used, contact the help desk to request installation or use a system that does have the program. Steps for downloading data from the sonde are as follows:

1. Connect the sonde to the Hydrolab-USB adapter cable and plug into USB port of computer. When plugged in the sonde should emit a 1-2 second monotone beep signaling the unit is powering up. If this does not occur, replace the batteries and perform Step 1 again.

2. Initiate the **Hydras 3LT software** and it will automatically search for any connected sondes. Upon locating the sonde, the files available for download will appear in the **Log Files** box in the bottom half of the window. Check the files to be downloaded and click the **Download Selected Files** button.

3. When the file completes its download it will be located in the ***C:\Program Files\HYDRAS3LT\LogFiles*** folder on the computer.

Eureka Manta Deployables

Eureka Multiprobe Manager software is required to operate Manta brand sondes, if it is not installed on the computer to be used, contact the help desk to request installation or use a system that does have the program. Steps for downloading data from the sonde are as follows:

1. Remove the black plug from the end of the Manta by unscrewing the bolt and pulling the plug out, thus exposing the data port.

2. Connect the sonde to the Manta-USB adapter cable and plug into USB port of computer.

3. Initiate the **Multiprobe Manager** software and it will automatically search for any connected sondes. Upon locating the sonde the program will automatically start downloading the data from the currently running file name.

4. Once the file has been downloaded, the program will automatically show the **Logged Data** page in the window. This window contains a list of all the downloaded files from that sonde.

5. Highlight the file names of the data set in which need to be saved (Press Ctrl Key if there is more than one file per data set, usually 2-3). Then, once highlighted, press the **Save Data** button, first button on the left at the bottom of the window. A **Save As** window will appear. Save file under the same name as it was named on the sonde.

6. To save a previously downloaded file (old files) from a sonde, perform Steps 2 and 3 above. The program will automatically start the **Real-time Data** window. Enter the **Logged Data** window by pressing the **Logged Data** button, 2nd button down in the left column. Follow steps 4-5 to save the downloaded file.

HOBO Conductivity Loggers

HOBOware Pro software is required to operate HOBO brand loggers, if it is not installed on the computer to be used, contact the help desk to request installation or use a system that does have the program. Steps for downloading data from the sonde are as follows:

1. Connect the HOBO Optic USB Base Station to the USB port of the computer.

2. Initiate the **HOBOware Pro** software and click the **Stop Device** Icon, located in the top left of the window under View. Next click the **Readout Device** Icon, two icons to the left of the Stop Device icon.

3. The **Save** window will open, check the **Filename** and make it matches the data file name if it doesn't already. **Click Save**.

4. The **Plot Setup Window** will open. Click **Cancel** to exit and end download or click **Plot** to see a plot of Conductance and Temperature. The location the file will be saved in is ***C:\Documents and Settings\(user name/number)\My Documents\HOBOware*** folder on the computer.

Section E. *Sonde Anchoring and Concealment Procedures*

Anchoring and concealing the sonde is the most critical step in assuring that equipment is not lost due to high flows, theft, or being caught on passing debris. The most stable and concealed location possible should be selected for an anchor point. One must be

keenly aware of high and low flows and the reaction the sonde will have to each and to any moving debris when establishing an anchor point. Will the meter remain covered in flowing water if there is no rain during the 30 day deployment? What will happen to the sonde during a high flow, will it wash up on the bank and stay there or will it roll back into the water? Are there any large pieces of debris that could potentially be washed into the anchor during high flow? Is the anchor point sufficiently positioned to withstand extreme flows?

Part 1. Anchor Techniques

The deployable should be fastened around a stable anchor point to secure the deployable and provide a stable position for gathering the desired data using a length of 1/8" galvanized cable and a 1/8" ferrule.

Create a loop as pictured in ***Figure 13-5 on right*** and use the swaging tool to swag the ferrule at least 2 times to attach to the anchor point.

Figure 13-5. Picture of typical anchor loop.

