

Snohomish County Surface Water Management
Resource Monitoring Group

Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and
Streams.

Version 1.2

Author – Steve Britsch
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Reviewers: Keith Westlund and Tong Tran

QA Approval - Robert Plotnikoff –Quality Assurance Officer
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Please note that Snohomish County Surface Water Management's (SWM) Standard Operating Procedures (SOPs) are adapted from Washington State Department of Ecology Standard Operating Procedure EAP 080, other published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Snohomish County use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

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

Although SWM follows the SOP in most cases, there may be instances in which the County uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
April 10 , 2018	1.0	Updated from SWM 2012 SOP Version 1.2 ..\.\.\.\.\.\.Wq\Temperature Logger\Protocols\Continuous Temperature Data Management Ver1.2 Update_March2012.pdf	All	Steve Britsch
September 10, 2019	1.1	Added attachment E, additional quality control detail.	14	Steve Britsch
January 2, 2020	1.2	Added clarity on correction of raw data after 2 nd failed post monitoring calibration check	14.4	Steve Britsch

Water Quality Monitoring Program

Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams.

Introduction

Onset Hobo® Water Temp Pro v2 loggers and other models are used by Snohomish County Public Works, Surface Water Management's (SWM) Resource Monitoring (RM) Group to collect time series water and air temperature data. Results help identify locations where protection of cold water refuge is important and where restoration is needed to reduce stream temperatures supportive of spawning, rearing and migration of salmonid species.



1.0 Purpose and Scope

This Standard Operating Procedure (SOP) details a methods used by the RM group to collect continuous temperature data. It may also contain methods that other users would find helpful for their monitoring work.

The scope of this SOP applies to instrument set up, calibration, placement, retrieval and basic data analysis.

2.0 Applicability

The Standard Operating Procedures (SOP) will be followed for the planning, calibration, installation, maintenance, downloading and management of continuous temperature instruments and associated data.

These protocols reflect in part those outlined in the Washington State Department of Ecology's Continuous Stream Temperature SOP (Ward, 2018), the TFW Stream Temperature Survey Manual (Schuett-Hames et al., 1999), Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section (<https://fortress.wa.gov/ecy/publications/summarypages/0303052.html>) (Ward, 2003),

Measuring Stream Temperature with Digital Data Loggers (USFS, 2005), and Standard Operating Procedures for continuous temperature monitoring of fresh water rivers and streams conducted in a Total Maximum Daily Load (TMDL) project for stream temperature (Bilhimer and Stohr, 2008).

3.0 Glossary of Acronyms

3.1 7DADMax - 7-day average of the daily maximum temperature

3.2 EAP - Ecology's Environmental Assessment Program

3.3 GPS - Global Position System

3.4 NIST - National Institute of Standards and Technology

3.5 PST - Pacific Standard Time

3.6 PDT - Pacific Daylight savings Time

3.7 QAMP - Quality Assurance Management Plan

3.8 SOP - Standard Operating Procedure

3.9 SWM - Surface Water Management

3.10 TFW - Timber, Fish, and Wildlife Program

3.11 TMDL - Total Maximum Daily Load

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified by job title in SWM's Safety Training database.

4.2 This SOP pertains to all Natural Resource Scientists, Environmental Specialists, Interns and Environmental Technicians in the RM group or other staff using this SOP.

4.3 All field staff must have read the instrument manual, this SOP, completed field training and be familiar with procedures for data collection.

4.4 All field staff must be familiar with the electronic data recording tablet.

4.5 The field lead directing sample collection must be knowledgeable of all aspects of the project's Quality Assurance Monitoring Plan (QAMP) to ensure that credible and useable data are collected. All field staff should be briefed by the field lead or project manager about the sampling goals and objectives prior to arriving at the site.

5.0 Equipment, Reagents, and Supplies

5.1 *General Field Equipment:*

5.2 See Attachment A for a list of the typical equipment and supplies that may be used to deploy temperature loggers.

5.3 *Specialized Field Equipment¹*

5.4 Rebar Pounder (see design specifications in Attachment B)

5.5 PVC Shade Device (see design specifications in Attachment B)

5.6 Onset Hobo[®] Water Temp Pro v2, (#U22-001), -20°C to +50°C, +/- 0.2C

5.7 Onset Water Level/Temp Logger (MX2001-0x-S +/- 0.44 0° to 50°C

5.8 Oakton Digital thermistor with an accuracy of +/-0.2°C

5.9 PC communication cables or optic shuttles

6.0 Summary of Procedure

6.1 *Pre-Deployment Preparation*

6.2 Gather equipment. Use a checklist to ensure that all of the necessary preparation tasks, equipment, supplies, and safety gear are completed (See Attachment A for the Continuous Temperature Sampling Checklist).

6.3 Calibration Checks. All temperature loggers must be calibration checked both pre- and post-study to document instrument accuracy specifications.

