STANDARD OPERATING PROCEDURES FOR MEASURING CONTINUOUS WATER TEMPERATURE

Bureau of Water Protection and Land Reuse
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APPROVAL PAGE

SOP Title: STANDARD OPERATING PROCEDURE FOR MEASURING CONTINUOUS WATER TEMPERATURE
Revision Number: 4
Originator Name: Meghan Lally
Effective Date: 12/20/2018

APPROVALS:

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Program Supervisor/Quality Control Officer:

Christopher J. Bellucci _____ Date: 1/23/19
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REVISIONS PAGE

Date	Review Number	Summary of Changes	Applicable Section
01/31/2011	0	Initial Approval	All
06/15/2012	1	Changed Agency name from DEP to DEEP; Added section on QA field checks Added language on ice bath preparation	Title page Section 1.0 Introduction Section 2.0 Applicability Section 4.7 Field Checks Section 3.1Data Logger Accuracy
04/11/2013	2	Revised language on data logger accuracy check Revised language on pre-deployment logger set-up Deleted data logger pre-field calibration Revised language for downloading data logger field data Added section on Post/Pre-calibration	Section 3.1 Data logger Accuracy Section 3.2 Setting Logger for Delayed Start Section 3.3 Data logger Pre-Field Calibration Section 4.6 Downloading Data logger Field Data 4.7 Post/Pre-Calibration
01/23/2014	3	Revised field data sheet	Appendix 4. Data sheet for recording deployment location of water temperature data logger
12/20/2018	4	Reorganized SOP into QA section, field section, and data management sections. Moved equipment information to Section 3.0	All sections. 2.0 Applicability

		Removed requirement to calculate mean of ice bath readings	3.3 Quality Assurance Check Laboratory Procedure
		Moved data logger care and maintenance section	3.5 Data Logger Care, Storage & Maintenance
		Revised logger delayed launch instructions to launch loggers at midnight	4.3 Field Equipment Preparation
		Revised logger file naming convention to include logger type	4.8 Post Fieldwork Activities
		Updated data management section	5.0 Data Management
		Added a field QC thermometer QA check procedure.	New Section 3.6
		Added field training section	New Section 4.1 Field Training
		Added field safety section	New Section 4.2 Field Safety
		Updated field instructions: loggers are to be placed on ice upon retrieval	4.7.1 Logger Retrieval
		Revised QA/QC log sheet	Appendix 2: Temperature Data Logger QA/QC Log Sheet
		Updated Equipment Lists	Appendix 3: Equipment Check lists
		Revised field data sheet	Appendix 4. Data sheet for recording deployment location of water temperature data logger
		Added instructions for reformatting data. Updated instructions to delete all partial-day data.	Appendix 5. Instructions for Reformatting Files for Database Upload

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APPENDICES:

1.0 INTRODUCTION

Ambient water temperature in rivers and streams is an important parameter to measure for the Connecticut Department of Energy and Environmental Protection (DEEP) ambient monitoring program. Continuous water temperature measurements are typically recorded during low flow, high stress warmer summer months (June-September) at site locations where DEEP has an interest evaluating the biological communities (e.g. fish, benthic macroinvertebrates, and periphyton). These summer data sets are also used to identify high quality, cold waters as part of the program's Healthy Waters Initiative.

In addition, annual continuous water temperature measurements are included in sampling programs to assess long-term trends at selected reference sites. Other potential reasons DEEP collects continuous water temperature data include assessing permit compliance, and other research projects.

It is the responsibility of the project manager to ensure that all individual(s) deploying temperature loggers are familiar with these Standard Operating Procedures (SOP). It is the responsibility of the field lead to insure these procedures are carried out correctly in the field.

2.0 APPLICIBILITY

This SOP applies to staff collecting water temperature data to evaluate biological communities and identify cold water and warm water habitat in wadeable rivers and streams. It may be also used for temperature monitoring related to permit compliance assessment as well as other research projects.