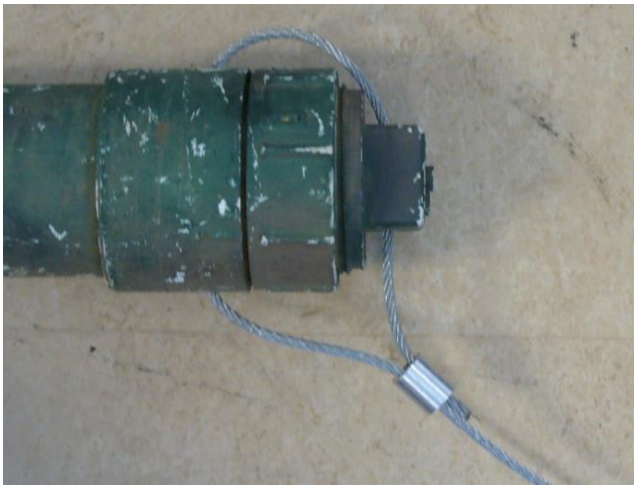

Figure 13-6. Picture of anchor cable looped directly thru the PVC sonde case.

In either case, loop the cable through the holes in the PVC sonde case and, when available, through the loop on the deployable (***see Figure 13-7 on right***).

After the cable attachment to an anchor point has been established, the case and end cap can be secured to the same piece of cable (***see Figure 13-6 on left***) or a loop can be fashioned at the other end for a semi-permanent anchor that can be reused on multiple site visits (see ***Figure 13-9 on next page***).

Figure 13-7. Picture of cable looped thru PVC sonde case and sonde.

Figure 13-8. Picture of cable threaded thru PVC sonde case and then looped thru screw cap.

Figure 13-9. Picture of a loop used as a semi-permanent anchor interlocked with a temporary loop attached to the end of the sonde case.

Screw on the end cap (if available) and thread the cable through the hole in the cap as in ***Figure 13-8 on left***.

In order to attach to the same cable, loop around the end and swag the ferrule to the anchor cable as in ***Figure 13-6 on the previous page***.

In order to attach to a semi-permanent anchor of fixed length (***as in Figure 13-10 below***), attach the cable to the PVC sonde case as stated shown in ***Figure 13-8 on left*** and swag a ferrule around the two ends and through the anchor as in ***Figure 13-9 on left***. The length of the loop of cable should be chosen to allow proper placement of the sonde without unnecessary slack (see ***Figure 13-11 on the next page***). On subsequent visits, the loop can be cut just below the ferrule and a new one placed on the newly opened loop with minimal length of cable wasted.

Figure 13-10. Picture of semi-permanent anchor of fixed length in field.

Figure 13-11. Picture of field deployed sonde with adequate anchor cable length to ensure proper placement in stream water column.

Rootwads

Rootwads are the preferred anchoring platform when available. A rootwad provides natural concealment and multiple locations to attach the anchor in a manner that will be very stable under all but the most extreme conditions. The anchor should be looped around the largest accessible piece of root structure that allows the sonde cable to be concealed as well as positioned in the substrate so that it receives proper flow, depth, and concealment. See ***Figure 13-12 on the next page*** for a typical rootwad used for sonde deployment.

Figure 13-12. Picture of typical rootwad used for anchoring a sonde. Arrow points to actual sonde deployment location.

Instream Boulder

Figure 13-13. Picture of typical instream boulder used for anchoring a sonde. Arrow points to actual sonde deployment location on the downstream side of boulder.

If a rootwad is unavailable or not close enough to the stream, the next best anchor is an instream boulder. In order to anchor to a boulder, it has to be shaped so that the anchor cable cannot slip over the boulder and large enough that the cable will not be pulled out from under it. Ideally the boulder needs to provide protection from debris and high flows while not subjecting the sonde to unacceptable sediment accumulation which would fill the sonde case and inhibit data collection. The cable should be looped around the base of the boulder at a pinch point, where the cable cannot slip over the over the top of the rock (***see Figure 13-13 above***). The sonde also needs to be located so that it receives proper flow, depth, and concealment.