6.4 The calibration checks are done using test-bath temperatures that bracket the intended monitoring range (near 20 and 0°C). The bath temperatures must be verified with a NIST traceable or calibrated reference thermistor, thermocouple, or thermometer (NIST thermometer)². *Note: This procedure is also used to determine correction factors (if required) for the field thermistor and thermometer measurements.*

6.5 A calibration-check test-bath method that can maintain a constant temperature is essential to obtain excellent test results.

6.6 Place a necessary number of open coolers half full of water overnight in room (SWM Lab) that has a constant air temperature near 20°C. If necessary, use an aquarium heater capable of warming and maintaining water temperatures near 20°C.

¹ The specialized equipment listed does not represent an endorsement by Snohomish County. Other equipment may be used if it meets the project QA/QC requirements for accuracy and reliability.

² All NIST reference thermistors, thermocouplers and thermometers, used for this test, need to have an annual three-point (near 0, 10, 20°C) calibration check through the manufacturer who provides a calibration certificate. Certificates are kept in hardcopy with each year's monitoring records and electronically on the County network.

Note: Test baths done in rooms that have the target temperature ensure stable bath temperatures and the overall quality of the test.

- 6.7 Program the temperature loggers for the test start time and a 10 minute logging duration at one minute measurement intervals.
- 6.8 On the day of calibration, fill a necessary number of coolers half full with ice and add just enough water to fill the space between the ice.
- 6.9 Put the programmed temperature loggers in the near 20°C water bath, stir for uniformity and ensure loggers stay submerged. Allow several minutes prior to start of check for loggers to stabilize in the water bath.
 - 6.9.1 At the same time, place the NIST thermometer in the water bath oriented to easily view the scale increments. Then, gently stir the water to help ensure a uniform water temperature.
 - 6.9.2 Gently stir the water bath again a few minutes before test and just after reading and recording the NIST thermometer temperature.
 - 6.9.3 Record ten relatively constant and consecutive (every 1 minute) NIST thermometer comparison measurements on the Calibration Check Form (See Attachment C1 for blank form and Attachment C2 for an example of a used form).
 - 6.9.4 Transfer the temperature loggers, thermometers, and thermistor probes to the ice bath coolers. Gently stir the transition ice bath and allow the loggers to soak there for several minutes to stabilize temperatures.
 - 6.9.5 Repeat the process noted above to obtain ten relatively constant NIST thermometer comparison measurements from the ice water bath.
 - 6.9.6 Download the temperature loggers as soon as possible after the test to shut them off and minimize battery life impacts.
 - 6.9.7 Calculate the mean absolute value of the difference between the temperature logger measurements and the NIST thermometer for water and ice baths independently. Water-temperature loggers that have a mean difference greater than 0.2°C in one or both water baths have failed the test and cannot be used unless they pass a follow up test. Air temperature loggers that have a mean difference greater than 0.4°C in one or both have failed the test and cannot be used unless they pass a follow up test.
 - 6.9.8 Launch temperature loggers. Adjust the computer clock settings to Pacific Standard Time (PST) and also make sure that it will not automatically adjust to Daylight Savings Time (DST). Then adjust the clock time to the atomic clock (e.g., <http://www.time.gov/>). These necessary steps ensure that all the data will be in PST year-round and that all loggers will monitor at exactly the same time.

6.9.9 Program the temperature loggers for a delayed launch that starts at least one hour before the first planned deployment time of the season and at a 30 minute monitoring interval.

7.0 Stream temperature logger site selection methods

7.1 Deploy temperature loggers in the active and well-mixed part of the stream (or as close as possible to it) to ensure representative temperatures (based on flow volume) are recorded throughout the entire deployment period.

7.2 The preferred location in these areas is against an in-stream landmark or other submerged structure that can help hide the logger and minimize the loss to vandalism or high-flow events and also where direct sunlight may be avoided. *Note: avoid deployment locations near popular swimming holes and fishing access points where there is a much higher chance of logger discovery and loss to vandalism.*

7.2 Ideal deployment locations are typically at the upstream outside edge or downstream inside edge of the river bends, or in the middle of riffles of low flow and wadeable stream (see Figure 1 below).

7.3 **Temperature logger locations should never be in eddies or pools or locations where these conditions may develop during low flows.** In addition, unless the study question requires it, locations just downstream of tributaries, stream-side wetland areas, point-source discharges, and potential hillside groundwater seeps should also be avoided because these conditions may seasonally bias the recorded temperatures. Consider locations either on the opposite side of the stream or upstream of these conditions.