3.0 EQUIPMENT SPECIFICATIONS AND QUALITY ASSURANCE CHECKS

3.1 Data Logger Specifications & Comparability

This SOP applies to the use of the following logger types to collect water temperature data:

- Onset brand HOBO Water Temp Pro v2 (U22-001) Data Logger
- Onset brand TidbiT v2 (UTBI-001) Water Temperature Data Logger
- Onset brand HOBO Pendant® Temperature/Light 8K (UA-002-08) and 64K (UA-002-64) Data Loggers
- Onset brand HOBO Fresh Water Conductivity (U24-001) Data Logger

Figure 1. Clockwise from top left: HOBO Pro v2 Water Temperature data logger, TidbiT v2 Water Temperature data logger, HOBO Pendant Temperature/Light data logger, and the HOBO Freshwater Conductivity data logger.

For simplicity, these logger types will be referred to as "HOBO Pro v2," "Tidbit v2," "Pendant," and "Conductivity" loggers in subsequent sections of this SOP. The table below summarizes their comparability for underwater temperature monitoring.

Logger Type	Operating Range	Accuracy	Resolution	Annual Drift	Battery Life
HOBO Pro v2	-40C to 50C	+/- 0.21C	0.02C	0.1C	6 years
TidbiT v2	-20C to 30C	+/- 0.21C	0.02C	0.1C	5 years
HOBO Pendant	-20C to 70C	+/- 0.53C	0.14C	<0.1C	1 year (replaceable)
HOBO Conductivity	-2C to 36C *nonfreezing	+/-0.1C	0.01C	N/A	3 years

More detailed manufacturer's specifications for each logger as well as the corresponding quick reference guide are included in Appendix 1.

Note: The Pendant and Conductivity loggers measure light and conductivity, respectively, along with temperature; this SOP applies only to the use of these loggers for the purpose of measuring water temperature.

3.2 Data Logger Quality Assurance Check Frequency

Data loggers are to be checked for accuracy upon initial receipt (i.e. after purchase) and before and after each deployment. If a new logger does not pass the initial quality assurance check, the logger is to be set aside and the lab manager notified. Any such loggers will be returned for replacement.

All data loggers will be quality assurance checked, at a minimum, every 12 months. Data loggers are to be quality assurance checked within 6 months prior to each field deployment and within 3 months after retrieval from field deployment.

Any logger that fails a pre- or post-deployment quality assurance check must pass two consecutive subsequent quality assurance checks before it is returned to use. Any logger that fails two consecutive quality assurance checks will be removed from use.

Any logger with a low or 'bad' battery will be removed from use.

3.3 Quality Assurance Check Laboratory Procedure

This SOP uses a single point 0°C quality assurance check to assess the accuracy of its temperature data loggers. All checks are to be recorded in an electronic temperature data logger QA/QC log sheet (Appendix 2). The required equipment is noted in Appendix 3 and shown in Figure 2 below:

Figure 2. Required containers for an ice water bath set-up (left to right): large plastic bin, small perforated container with attached 'foot' stands, and a plastic container with a weight.

The following are the procedures for conducting temperature data logger quality assurance checks:

1. Prepare an ice water bath.

   Ideally, the ice bath will be prepared the day prior to the checks to allow for optimal temperature stabilization. If this is not possible, ice baths may be prepared in the morning, and checks conducted in the afternoon of the same day. Up to two ice water baths may be utilized for concurrent checks.

   Place a small perforated basket with attached foot stands in the center of a large plastic bin. (Note: the stands keep the basket elevated off the ice water bath, which insures that submerged data loggers are not influenced by walk-in cooler ambient air vs. ice water bath temperature differences; failure to elevate the basked above the bin

bottom can result in the data loggers not passing the QA accuracy check.) Place the bin on a rolling cart. Fill the plastic bin with ice. Add cold water to the bin to fill approximately ¾ full. Add additional ice to fill the bin to the top, then add additional cold water to bring the water level to just below the top of the perforated basket (Figure 3).

