



DEPARTMENT OF
ECOLOGY
State of Washington

Standard Operating Procedure EAP080, Version 2.2

Continuous Temperature Monitoring of Freshwater Rivers and Streams

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Purpose of this Document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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

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

SOP Revision History

Revision Date	Revision History	Summary of Changes	Sections	Reviser(s)
4/12/2010		First draft updating and incorporating existing 2003 Continuous Temperature Protocols with the 2008 TMDL SOP.	All	W. Ward
		Draft addressing Dan Sherratt and Dave Hallock comments	All	W. Ward
		Draft addressing James Kardouni comments	All	W. Ward
	1.0	Final draft	All	
10/26/2011	1.0	Editorial cleanup	All	B. Kammin
3/25/2015	2.0	Minor editorial updates and recertified	All	W. Ward
3/25/2015	2.0	QA approval	All	B. Kammin
3/25/2018	2.1	Minor editorial updates	5,6, & 10	W. Ward
3/25/2018		Recertified	All	T. Gries
3/14/2022	2.2	Transferred to new template. Updated Records Management to reflect new database. Minor editorial updates.	All	S. Nelson
3/24/2022	2.2	Minor editorial updates. Added instrument. Minor clarifications to calibration and deployment procedures and text. Added and updated references. Updated AltText. Recertified.	All	D. Dugger

1.0 Purpose and Scope

- 1.1 This Standard Operating Procedure (SOP) details a methods used by the Department of Ecology (Ecology) to collect continuous temperature monitoring data. It may also contain methods that other entities would find useful for their monitoring work.
- 1.2 The scope of the continuous temperature monitoring program currently focuses on summer (June-September) stream temperatures, but will be expanded to year-round as resources allow.
- 1.3 The intended purpose of the continuous temperature monitoring program is to collect diel stream temperature data that may be used to expand the interpretation of a station's ambient monitoring results and to determine its compliance with state water quality standards. The continuous temperature results are assessed using Ecology's policy for identifying impairments under the federal Clean Water Act (Section 303(d)), which requires stream temperature to be measured on consecutive days in order to apply the criterion.

2.0 Applicability

- 2.1 The Standard Operating Procedures (SOP) will be followed for the installation and maintenance of continuous temperature ambient monitoring stations. These protocols reflect in part those outlined in the following publications:
- TFW Stream Temperature Survey Manual (Schuett- Hames et al., 1999)
 - Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section (Ward, 2003)
 - Measuring Stream Temperature with Digital Data Loggers: A User's Guide. (USFS, 2005)
 - Standard Operating Procedure EAP044, Version 4.0: Collecting Data to Support a Temperature Total Maximum Daily Load (TMDL) Study. (Bilhimer and Stohr, 2019)

3.0 Definitions

- 3.1 *7DADMax*, 7-day average of the daily maximum temperature
- 3.2 *EAP*, Ecology's Environmental Assessment Program
- 3.3 *EIM*, Ecology's Environmental Information Management database for environmental data
- 3.4 *EPA*, US Environmental Protection Agency
- 3.5 *GIS*, Geographical Information System
- 3.6 *GPS*, Global Position System
- 3.7 *NIST*, National Institute of Standards and Technology
- 3.8 *PST*, Pacific Standard Time
- 3.9 *PDT*, Pacific Daylight savings Time

3.10 *QAPP*, Quality Assurance Project Plan

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified in EAP's Field Safety Manual (Ecology, 2016), such as First Aid, CPR, and Defensive Driving.

4.2 Typical Job Class performing SOP: Natural Resource Scientist 1/2/3, Environmental Engineer 1/2/3/4/5, Environmental Specialist 1/2/3/4/5, Administrative Intern 1/2/3.