Large Stream Debris

The least preferred anchoring method is to anchor the sonde to a large or seemingly immovable piece of stream debris, such as a downed tree or large trash/debris (*e.g.*, automobile parts, large appliances, *etc*.; see ***Figure 13-14 below***). One must take particular care when attaching sondes to these types of anchor points due to the possibility of them moving downstream during an extreme flow event. Downed trees should be very large (>25 feet long & >4 feet diameter) before even being considered for use. Preference should be given to downed trees that have most or at least some of their mass outside or above (*e.g.,* bridging) the stream channel. Best professional judgment must be used to determine what will work and what will not for these types of anchors.

Figure 13-14. Pictures of typical large stream debris used for anchoring a sonde. Left picture is a large piece of metal trash/debris (*e.g.,* automobile parts, large appliances, *etc*.). Right picture is a downed tree that is partially bridging and mostly out of the stream channel.

Anchor Maintenance

Well-placed and maintained anchors are the primary defense against equipment loss. The best anchor point is useless if the anchor itself is not checked and replaced periodically. Yearly replacements are required. Beyond that, anchors should be checked at each deployment for excessive corrosion, kinks, breakage, or other signs of weakness and replaced immediately if any indications of failure exist.

Part 2. Concealment

Figure 13-15. Picture of sonde concealed by large substrate.

Concealing the sonde serves several purposes. It protects the sonde from being spotted by individuals who might disturb or attempt to steal/sabotage the equipment. Additionally, if done correctly, it provides stability and protection from increases in flow that might batter, dislodge, or move the sonde to dry ground. The best material for camouflage, when available, is in-stream large cobble and boulder-sized substrate. The main method for establishing effective concealment for the deployable is to surround the sonde on all sides with large substrate in a manner that the probes are protruding from the end of the substrate in a column of moderate to swiftly moving water (***see Figure 13-15 on right***). Care must be taken to place the probe end of the sonde in a manner that will keep it off the bottom and into a flow vector that will minimize sediment accumulation within the sonde case. In locations that do not provide adequate substrate for the construction of this type of structure, creativity will be necessary. Tires, cinder blocks, and pieces of trash or appliances will also serve nicely to provide the necessary materials for concealment. In some cases the anchor point itself can provide adequate concealment, such as when dense rootwads are present. Stream structure can also be used to create effective concealment, try using undercuts, bedrock fractures, or other natural features when other methods are inadequate or unavailable. The following figures (***Figure 13-16 thru Figure 13-21)*** show examples of how to properly provide concealment.

Figure 13-16. Picture of sonde anchor wire before concealment with cobble.

Figure 13-17. Picture of sonde anchor wire after concealment with cobble. Note placement of the probe end of the sonde into the channel.

Figure 13-18. Picture of sonde anchor wire before concealment with cobble.

Figure 13-19. Picture of sonde anchor wire after concealment with cobble. Note placement of the probe end of the sonde into the channel.

Figure 13-20. Picture of sonde before (left) and after (right close-up) concealment with cobble. Arrow points to sonde placed in stream channel.

Figure 13-21. Picture of sonde concealed by cobble in pool created by rootwad.

Section F. *Water Quality Sampling Procedures*

If prescribed by the site list or project needs, water samples and flow measurements may also be taken periodically if necessary. Refer to **CHAPTER 3. WATER COLLECTION PROTOCOLS** starting on **page 3-1** and **CHAPTER 4. STREAM FLOW MEASUREMENT PROTOCOLS** starting on **page 4-1** for details on these protocols.