7.4 Deployment depth locations should not be on the stream bottom where the loggers may record groundwater inflow, but deep enough that they do not become exposed to air during a low-flow period. The basic deployment location depth goal is six (6) inches (<0.5 ft) off the stream bottom in smaller streams and wadeable locations and, if possible, at about one half of the water depth in the large streams (Schuett-Hames et al., 1999). *Note: Locating temperature loggers near the stream bottom may be necessary in small streams to ensure that the logger remains submerged during low flows.*

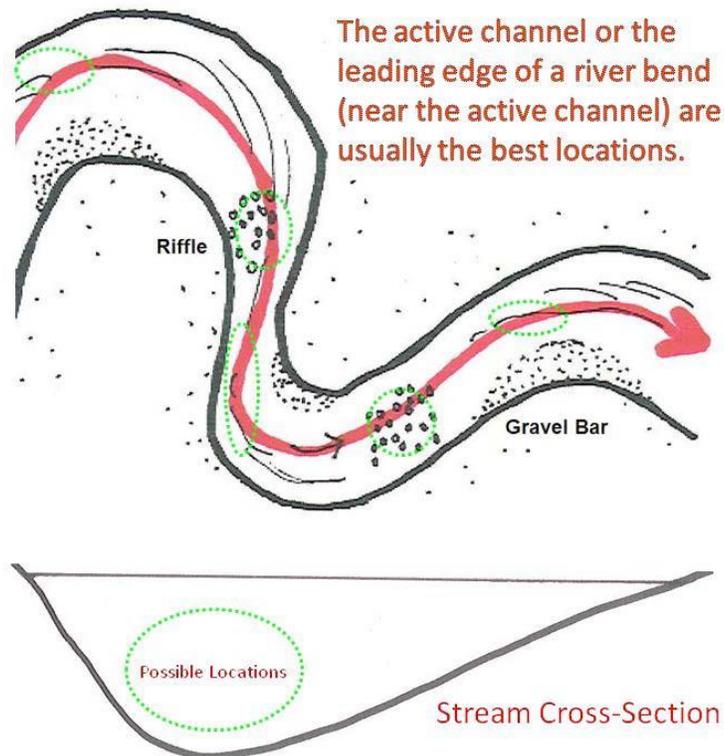


Figure 1. Potential Temperature Logger Deployment Locations

8.0 Stream temperature logger deployment options

- 8.1 Record the water-temperature-logger serial numbers on the survey form. (See Attachment D1 for blank form and Attachment D2 for an example).
- 8.2 Pre-assemble the water-temperature logger with a PVC shade device cover (See fig.2 below and design in Attachment B) that helps hide the logger and prevent any bias from indirect solar radiation.
- 8.3 Avoid low-flow and direct-sunlight temperature logger deployment locations. If the temperature logger needs to be deployed in these locations, then a PVC shade cover must be used to prevent any solar-biased temperature results (USFS, 2005).

8.4

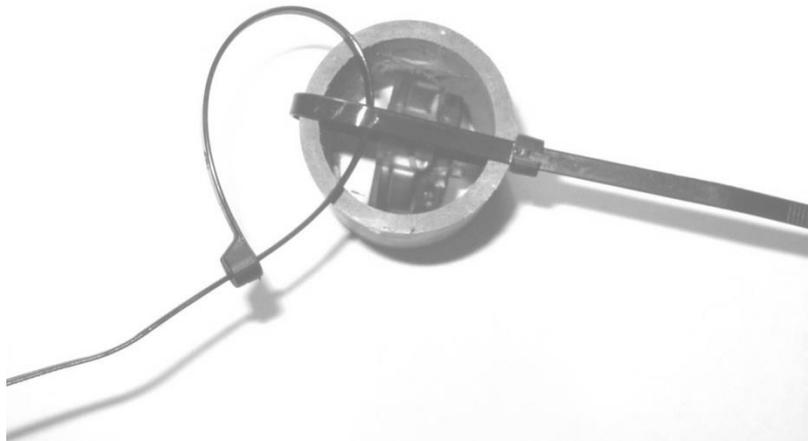


Figure 2. Assembled Temperature Logger and PVC Cover

- 8.5 Rebar Deployments. This option is typically used in small- and medium-sized streams to create a suitable temperature logger attachment location in or as near as possible to the active part of the stream. In most cases, this method is best used against the active-part-of-the-stream side of a large landmark rock or log.
- 8.6 Choose a 2-3 foot length of rebar that can be driven deep enough into the streambed to stay in place during high streamflow events and provide an attachment location that is six inches to one-half of the expected total stream depth during the seasonal low-flow period.
- 8.7 Insert the rebar into the open end of the rebar pounder and use a 4# engineering hammer (or an alternative) to hammer the rebar into the streambed by striking the heavy steel head of the pounder. Hammer all but eight inches of the rebar into the streambed³.
- 8.8 Leave the rebar pounder on the rebar, and document the water-temperature logger location with photographs.
- 8.9 Large Rock, Tree Root, or woody debris deployments. This option uses existing instream structures such as large rocks or boulders, woody debris, or roots that are located in or extend into the desired location in the active part of the stream. Attach the water-temperature logger to these structures with cable ties or wire, or to cable or heavy wire that may be used to create the location near the base of these structures. Photos of the location using a visual marker (such as the rebar pounder, hammer handle, nearby

³ If a mid-stream depth is desired, then leave more rebar exposed.

flagging, or pointing with a finger) are essential to help relocate loggers installed by this method.