5.0 Equipment, Reagents, and Supplies

5.1 General Field Equipment

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

5.2 Specialized Field Equipment (*Note: the equipment listed does not represent an endorsement by Ecology. Other equipment may be used if it meets the project QA/QC requirements for accuracy and reliability.*)

5.2.1 Rebar Pounder (see design specifications in Attachment B)

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

5.2.3 Onset HOBO TidbiT MX Temperature 400' Data Logger (#MX2203)
±0.25°C from -20° to 0°C , ±0.2°C from 0° to 70°C

5.2.4 Onset Tidbit[®] v2 Temp Logger, (#UTBI-001), +/- 0.2°C

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

5.2.6 Onset StowAway Tidbits[®], -5°C to +37°C model, +/- 0.2°C (no longer available)

5.2.7 Onset StowAway Tidbits[®], -20°C to +50°C model, +/- 0.4°C (no longer available)

5.2.8 Spirit-filled thermometer or long-line thermistor with an accuracy of +/-0.2°C

5.2.9 PC communication cables or optic shuttles specific for each instrument type

6.0 Summary of Procedure

6.1 Pre-Deployment Run Preparation

6.1.1 Assemble 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).

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

6.1.2.1 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). *Note: This procedure is also used to determine correction factors (if required) for the field thermistor and thermometer measurements.*

- 6.1.2.1.1 All NIST reference thermistors, thermocouples, and thermometers, used for this test, need to have an annual three-point (near 0, 10, 20°C) calibration check against the Lacey Operations Center NIST or be sent in for an Accredited Calibration Certificate.
- 6.1.2.2 A calibration-check test-bath method that can maintain a constant temperature is essential to obtain precise and representative test results. We describe one effective method below. Other effective temperature calibration check methods are described in the Appendix of EAP011, Standard Operating Procedure EAP011, Version 2.0. Instantaneous Measurements of Temperature in Water (Nipp 2022).
- 6.1.2.2.1 Place one open cooler half full of water overnight in a walk-in cooler or room that has a constant air temperature near 0°C and two coolers (setup similarly) in a room with a temperature near 20°C. *Note: Test baths done in rooms that have the target temperature ensure stable bath temperatures and the overall quality of the test.*
- 6.1.2.2.2 Program the temperature loggers for the test start time and up to a five-minute logging interval (a one- to two-minute interval is preferred). String the loggers together to facilitate their transfer into each water bath.
- 6.1.2.2.3 Put the programmed temperature loggers in the near 0 °C test bath overnight.
- 6.1.2.2.4 Twenty minutes before the start of the test, 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.
- 6.1.2.2.5 Gently stir the water bath again a few minutes before test and just after reading and recording the NIST thermometer temperature.
- 6.1.2.2.6 Record 10 relatively constant and consecutive 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) when the logger records the water bath temperature. If the logger has a two-minute sampling interval, it may take twenty minutes to obtain the 10 NIST measurements.
- 6.1.2.2.7 Dewater and transfer the strings of temperature loggers, thermometers, and thermistor probes to one of the room temperature (near 20°C) water baths. Gently stir the transition water bath and allow the loggers to soak there for several minutes. Then transfer them to the other room temperature water bath for a few minute soak. *Note: this two-step process helps minimize the temperature changes in the final water bath.*
- 6.1.2.2.8 Repeat the process noted above to obtain ten relatively constant NIST thermometer comparison measurements the final water bath.
- 6.1.2.2.9 Download the temperature loggers as soon as possible after the test to shut them off and minimize battery life impacts.

- 6.1.2.2.10 Calculate the mean absolute value of the difference between the temperature logger measurements and the NIST thermometer for each water bath with spreadsheet software or by hand. 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.
- 6.1.3 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., <https://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.
 - 6.1.3.1 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- (or 15-) minute monitoring interval (with two of the measurements per hour occurring on the hour and half hour of the local-time zone daily 24-hour clock cycle).
- 6.2 Stream temperature logger site selection methods
 - 6.2.1 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. The preferred location in these areas is against an instream 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.*
 - 6.2.2 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 streams (see Figure 1 below).