Side-By-Side Measurement

An integral part of validating the data collected on the deployable sonde is gathering discrete readings from the deployable meter, 1st during all deployments/redeployments and 2nd during any retrievals of the monthly deployment cycle. These measurements allow identification of any calibration shifts, fouling or parameter drift incurred during deployment. Upon retrieval of the deployed sonde, clean the sonde of any biofilms, sediment, *etc*. that may interfere with readings and document any such potential sources of interference on the field form, then connect the meter to the appropriate display for discrete sampling. Place a second "clean" calibrated discrete YSI (or other discrete sampler) directly beside the deployable. Allow both meters to run until all parameters are stable and record all monitored parameters from the deployable in the Retrieved Deployable Sonde Check block at the bottom of the Deployable Sonde form along with the retrieved sonde ID number and location. The same just mentioned steps are followed for all deployments and parameters are recorded in the Deployed Sonde Check block. Make detailed notes about any departures/parameter discrepancies between the two sondes and infer causes when possible why these exist. Also indicate the presence of any significant sediment deposits inside the sonde case that might interfere with the accuracy of the meter.

In some cases, it may be necessary as well as beneficial to complete a discrete check in the middle of the monthly deployment cycle. These mid-deployment checks can help validate data where swings of parameter values occur. All that can be done is to place a discrete meter next to the deployed sonde in the water column and record the readings.

Section G. *Special Concerns*

Part 1. Sediment

Sediment loads vary widely depending on the system being monitored. A build-up of sediment in the sonde case will eventually fill the cavities in the conductivity/temperature probe and heavily affect the accuracy of the measures of these parameters. Excess sediment will also obscure optical DO probes and surround pH bulbs causing departures from actual and recorded values for these parameters. Care must be taken when anchoring in streams with moderate to high sediment loads to anticipate sediment impacts. Placing the sonde directly on the bottom is inadvisable in any stream and especially so where sedimentation is elevated. Measures to minimize sediment impacts include suspending the sonde from an anchor point in such a manner

that it is hanging without making any contact with the substrate (if depth is sufficient), using a sonde case that is open on the bottom end so that excess sediment can easily escape the case, and periodic mid-deployment revisits to manually remove sediment by agitating the sonde case (a perfect opportunity to also obtain another discrete data point as described above in ***Side-By-Side Measurement on page 13-31***).

Part 2. Heavily Populated Sites

Generally, a deployable sonde should not be anchored in an area that is frequently used for fishing, swimming, boating, partying, or overtly visible to passers-by. The best protection against theft or vandalism of the equipment is keeping their locations as secret as possible. Periodically it is necessary to place a sonde into an area that has increased human traffic, in these instances extreme caution must be exercised. Begin by selecting the most concealed working area possible. The anchor point and the sonde must be completely invisible to onlookers. Use large cobble/small boulders, undercuts, large woody debris, trash, *etc*. to conceal the point of attachment and meter (***see Figure 13-15 to Figure 13-21***). Additionally, it is very important to avoid drawing attention to the work area if anyone is in the area. Return to the site at a later date/time if the sonde cannot be serviced in a clandestine manner.

Part 3. Missing Sondes

In the event a sonde is absent from the anchor location during a retrieval visit, a survey of the surrounding area will lead to discovery of the meter in many instances. Even during very high flow events, the meter will rarely travel beyond the next sizeable pool downstream of the anchor site. If the anchor point is within a pool, many times the meter can be found at the bottom of that particular pool. If the meter is not immediately visible, visualize the stream at bankfull, and project what path is most likely for the highest flow vectors and ascertain where the sonde would likely be moved. Walk the stream and meticulously search the substrate, especially depositional areas and any piles of debris in the area. If a thorough search doesn't result in retrieval of the sonde, report the loss and the sonde identification information on the form and to a supervisor.