- 8.10 Anchor deployments. This option can be used where stable large woody debris is not available or where near-surface bedrock or other consolidated sediments prohibit rebar use. The basic approach is to attach the water-temperature-logger assembly to a heavy weight (i.e., rock, brick, concrete block, wadded up piece of chain, or rebar) that may be set in the desired water-temperature-logger location.
- 8.11 It is also advisable that the heavy object be cabled or chained to something on the nearest bank (or other stable instream structure) to prevent loss during a possible high flow event (*Note: rusty chain use may deter logger loss to vandalism more than a shiny cable*). The heavy weight may be encouraged into the desired deployment location using a stick or boat hook (or similar device). *Note: this is not considered a viable option in locations with a significant groundwater inflow.*
- 8.12 Streamside or pile deployments. A long protective PVC or metal pipe housing may be used to establish a deployment location along deep rivers or at wildly fluctuating streams. The pipe can be fastened to a piling, pier, or anchored to large rocks and trees on the stream bank with the lower end extended into the active part of the stream. The upper end of the pipe should be secured with a threaded or locking cap to discourage casual vandalism. The lower end of the pipe should be perforated to allow streamflow around the logger and also be blocked with a diagonal bolt (or similar device) to prevent logger loss out that end. The logger in a protective cover needs to be kept at the lower pipe end with a weighted cord, length of PVC pipe, or any other method that also allows retrievals and deployments to be made through the upper capped end (see figure 3 example below).
- 8.13 Buoy or dock deployments. This option may be useful where no pilings are available or where a string of thermistors is desired to monitor stratified conditions. One issue with this type of deployment option is the high vandalism potential. This potential increases dramatically when establishing a new floating structure, so it is best to use existing structures if permission can be obtained.
- 8.14 Aquatic Invasive Species. Clean all field equipment that contacted water following procedures in the State of Our Waters Quality Assurance Monitoring Plan.



Figure 3. Deployment method using a length of PVC pipe

9.0 Documentation Procedures

- 9.1 Record all the field data and deployment location information on the Continuous Temperature Station Survey Form (See example in Attachment D-1) or by a similar method. Be sure to note the station number and name, temperature logger ID numbers, and any other useful narrative observations, especially those useful for finding the location (e.g. – “upstream of largest boulder on right bank”).
- 9.2 Draw a map and describe the general area, noting the temperature-logger locations, logger installation technique, and any landmark references such as a unique rock, log, root, flagging, or tree (See example in Attachment D-2). *Note: if possible, draw the map with north being toward the page top or denote the direction of north on the drawing.* Use your cell phone compass application to find the north-facing direction.
- 9.3 As necessary, take upstream and downstream photographs of the water-temperature-logger location that includes useful and easily identifiable landmark tree(s), flagging, or boulder. It is also important that the photographs include some visual marker (such as the rebar pounder, hammer handle, or pointing with a finger) to use along with the information on the survey form to help relocate and retrieve it in the future (See Fig 4 below).



Figure 4. Photo showing the water-temperature-logger deployment location.

10.0 Mid-deployment checks

- 10.1 Periodically visit the temperature-logger location during the deployment period and to make sure that it remains submerged and in a representative location. If the logger needs to be moved or is missing and needs to be replaced, then take the appropriate action and enter new remarks and notes on the survey form. *Note: consider taking replacement loggers and deployment equipment along when doing these checks to help expedite the relocation process.*

11.0 Retrieval Procedures

- 11.1 Record all the retrieval information on the Continuous Temperature Station Survey Form (See example in Attachment D-1).
- 11.2 If the stream may be easily waded, then also consider doing a cross-sectional survey of the stream temperature. The survey results may help determine if the stream-temperature logger measured representative temperatures and show any cross-sectional temperature differences.
- 11.3 Remove all rebar, cement blocks, or other deployed equipment at the end of the study.
- 11.4 Aquatic Invasive Species. Clean all field equipment that contacted water following the procedures in the State of Our Waters Quality Assurance Project Plan.

12.0 Downloading Procedures

- 12.1 Gently clean the temperature loggers with a soft wet cloth to remove any bio-fouling or sediment that may affect its ability to communicate optically during the downloading process. The preferred method is to use water and a soft cloth or soft-bristled brush. Note: avoid using any method that can scratch the logger optic communication area.
- 12.2 Set the computer clock to atomic clock time for the **Pacific Time Zone** before downloading any temperature loggers. Then follow the manufacturer's downloading procedures, and save the data in text files that may be opened in Excel or another type of spreadsheet software.