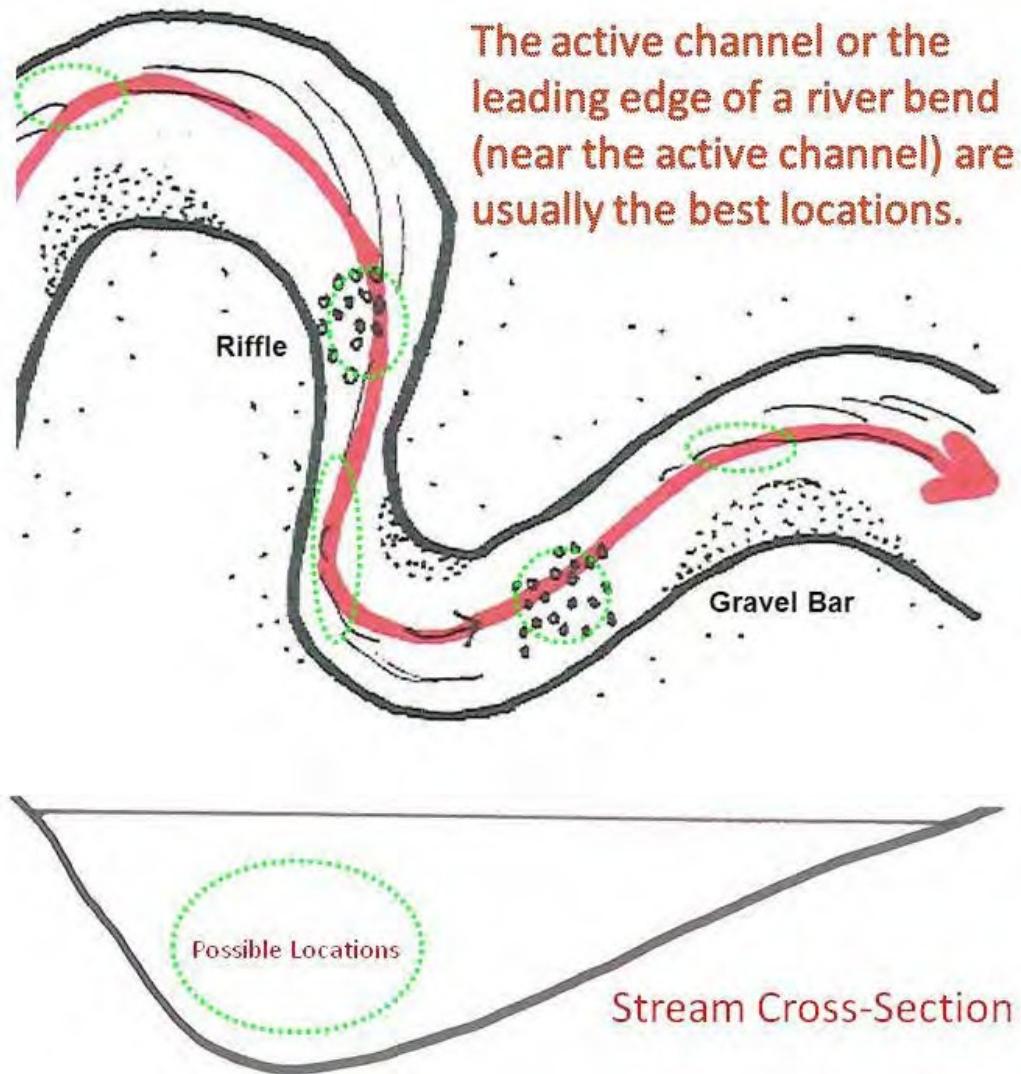


Figure 1 Potential Temperature Logger Deployment Locations

- 6.2.3 Temperature logger locations should never be in eddies or pools or locations where these conditions may develop during low flows. In addition, 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.
- 6.2.4 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.*

- 6.2.5 The representativeness of the temperature logger deployment location should be verified by measuring several points in and near the vicinity of the logger and the temperature of the well-mixed part of the stream. If the stream can be easily waded, then a simple cross sectional temperature survey could also be done. Review the survey results, and consider another deployment location, if necessary, to help ensure that the logger will record representative results.
- 6.3 Stream temperature logger deployment options
- 6.3.1 Record the water-temperature-logger serial numbers on the survey form. (See Attachment D1 for blank form and Attachment D2 for an example).
- 6.3.2 Pre-assemble the water-temperature logger with a camouflage-painted PVC shade device cover (See Figure 2 below and the design in Attachment B) that helps hide the logger and prevent any bias from indirect solar radiation.