Figure 3. A prepared ice water bath.

The standard thermometer against which all other thermometers are calibrated must be certified by the National Institute of Standards and Technology (NIST). Thoroughly mix the ice water bath and allow to sit until the temperature achieves a uniform 0°C as measured by a NIST certified thermometer. Place the cart with ice bath in the temperature certified walk-in cooler in the Chemistry and Fish Prep Laboratory Room at 9 Windsor Ave, Windsor CT.

2. Enter the QA date and logger information for all loggers to be QA checked in the electronic Temperature Data Logger QA/QC log, as shown below:

	A	B	C	D	E	F	G	H	I	J	
1	Year	QA_DATE	QA_Staff	PROBEID	PROBE_TYPE	Owner	New Logger?	BATTERY_STATUS	StartTime	StartTemp	Mi
2	2018	4/25/2018	M Lally	10324585	HOBO ProV2	VOL	FALSE				
3	2018	4/25/2018	M Lally	10324586	HOBO ProV2	VOL	FALSE				
4	2018	4/25/2018	M Lally	10324587	HOBO ProV2	VOL	FALSE				
5	2018	4/25/2018	M Lally	10324588	HOBO ProV2	VOL	FALSE				
6	2018	4/25/2018	M Lally	10324589	HOBO ProV2	VOL	FALSE				
7	2018	4/25/2018	M Lally	10324590	HOBO ProV2	VOL	FALSE				
8	2018	4/25/2018	M Lally	10324591	HOBO ProV2	VOL	FALSE				
9	2018	4/25/2018	M Lally	10767215	HOBO ProV2	VOL	TRUE				
10	2018	4/25/2018	M Lally	10767216	HOBO ProV2	VOL	TRUE				
11	2018	4/25/2018	M Lally	20298111	HOBO ProV2	VOL	TRUE				
12	2018	4/25/2018	M Lally	20298117	HOBO ProV2	VOL	TRUE				
13	2018	4/25/2018	M Lally	20298113	HOBO ProV2	VOL	TRUE				
14	2018	4/25/2018	M Lally	20298089	HOBO ProV2	VOL	TRUE				
15	2018	4/25/2018	M Lally	20142135	HOBO ProV2	VOL	TRUE				
16	2018	4/25/2018	M Lally	20298105	HOBO ProV2	VOL	TRUE				
17	2018	4/25/2018	M Lally	20298120	HOBO ProV2	VOL	TRUE				
18	2018	4/25/2018	M Lally	20298081	HOBO ProV2	VOL	TRUE				

For owner use “ABM” to indicate a Monitoring Group logger. If a logger to be checked is owned by the Fisheries Division or a volunteer group note the owner as “FISH” or “VOL”, respectively.

Note any new loggers so as to document the start date of their use by the program.

3. Open HOBOware Pro software. Connect the HOBO Optic USB Base Station to the computer using the USB cable. Attach the appropriate coupler to the base station.

Figure 4. HOBO Optic USB Base Station shown with HOBO Pro v2 (blue, attached) and Tidbit (orange) couplers.

4. Insert the logger to be checked into the coupler using the communication alignment arrows as a guide (Figure 5a-b).

Figure 5a-b: (a; top) Coupler and logger alignment arrows (yellow circles); (b; bottom) HOBO Pro v2 logger successfully inserted into the coupler.

If the base station has successfully connected the logger to the computer, a message indicated the logger type and serial number as well as a "1 device connected"

message will appear at the bottom of the HOBOware screen (Figure 6). Note: It may take up to 10 or so seconds for this message to appear.