13.0 Records Management

- 13.1 Continuous Temperature Survey Forms are used to document the deployment and retrieval information for a station. Filled-out field forms are organized and stored in binders to use for long-term recordkeeping.
- 13.2 Use standard data processing and analysis sheets to trim, process and analyze data. The WISKI database will be used to store, process and view data.
- 13.3 Spatial, technical and data quality attributes are maintained in a geographical information systems file.
- 13.4 Guidance for archival of records can be found at <https://team/depts/spw/AO/Records/default.aspx>

14.0 Quality Control and Quality Assurance Section

- 14.1 The reference thermistor, used for calibration of data loggers, receives annual factory calibration. Digital calibration certificates are saved to network drives.
- 14.2 *Temperature Logger Post-Deployment Accuracy Check.* Verify the accuracy of the retrieved temperature loggers by conducting a post-deployment calibration check (Refer to Calibration Check section 6, above).
- 14.3 If the mean absolute value of the temperature difference for a logger in each ice and water bath, compared against the NIST certified thermometer, is equal to or less than the manufacturer stated accuracy $\pm 0.2^{\circ}\text{C}$ for a water-temperature logger, a second check should be performed. Air temperature loggers that have a mean difference greater than 0.4°C in one or both have failed the test and cannot be used unless they pass a follow up test.

- 14.4 If a second calibration check result confirms a consistent bias above the stated accuracy, then the raw data should be adjusted by the average of all absolute means of the pre- and post-calibration check cold and warm water bath results to correct for the logger bias (Schuett-Hames *et al.*, 1999). If the average of all absolute means is higher than the true value then this number is subtracted from the raw data. If the average of all absolute means is lower than the true value then this number is added to the raw data.
- 14.5 *Data Proofing Procedures.* Data from temperature loggers that met the calibration-check accuracy requirement are proofed/trimmed by charting the records to identify times when the logger may have been out of the water. A second useful check includes evaluating data points above 20 Degrees Celsius to identify anomalous records.
- 14.6 *Note: all identified anomalous data may be omitted from the data set, provided that the justification remark(s) is inserted on the station Continuous Temperature Station Survey Form and in the electronic record for the data. Similarly, all explainable climatic caused data spikes (i.e. - rain events) should also be noted in these same two records.*
- 14.7 All data are assigned a data quality code between 1 (best) and 9 (worst) based upon include the accuracy of the location, the calibration procedure, the availability of calibration records, whether the logger passed calibration and the logging interval. Data sets assigned quality codes 1 – 4 are accepted for use without qualification. Those assigned codes of 5, 6 or 7 are accepted as estimates, while those assigned codes of 8 or 9 are rejected from use. (Refer to attachment E).
- 14.8 The quality of datasets can be identified through queries of the WISKI database and/or a master geographical information systems file.
- 14.9 Datasets are trimmed to remove records where loggers were dry or inadvertently monitoring air temperature before, during, or after deployment.
- 14.10 Trimmed datasets are used for calculation of the seven day average of daily maximums (7dadmax) and other temperature metrics.

15.0 Safety

- 15.1 Persons involved with collection of temperature data could be subjected to unsafe environments. Hazards include, but are not limited to roadside traffic, slips, trips, falls, drowning, heat and cold stress, exposure to chemicals and biological pathogens.
- 15.2 Staff are provided appropriate PPE to minimize hazards. Teams of two should be considered especially for sites where data are gathered on larger streams/rivers during moderate to high flow events.
- 15.3 Washington State Department of Labor and Industries requires that employers provide a safe work environment through communicating hazards and providing adequate training.
- 15.4 Required safety training, inclusive of General Field Safety, Chemical Hygiene, Hazwoper, Roadway Safety, and Swift-water awareness have been identified by position.

16.0

References

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Attachment A

This Attachment contains the checklist used to prepare for temperature logger deployments.

Continuous Temperature Sampling Checklist

Pre-Deployment Preparation

- Determine Number of Stations
- Determine Deployment Equipment Needs
- Obtain or Make Deployment Equipment
- Check Calibration of:
 - Temperature Loggers
 - Thermometer
 - Thermistor
- Plan Deployment Schedule
- Schedule Field Assistance
- Program Temperature Loggers
- Make Motel Reservations
- Fill out Field Work Plan and Contact Person Designation Form
- Gas Van

Van/Safety Equipment

- Tire Chains
- Yellow Hazard Beacon
- Flashlight
- Tool Chest
- Jumper Cables
- Flares/Reflectors
- First Aid Kit
- Foil Blanket
- Orange Vests
- 2 Gallons Drinking Water
- Hand Towels
-
-

Sampling Equipment and Supplies

- Programmed Temperature Loggers
- Continuous Temperature Survey Forms
- Thermometer
- Thermistor
- Compass
- Maps
- Watch
- Camouflaged PVC Pipe
- Cable Ties
- Rebar Pounder
- 3/8 inch x 2 – 3 Ft. Rebar Pieces
- 4# Hammer
- Several lengths of Chain or cable
- Pyramid Blocks
- Small Wire Cutters
- 6' Pole W/Hook
- Knife
- Hand Trimmer
- Machete
- Survey Flagging
- Digital Camera
- Duct Tape