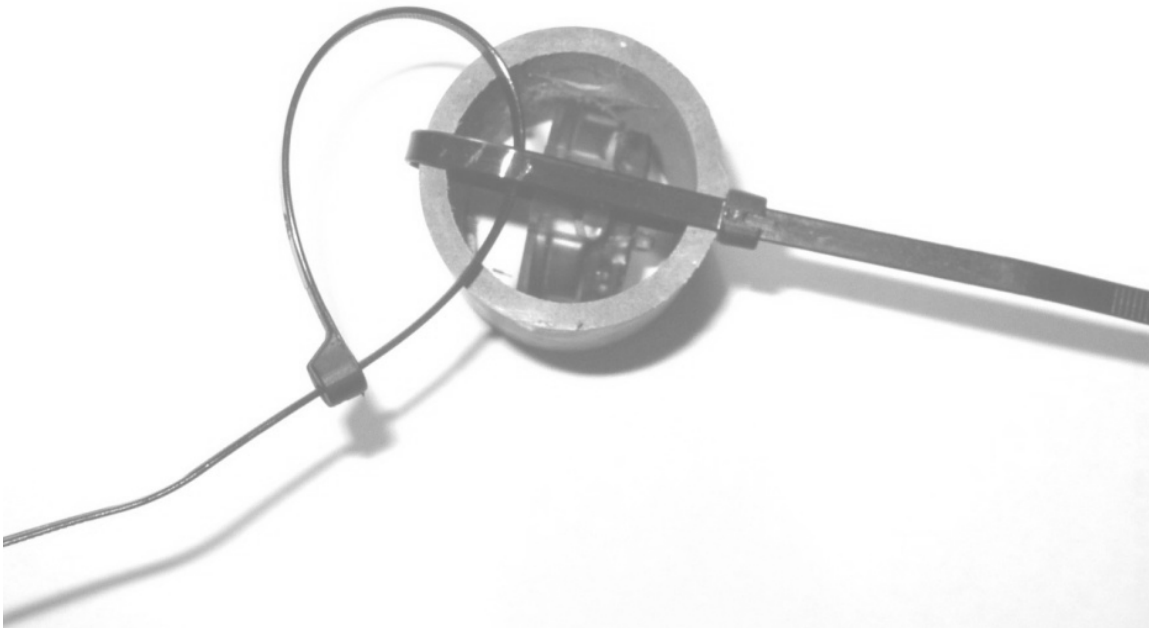


Figure 2 Assembled Temperature Logger and PVC Cover

- 6.3.3 Avoid low-flow and direct-sunlight temperature logger deployment locations. If the temperature logger needs to be deployed in these locations, then a white PVC shade cover must be used to prevent any solar-biased temperature results (USFS, 2005).
- 6.3.4 Place a thermometer or thermistor as close as possible to the identified deployment location and record the measurement after the logger has been deployed. Consider use of one of the following deployment methods:

- 6.3.5 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.
- 6.3.6 Choose a two-to-three-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 above the streambed by six inches to one-half of the expected total stream depth during the seasonal low-flow period.
- 6.3.7 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 streambed (if a mid-stream depth is desired, then leave more rebar exposed).
- 6.3.8 Leave the rebar pounder on the rebar, and document the water-temperature logger location with photographs.
- 6.3.9 Remove the rebar pounder and attach the temperature logger assembly to the rebar about 6 inches off the bottom (or mid-water depth) with a cable tie. *Note: In fast-flowing locations an additional cable tie should be attached to the rebar just above the temperature logger assembly attachment point to prevent its loss should the second cable tie loosen on the rebar. Or attach the assembly using a small gage wire.*
- 6.3.10 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.
- 6.3.11 Photographs of the location using a visual marker (such as the rebar pounder and hammer handle in Figure 4, nearby flagging, or pointing with a finger) are essential to help relocate loggers installed by this method.
- 6.3.12 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.
- 6.3.13 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.*

- 6.3.14 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).



Figure 3: Deployment method using a length of PVC pipe

- 6.3.15 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.
- 6.3.16 Aquatic Invasive Species. Clean all field equipment that contacted water following procedures in EAP070 (Parsons, et al. 2018).