Part 4. Low Conductivity

Specific conductance values <100 can cause extended equilibration times in pH values, especially in freshly calibrated meters. In some cases it may require 30 minutes or more to gather an accurate pH values in a stream with a specific conductance value around 20 uS/cm. Extreme caution must be exercised in low conductance streams to ensure side-by-side values are accurate due to this phenomenon. A large pH departure in the side-by-side measurement can provide an easy clue that the discrete meter is not yet ready to be recorded. As a general rule, it is best to calibrate the meter for work in this type of stream before leaving the lab and then place the probe in a small amount of DI or distilled water during travel. Then upon arrival on site, place the discrete meter into the stream immediately before initiating any other assessment activities. The best method for determining the equilibration status of the pH Sensor is to look at the pH mV

value and then recheck this value at 1 minute intervals. If after 5 minutes, the pH mV values are static or bouncing nominally the value is ready to be recorded. If, however, the pH mV values are continuously moving up or continuously down, the pH is not at equilibrium and must continue to run for an accurate discrete value to be obtained. Do not wait in excess of an hour for discreet readings. If several low conductance sites will be visited concurrently, keeping the calibration cup full of water from the site and the meter running during travel will greatly reduce waiting times for equilibration. After completing sampling for the day in low conductance streams, return the sonde to pH 4 buffer so that electrolytes are not leached from the pH Sensor needlessly overnight.

Part 5. Large Rivers

Large rivers present multiple problems to sonde deployment. In some areas, large streams have few rootwads that are near deep enough water to provide an effective anchor point that doesn't place the meter in a position to be inundated with sediment or easily seen. The next anchoring option and in many cases the only option is a downed tree, which is susceptible to being washed downstream during high flows. The other confounding factors are the frequent presence of fishermen, boaters, or onlookers and periodic very high flows. Camouflaging a sonde in these areas is especially important. In some instances stream flow will rise overnight following a hard rain or repeated precipitation events to a level where a sonde cannot be retrieved safely for weeks. Sondes should be visited at the first available instance to check/secure the equipment and prevent a loss should this occur. As a general rule in large rivers, attempt to use a rootwad if at all possible and keep the sonde from resting on the substrate, keeping in mind sediment effects and the necessity of camouflage. Be acutely aware of the need to retrieve the sonde if the water level should rise precipitously without warning and tie high water retrieval anchors if necessary. Use downed trees as anchors if no other option exists. Attempt to use one that still buried in or rooted to the bank versus one that is only resting on the stream bed. Use only very large trees that were likely moved during the previous spring and likely won't be moved again until a very large rain event occurs. Keep monitoring all available precipitation and hydrograph data to anticipate potential retrieval problems. Preemptively retrieve the sonde before a high flow event may occur if possible. Be aware that equipment is lost more likely in large rivers due to larger flow volumes and difficulty of searching the pools due to depth.

Section H. *Troubleshooting and Manufacturers*

Part 1. Troubleshooting by Brand

YSI

Problem	Corrective Measures
pH does not calibrate Calibrates but shows large departures from standards, discrete values and/or deployable data files	Check pH millivolts (mV), at pH 7 the values should be ± 30. Check the date of manufacture on the pH Sensor (imprinted on side of probe). If the millivolts are outside of this range or the manufacture date is >18 months, probe needs to be replaced. Recalibrate. Check for moisture in the contact area. If moisture is present, it will interfere with a proper connection. The moisture must be removed. If probe still fails to function properly the sonde must be sent to Fondriest for diagnostics.
Conductance reads >5 uS/cm in DI or distilled water Conductance/Temperature shows significant departures from discrete values and/or deployable data files	Scrub contacts with cleansing brush, rinse well with DI/distilled water and check zero again. Check the date of manufacture on the Cond/Temp probe (imprinted on side of probe). If >3 years, probe needs to be replaced. Recalibrate. Check for moisture in the contact area. If moisture is present, it will interfere with a proper connection. The moisture must be removed. If probe still fails to function properly the sonde must be sent to Fondriest for diagnostics.
Ecowatch showing lines of data instead of # symbol upon attaching sonde to software	Repeatedly press ESC until # symbol appears
Ecowatch showing random scripts/missing menu options/becoming unresponsive within menus	Unplug sonde, close Ecowatch, restart program and reconnect to sonde