Personal Gear

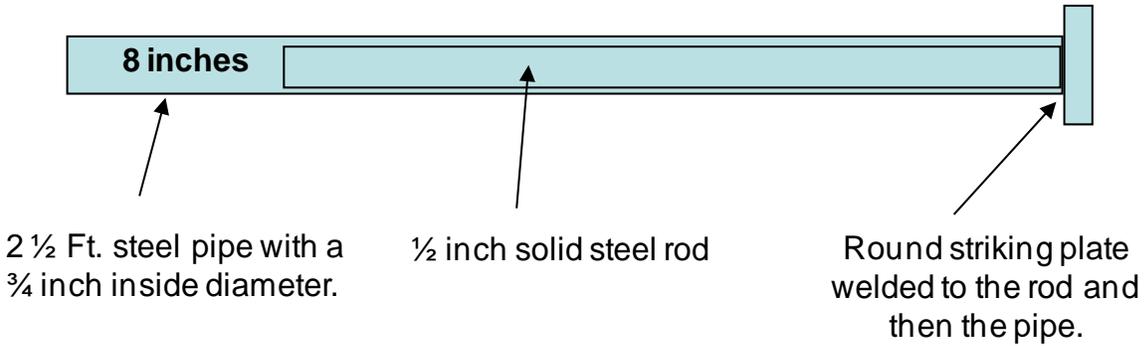
- Rain Gear
- Knee Boots
- Waders
- Watch
- Gloves
- Extra Clothing
- Hat
-
-
-

Attachment B

This attachment contains the design specifications for the equipment that is made “in-house.” These designs have been created to meet specific needs for past field studies and can be modified as needed. The equipment to make these includes: power saws, drill press, and other hand tools. The rebar pounder is manufactured by a contracted welder

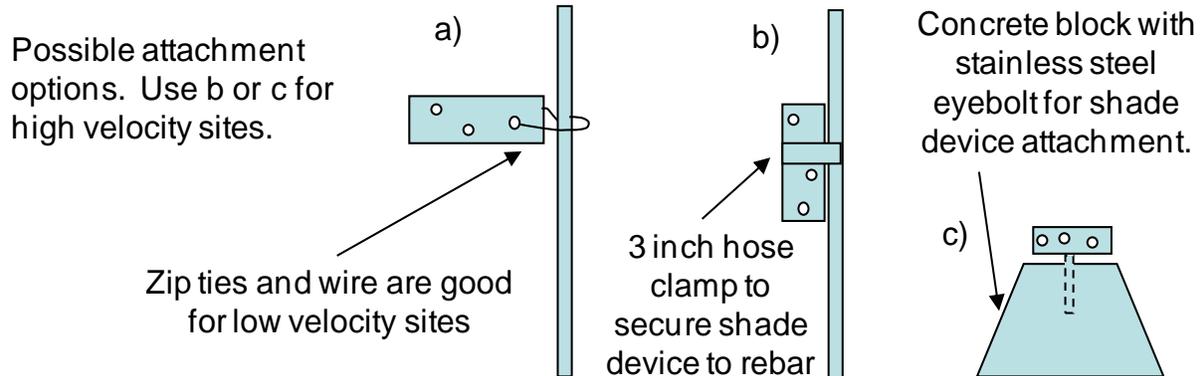
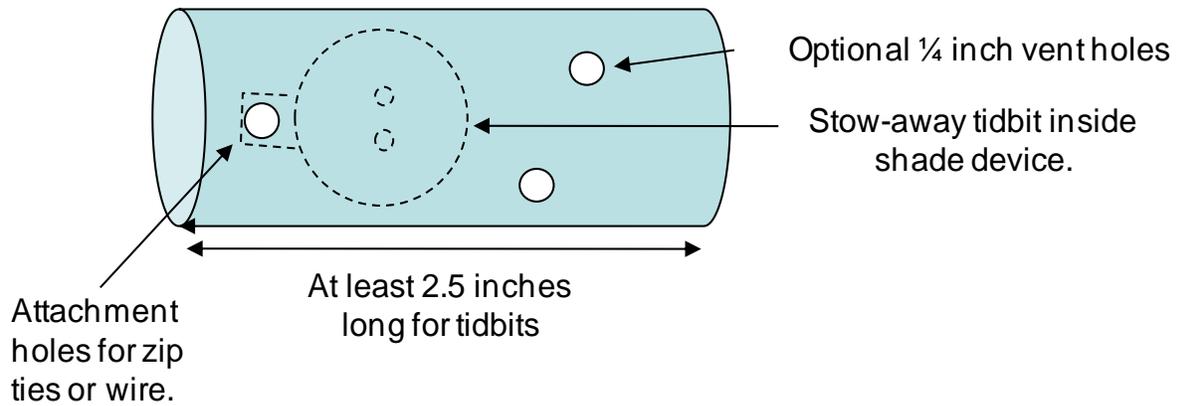
Rebar Pounder Design

Used to drive #4 (½ inch) rebar sections (2-4ft in length) into the streambed to establish an instream thermistor attachment location. The rebar is inserted in the hollow end and a heavy hammer is used to pound on the striking plate.