- 6.4 Air temperature logger deployment methods
 - 6.4.1 Use temperature loggers that can record the maximum expected temperature for the deployment location. If you are locating loggers in an area where the summer air temperatures can exceed 100°F (37°C), then use an air thermistor that has the higher temperature range setting.
 - 6.4.2 Record the air-temperature-logger serial numbers on the survey form.
 - 6.4.3 Pre-assemble the air-temperature logger with a PVC shade device cover. The pre-assembly should be done before beginning the process to install the logger (See Figure 2 above).
 - 6.4.4 These temperature loggers need to be located within the same microclimate of the water logger. Ideal locations are one to three meters into the riparian zone (Schuett-Hames et al., 1999) and about four to eight feet above the ground (USFS, 2005). Avoid placing them in areas that are not representative of streamside conditions at your location or where they will be severely impacted from solar radiation. The north side of a shrub or tree trunk should work well in most locations, especially those with limited streamside vegetation choices.
 - 6.4.4.1 Do not use weeping or crack willows, as they can secrete fluid during hot weather and create error in the air temperature results.
 - 6.4.5 One air-temperature logger should be deployed near every water-temperature-logger location. However, if the vegetation and streamside conditions are similar, then one air-temperature logger may be used to cover several nearby water-temperature loggers. *Note: Air loggers deployed for Total Maximum Daily Load studies (Bilhimer and Stohr, 2008) must be within approximately 0.5 mile of the most distant water logger.*
- 6.5 Documentation Procedures
 - 6.5.1 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 air- and water-temperature measurements, and any other useful narrative observations, especially those useful for finding the location (e.g. – “upstream of largest boulder on right bank”).
 - 6.5.2 Also, record all observation times in PST (or note when they are DST, so they may be converted to PST later), and use a timepiece that has been calibrated to the atomic clock (or use the cell-phone time).
 - 6.5.3 Further, 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.*

- 6.5.4 Take upstream and downstream photographs of the water-temperature-logger location that includes useful and easily identifiable landmark tree(s), flagging, or boulder(s). 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.

- 6.5.5 Measure and record: the total water depth (water depth), distance from the logger to the streambed (height), distance from water surface to the logger (deployment depth), and the stream temperature on the survey form.
- 6.5.6 Record the temperature logger GPS coordinate location (or note the logger location on an accurate map and determine the coordinates later).
- 6.6 Mid-deployment checks
- 6.6.1 If possible, periodically visit the temperature-logger location during the deployment period to get mid-deployment temperature-check data 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 to process.*

- 6.7 Retrieval Procedures
- 6.7.1 Measure and record the stream temperature and surface depth of the water-temperature logger (retrieval depth), and record the results on the field form. Also, measure and record the distance from the streambed up to the logger, and note any differences between the result and what was recorded during deployment.
- 6.7.2 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.
- 6.7.3 Remove all rebar, cement blocks, or other deployed equipment at the end of the study.
- 6.7.4 Aquatic Invasive Species. Clean all field equipment that contacted water following the procedures in Hallock, et al., 2010 (EAP070).
- 6.8 Downloading Procedures
- 6.8.1 Gently clean the temperature loggers with a soft wet cloth to remove any biofouling 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.
- 6.8.2 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.

7.0 Records Management

- 7.1 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.
- 7.2 Use Ecology's Monitoring Program Automation (MPA) site to manage, store, export, and upload data summaries to Ecology's Environmental Information Management System (EIM). *Note: the database is available to interested agencies and organizations upon request.*

8.0 Quality Control and Quality Assurance

- 8.1 *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 procedure, 6.1.2, above).
- 8.1.1 If the mean absolute value of the temperature difference for a logger in each water bath, compared against the NIST certified thermometer, is equal to or less than the manufacturer stated accuracy (i.e. usually $\pm 0.2^{\circ}\text{C}$ for a water-temperature logger or $\pm 0.4^{\circ}\text{C}$ for an air temperature logger), then a second check should be performed.

- 8.1.2 If a second calibration check result confirms a consistent bias above the stated accuracy, then the raw data should be adjusted by the mean difference of the pre- and post-calibration check results to correct for the logger bias (Schuett-Hames et al., 1999).
- 8.2 *Data Proofing Procedures.* Data from temperature loggers that met the calibration- check accuracy requirement are proofed and QC checked using *Ecology's FMU Access® Data Logger Database*. This database allows the information recorded on the Continuous Temperature Data Report Form (deployment/retrieval times and temperatures) and available climatic and flow data to be used to proof, edit, run automated QC checks, store, summarize, report, and export the finalized data (to text files, Microsoft® Excel, or to Ecology's Environmental Information Management (EIM) system Excel template).
- 8.2.1 *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.*
- 8.2.2 All data will be assigned a measurement accuracy value based on the pre- and post-deployment calibration check results.