Problem	Corrective Measures
Sonde will not connect to display or Ecowatch program	Make sure the cable is securely fastened to end of sonde. Change the batteries in the sonde. Check for corrosion on the sonde contacts or moisture in the contact area. If either is present, they will interfere with a proper connection. The corrosion and all moisture must be removed. Close the sonde window, click the sonde icon again and change the selected COM port #. Go through COM port numbers and repeat process until # sign appears. If # sign never appears, change USB port and reinitiate software then repeat port selection process. If a connection still fails the sonde must be sent to Fondriest for diagnostics.

Hydrolab

Problem	Corrective Measures
pH does not calibrate Calibrates but shows large departures from standards, discrete values and/or deployable data files	Change pH electrolyte solution; ensure that new solution is not expired. Check pH junction cap, if it is more than 18 months old or looks clogged, the cap must be replaced and the meter recalibrated.
LDO (Luminescent Dissolved Oxygen) does not calibrate LDO shows significant departures from discrete values and/or deployable data files but calibrates normally	Twist cap off LDO probe. Check under cap and exposed portion of probe glass for moisture, being very careful not to introduce dirt or moisture. If moisture is present, gently dry off cap/probe. Replace cap and Recalibrate. After performing previous step, check under the probe glass in the blue reflective lens for moisture. If moisture is present under the lens, water has infiltrated the probe seals and must be sent to HACH for diagnostics/repair.
Conductance/Temperature shows standards, significant departures from discrete values and/or deployable data files	Scrub contacts with cleansing brush, rinse well with DI/distilled water and check zero again. Check 0 and 1000 us/cm to determine what departures are. Do a 2 point calibration with these two points and recheck standards. If values continue to significantly depart from standards, must be sent to HACH for diagnostics/repair.
Hydras3LT software will not acknowledge sonde is connected to computer	Change batteries in sonde. Unplug sonde, close software, reinsert plug and restart program.
Hydras3LT software is not in English	Press F3 until language cycles to English

Sonde will not connect to Hydras3LT interface	Make sure the cable is securely fastened to end of sonde. Change the batteries in the sonde. Meter should make an audible beep when batteries are replaced and battery cap is secured. If no beep is heard then sonde is not receiving power. Close down software, unplug and reconnect cable, restart software. This may require multiple attempts. Obtain a different connection cable and attempt operation again. If a connection still fails the sonde must be sent to HACH for diagnostics/repair.

Eureka

Problem	Corrective Measures
pH does not calibrate Calibrates but shows large departures from standards, discrete values and/or deployable data files	Change pH electrolyte solution; ensure that new solution is not expired. Check pH junction cap, if it is more than 18 months old or looks clogged, the cap must be replaced and the meter recalibrated.
Conductance/Temperature shows significant departures from standards, discrete values and/or deployable data files	Scrub contacts with cleansing brush, rinse well with DI/distilled water and check zero again. Check 0 and 1000 us/cm to determine what departures are. Do a 2 point calibration with these two points and recheck standards. If values continue to significantly depart from standards, must be sent to Eureka for diagnostics/repair.
Hydras3LT software freezes while downloading logged files	Unplug sonde, close software, reinsert plug and restart program. Freezing during download can occur several times before download is successfully completed. Repeat the process each time until all files are downloaded.
Eureka Multiprobe Manager software will not acknowledge sonde connected to computer	Unplug sonde, close software, reinsert plug and restart program. Watch electrical board through sonde case for a pair of small lights (one green, one orange) to illuminate within 10 seconds of being plugged into computer. If lights do not come on, sonde must be sent to Eureka for diagnostics/repair. If lights illuminate but sonde is still not recognized by the software, unplug, close, reinsert plug and restart. This may take several attempts before a successful connection is achieved.