PVC Shade Device

This is typically made from 1.5 inch (inside diameter) PVC pipe. It should completely cover the thermistor to prevent solar radiation absorption. This design may be used for both instream and air thermistors.



Attachment C.

C-1. Temperature Logger Calibration Check Form - Blank Form.

C-2. Temperature Logger Calibration Check Form - Filled Out Form.

C-2. Temperature Logger Calibration Check Form - Example Data Entries Provided.

Calibration Check Worksheet															
Year: 2018															Green = passed calibration check
Steward: WQ IM															
1st Pre-Cal Check															
	NIST	Logger	Difference	Logger	Difference	Logger	Difference	Logger	Difference	Logger	Difference	Logger	Difference		Red = Failed calibration Check
Date / Time	Ref Temp	I.D. 9		I.D. 19		I.D. 20		I.D. 23		I.D. 28		I.D. 32			
5/15/2018 9:10	-0.1	-0.088	0.012	-0.032	0.068	-0.088	0.012	-0.06	0.04	-0.06	0.04	-0.06	0.04		
5/15/2018 9:11	-0.1	-0.088	0.012	-0.032	0.068	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.06	0.04		
5/15/2018 9:12	-0.1	-0.088	0.012	-0.032	0.068	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.06	0.04		
5/15/2018 9:13	-0.1	-0.088	0.012	-0.032	0.068	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.06	0.04		
5/15/2018 9:14	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
5/15/2018 9:15	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
5/15/2018 9:16	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
5/15/2018 9:17	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
5/15/2018 9:18	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
5/15/2018 9:19	-0.1	-0.088	0.012	-0.06	0.04	-0.088	0.012	-0.088	0.012	-0.088	0.012	-0.088	0.012		
Mean Absolute Difference			0.012		0.0512		0.012		0.0176		0.0148		0.0232		
5/15/2018 8:31	17.2	17.201	0.001	17.153	0.047	17.177	0.023	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:32	17.2	17.177	0.023	17.153	0.047	17.201	0.001	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:33	17.2	17.177	0.023	17.153	0.047	17.201	0.001	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:34	17.2	17.177	0.023	17.153	0.047	17.201	0.001	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:35	17.2	17.201	0.001	17.153	0.047	17.201	0.001	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:36	17.2	17.225	0.025	17.153	0.047	17.201	0.001	17.225	0.025	17.225	0.025	17.177	0.023		
5/15/2018 8:37	17.2	17.225	0.025	17.153	0.047	17.201	0.001	17.249	0.049	17.249	0.049	17.177	0.023		
5/15/2018 8:38	17.2	17.225	0.025	17.153	0.047	17.201	0.001	17.249	0.049	17.249	0.049	17.177	0.023		
5/15/2018 8:39	17.2	17.225	0.025	17.153	0.047	17.225	0.025	17.225	0.025	17.272	0.072	17.177	0.023		
5/15/2018 8:40	17.2	17.249	0.049	17.177	0.023	17.225	0.025	17.249	0.049	17.249	0.049	17.177	0.023		
Mean Absolute Difference			0.022		0.0446		0.008		0.0322		0.0369		0.023		

Attachment D

This section contains a blank and filled out example of the Continuous Temperature Survey Form that should be used for Ambient Monitoring - continuous temperature logger deployments. The form must be printed on waterproof paper and all completed ones need to be organized and stored in binders for archival purposes.

D-1. Blank Survey Form

D-2. Filled-out Survey Form

D-1. Blank Survey Form

Snohomish County Temperature Logger Field Form		SWM Probe #: _____ Probe Serial #: _____
Logger		
Placement	Personel: _____	Date/Time: ____-____-____
	Program (circle): IM, CAR, Ambient, Proj Effect, Grant	
Water Body:	_____	Air _____ Water _____
Site ID #	_____	
Stream Name	_____	
Site Description	_____	
Canopy Cover:	_____	
Habitat unit (pool, riffle, glide):	_____	
Landmark:	_____	
Notes:	_____ _____	
Site Sketch or Photo		
Retrieval	<u>Date:</u> ____-____-____	Time: _____
Condition/Notes:	_____	

D-2. Example Data Entry on the Survey Form

Snohomish County SWMTemperature Logger Field Form		SWM Probe #: <u>12</u>
Logger		Probe Serial #:
Placement	Personel: <u>KMW, TTI</u>	Date/Time: <u>06/01/17 14:10</u>
Program (circle): CAR, Ambient, Proj Effect, Grant		
Water Body:	<u>STILLAGUMISH RIVER</u>	Air _____ Water <u>X</u>
Site ID # _____		
Stream Name	<u>CHURCH CREEK AT JENSEN ROAD</u>	Temperature: _____
Easting (DD/MM/SS.#): _____		Northing: _____
State Plane Coordinate System _____		GPS Unit Used _____
Township/Section/Range (E.g., N38W22S18): _____		
Flow: _____	BFW: _____	WW: _____
Site Description <u>75' DOWNSTREAM OF BRIDGE AT BASE OF LARGE ALDER TREE ON L3</u>		
Canopy Cover: <u>90%</u>		
Habitat unit (pool, riffle, glide): _____		
Landmark: _____		
Notes: <u>SAME LOCATION AS 2016</u>		
Site Sketch or Photo		
Retrieval	Date: <u>10/02/17</u>	Time: <u>13:05</u> Temperature: _____
Condition/Notes: <u>Submerged</u>		