9.0 Safety

- 9.1 Safety is the primary concern when deploying temperature loggers. Proper fieldwork safety procedures are outlined in the Environmental Assessment Program Safety Manual (Ecology, 2016). A minimum of two people are required when streams are waded. One can deploy the stream temperature loggers, and the other can assist from shore. If streamside hazards such as high flow, weather, and debris make the temperature logger deployment dangerous, then an alternate location, different deployment method, or different deployment time should be considered.
- 9.2 Material Safety Data Sheets (MSDSs) for all chemicals used in EAP field sampling or analytical procedures can be found at the following SharePoint link:
<http://teams/sites/EAP/QualityAssurance/ChemicalSafetyDataSheets/Forms/AllItems.aspx>.
- 9.3 Binders containing MSDSs can be found in all field vehicles, vessels, Ecology buildings, or other locations where potentially hazardous chemicals may be handled. EAP staff following Ecology SOPs are required to familiarize themselves with these MSDSs and take the appropriate safety measures for these chemicals.

10.0 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

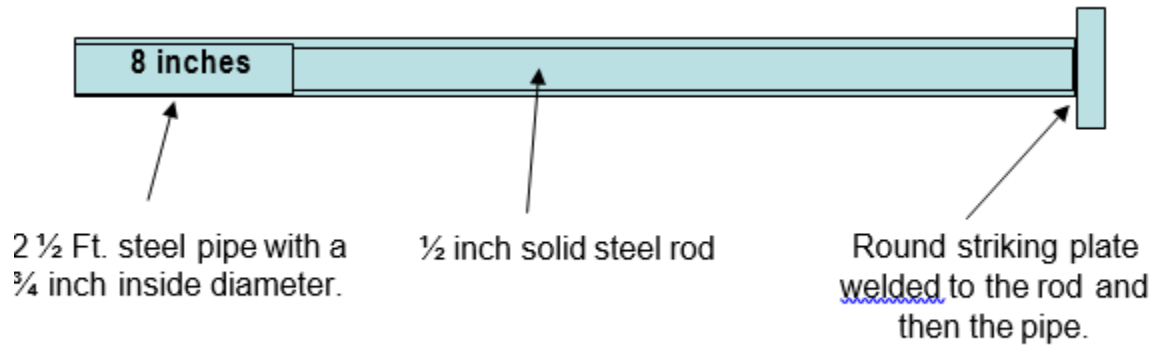
- Rain Gear
- Knee Boots
- Waders
- Watch
- Gloves
- Extra Clothing
- Hat
-
-

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.

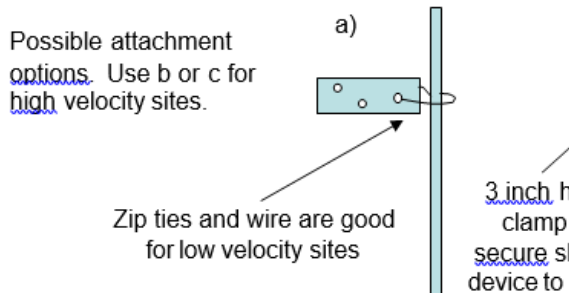
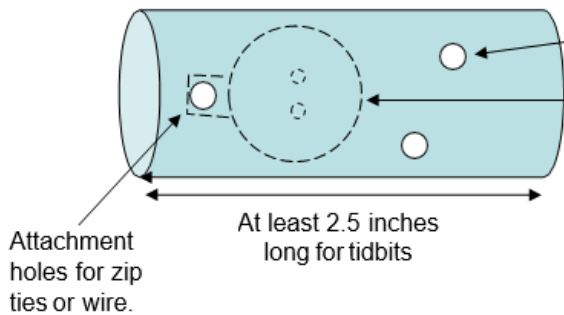
Rebar Pounder Design

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 thermistor



Attachment C.