Part 2. Service Contacts

Brand	Company	Contact	Telephone	Address
YSI	Fondriest Environmental	Paul Nieberding	(937) 426-2151	Nexsens Tech Inc. 1415 Research Park Dr. Beavercreek, OH 45432
Hydrolab	HACH Company	Paul Johnson	(800) 949-3766 x 6444	Loveland Service Center 5600 Lindbergh Dr. North Dock Loveland, CO 80538
Eureka	Eureka Environmental	Ric Bertrand	(512) 302-4333 x 111	2113 Wells Br. Pkwy Suite 4400 Austin, TX 78728
HOBO	Onset	Customer Support	(800) 564-4377	470 MacArthur Blvd. Bourne, MA 02532

Section I. *Continuous Monitoring Data Analysis*

Upon return to the office, all data files are copied from the field laptops to the network for permanent archive. Within a week, the deployment data file is imported into the AQUARIUS time series software by Aquatic Informatics (see http://aquaticinformatics.com/aquarius-workstation for support documentation). The data files are trimmed to match the applicable deployment time period (*e.g.*, readings taken during travel between the office and field location are excised). Discrete information is retrieved from the WABbase or is manually entered from the field forms. Multiple deployments from a particular station are spliced together and then analyzed for potential errors (*e.g.*, calibration drift, sonde out of water, sediment/biofilm interference, and equilibration adjustment period). Corrections to the data are made and noted according to the suspected cause. Corrections can include offset, percent increment, or wholesale deletion. The raw and corrected data are graphed per deployment period and exported to the network for archive. The raw and corrected data are also exported to WABbase for general use.

Continuous Monitoring Quality Assurance/Quality Control

Once a year, all field participants in the WAB attend mandatory training sessions in March-April prior to the initiation of the major sampling season. The purpose of these sessions is to ensure that all field personnel are familiar with sampling protocols and calibrated to sampling standards. Whilst a specific session on Continuous Monitoring is not covered, other sessions (*e.g.,* site documentation and completing the stream assessment forms, sonde calibration, water collection protocols, stream flow measurement, field blanks and duplicates, *etc*.) are covered. In the field, individuals who are more experienced in Continuous Monitoring will be teamed up to give hands-on training to less experienced to assure reinforcement of training and accurate results before they are allowed to maintain these stations solo. This document is also provided to all program personnel for review and use in the field.

Sample labels are to be accurate and complete and contain all the pertinent information.

Sampling equipment will be checked for contaminants and excess dirt or moisture cleaned before and after each sampling event. Lot numbers of all preservatives are recorded on the Analysis Request Form for each sample submitted and entered into the database to allow for easy tracking. Sample transfer to the lab shall also be documented using the Chain-of-Custody (COC) portion of the Analysis Request Form.

When water quality samples are required, duplicate sampling and field blanks must be performed at a minimum of 2.5% of Continuous Monitoring sites for each sampling round. The field blank and duplicate data are looked at by Watershed Assessment Branch staff and scrutinized to find any possible discrepancies, contamination, or faults in the sampling methods and techniques. Any problems are brought to the attention of the program management and steps are made to immediately correct the problem. Data that is related to the problem are flagged with notes concerning the details of the situation so that decisions can be made whether or not to include the data in any further assessments or analysis. Procedures for performing duplicates and field blanks are presented in ***CHAPTER 14. Section A. Blanks and Duplicates starting on page 14-1.***

Continuous monitoring sondes are routinely cross-checked to the results of discrete sonde measurements at the beginning, end of deployment, and in some cases during deployment. Upon recovery, the deployable sondes are used to perform a post-deployment discrete measurement as a “clean”, uncalibrated side-by-side comparison to a recently calibrated discrete meter. This result can help differentiate between probe calibration drift versus other factors that may have altered the readings during deployment (*e.g.*, biofilm, sediment, *etc*. on or in the probes). The sonde readings (or the data file) from the deployments just prior to and after the deployment of interest are also used as a basis of validation of the data.