Attachment E. Data Quality Code Determination

Quality Code of 1

- Location Code is 1
- Pre-calibration and post-calibration files are available
- Pre-calibration and post-calibration files meet guidelines
 - Logger was subjected to at least two water baths (0°C and room temperature ~20°C)
 - Logger calibration check temperatures were referenced against a certified (NIST) thermometer
 - Logger was set at five minute logging intervals
 - At least 5 temperatures were recorded at each temperature
- Temperature logger “passed” calibration check meaning the mean absolute difference between the logger and the certified thermometer for both temperature baths were <0.2°C for a water temperature logger and <0.4°C for an air temperature logger.
- Logging interval was 30 minutes when logger was deployed.

Quality code of 2

- Location Code is 1
- Pre-calibration and post-calibration files are available
- Pre-calibration and post-calibration files meet guidelines
 - Logger was subjected to at least two water baths (0°C and room temperature ~20°C)
 - Logger calibration check temperatures were referenced against a certified (NIST) thermometer
 - Logger was set at five minute logging intervals
 - At least 5 temperatures were recorded at each temperature
- Temperature logger “passed” calibration check meaning the mean absolute difference between the logger and the certified thermometer for both temperature baths were <0.2°C for a water temperature logger and <0.4°C for an air temperature logger.
- **Logging interval was ≤60 minutes when logger was deployed.**

Quality code 3

- Location Code is 1
- A Pre-calibration **or** a post-calibration file is available
- Pre-calibration **or** post-calibration file meet guidelines

- Logger was subjected to at least two water baths (0°C and room temperature ~20°C)
- Logger calibration check temperatures were referenced against a certified (NIST) thermometer
- Logger was set at **ANY** calibration logging interval
- At least 5 temperatures were recorded at each temperature
- Temperature logger “passed” calibration check meaning the mean absolute difference between the logger and the certified thermometer for both temperature baths were <0.2°C for a water temperature logger and <0.4°C for an air temperature logger.
- Logging interval was ≤60 minutes when logger was deployed.

Quality code 4

- Location Code is 1 or 2
- A Pre-calibration or a post-calibration file is available
- Pre-calibration or post-calibration files meet the following guidelines
 - Logger was subjected to at least two water baths (0°C and room temperature ~20°C)
 - Logger calibration check temperatures were referenced against a certified (NIST) thermometer
 - Logger was set at ANY calibration logging interval
 - At least 5 temperatures were recorded at each temperature
- Temperature logger “passed” calibration check
- Logging interval was ≤60 minutes when logger was deployed.

Quality code 5

- Location Code is 1 or 2
- A Pre-calibration or a post-calibration file is available
- Pre-calibration or post-calibration files do not meet all guidelines
- **Calibration file includes only one of the following flaws**
 - Logger **MAY HAVE BEEN** subjected to **ONLY ONE** water bath (0°C **OR** room temperature ~20°C)
 - Logger calibration check temperatures **MAY NOT BE** referenced against a certified (NIST) thermometer
 - **LESS THAN 5** temperatures **MAY HAVE BEEN** recorded at each temperature
- Logger was set at ANY calibration logging interval Temperature logger “passed” calibration check
- Logging interval **MAY BE >60** minutes when logger was deployed.

Quality code 6

- Location Code is 1 or 2 **or 3**
- A Pre-calibration or a post-calibration file is available
- Pre-calibration or post-calibration files do not meet all guidelines
- Calibration file includes **ONLY ONE** of the following
 - Logger **MAY HAVE BEEN** subjected to **ONLY ONE** water bath (0°C OR room temperature ~20°C)

Quality code 7

- Location Code is 1 or 2 or 3
- A Pre-calibration or a post-calibration file is available
- Pre-calibration or post-calibration files do not meet all guidelines
- Calibration file includes **MORE THAN ONE** of the following
 - Logger was subjected to **ONLY ONE** water bath (0°C OR room temperature ~20°C)
 - Logger calibration check temperatures **MAY NOT BE** referenced against a certified (NIST) thermometer
 - 5 temperatures **MAY NOT HAVE BEEN** recorded at each temperature
- Logger was set at **ANY** calibration logging interval
- Temperature logger **“DID NOT”** calibration check
- Logging interval **MAY BE** >60 minutes when logger was deployed

Quality code 8

- **No calibration files**

Quality code 9

- **No location coordinate or calibration files**