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

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

Date: _____

Temperature Logger Calibration Check Form

Technicians:

	Time	NIST	Thermistor	Red Liquid	SN-	SN-
		SN-	#	SN-		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Technicians:

	Time	NIST	Thermistor	Red Liquid	SN-	SN-
		SN-	#	SN-		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

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

Date: 5/4/09

Temperature Logger Calibration Check Form

Technicians: Wfred

	Time	NIST SN-70409	Thermistor # SLLT-1	Red Liquid SN-8N935	Red Liquid SN-8N911	SN-
1	08:30	4.3	4.2	4.3	4.3	
2	:32	4.3	4.2	4.3	4.3	
3	:34	4.3	4.2	4.3	4.3	
4	:36	4.3	4.2	4.3	4.3	
5	:38	4.3	4.2	4.3	4.3	
6	:40	4.3	4.2	4.3	4.3	
7	:42	4.3	4.2	4.3	4.3	
8	:44	4.3	4.2	4.3	4.3	
9	:46	4.3	4.2	4.3	4.3	
10	:48	4.3	4.2	4.3	4.3	
11	:50	4.3	4.2	4.3	4.3	
12	:52					
13						
14						
15						

	Time	NIST SN-70409	Thermistor # SLLT-1	Red Liquid SN-8N935	Red Liquid SN-8N911	SN-
1	09:14	21.0	21.0	21.0	20.9	
2	09:16	21.05	21.0	21.1	20.9	
3	:18	21.1	21.1	21.1	21.0	
4	:20	21.1	21.1	21.1	21.0	
5	:22	21.1	21.1	21.1	21.0	
6	:24	21.1	21.1	21.1	21.0	
7	:26	21.1	21.1	21.1	21.0	
8	:28	21.1	21.1	21.1	21.0	
9	:30	21.1	21.1	21.1	21.0	
10	:32	21.1	21.1	21.1	21.0	
11	:34	21.1	21.1	21.1	21.0	
12	:36	21.1	21.1	21.1	21.1	
13						
14						
15						

5000

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

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-2. Filled-out Survey Form

Continuous Temperature Survey Form

Station #: 08C110 Station Name: CEDAR NR LANDSBURG Samplers: WARD/MYERS

Interval Frequency 00:30

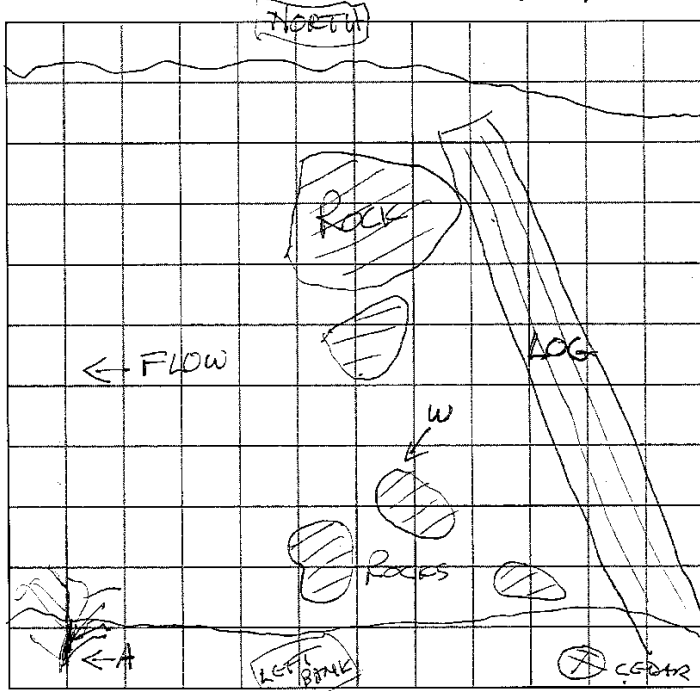
Water Temperature Logger

I.D. # 457373
 Water Depth 1.5 ft Deployment Depth 1.0 ft
 Height (Abv Bottom) 0.5 ft Retrieval Depth 0.7 ft

Air Temperature Logger

I.D. # 457375
 Height (Abv Stream) 6 ft

Date	Time	Water Temp	Air Temp	Weather/Comments
6/25	11:40	11.8	12.5	OUGLCST
7/24	10:20	12.3		PARTLY SUNNY



Air Temperature Logger Location:
 ON VINE MAPLE N 3.5' OFF GROUND, TREE IS LOCATED N 15' DOWNSTREAM OF WATER LOGGER LOCATION (ORANGE FLAGGING). LOGGER IS ON BACK SIDE OF TREE.

Water Temperature Logger Location: ON REBAR INSTALLED ON THE STREAM/UPSTREAM CORNER OF THE FIRST OF TWO LARGE ROCKS (> 3.5' DIAMETER) BELOW LARGE LOG (N 9' FROM LOG). NEAR LEFT BANK.