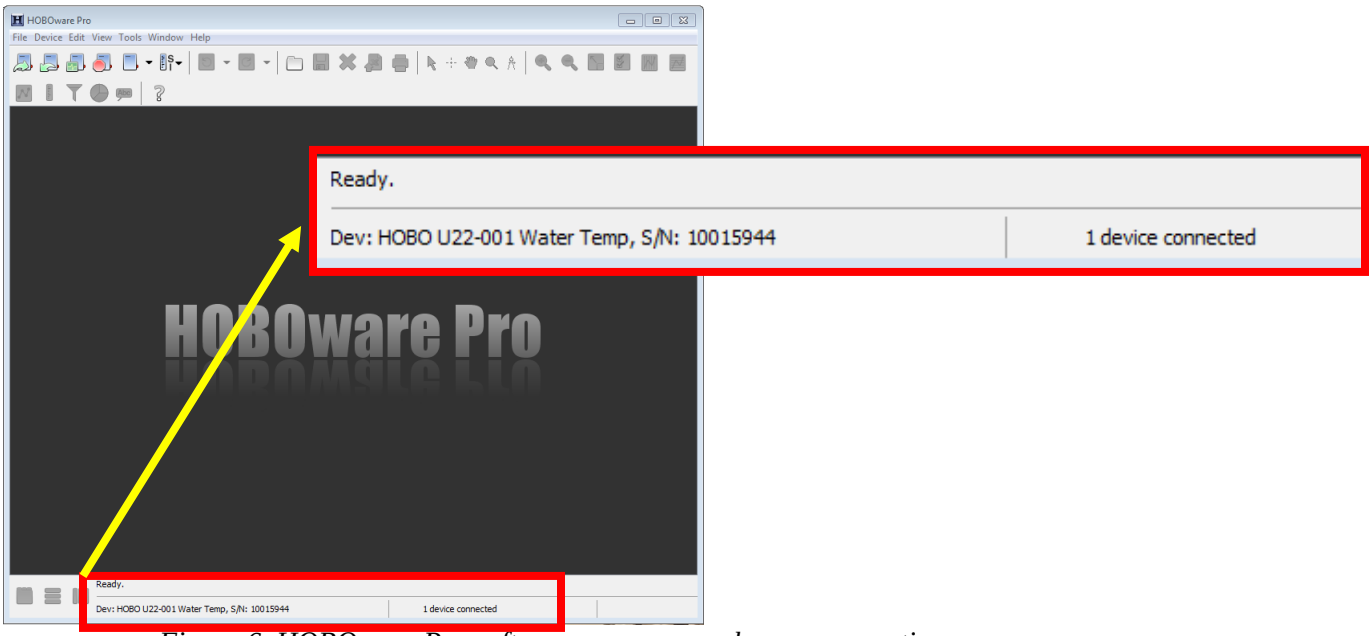

Figure 6. HOBOware Pro software screen upon logger connection.

Trouble shooting: If this message does not appear, readjust the logger insuring the communication alignment arrows are correctly aligned. If the logger still does not connect, attach a manila tag to the logger, label it with the date, logger serial number and "unable to connect." Place the logger in the "Loggers with Issues" bin in the temperature logger station within the Fish/Chemistry Prep lab.

5. Check the logger battery state and launch the logger (Figure 7):
    a. Select 'Launch' from the 'Device' menu. The launch menu should open.
    b. Confirm that the battery state is 'Good' or >75%. If so, type "Good" in the Battery_Status column in the electronic QA/QC log.
    If the battery state is "BAD" or less than 75% do not continue the QA check. Attach a manila tag to the logger, label it with the date, logger serial number and "Bad/Low Battery." Note in the electronic QA/QC log that the battery status was "BAD" and mark the QCResult as "Fail." Type "True" in the QC Flag and Removed from Circulation columns. Enter "N/A" in any remaining fields. Place the logger in the "Loggers with Issues" bin in the temperature logger station within the Fish/Chemistry Prep lab.
    c. Change the file name to include the logger serial number, QA, and date (Example: 123456_QA_031513). (If needed, the serial number is shown directly beneath the file name box.)
    d. Ensure the temperature sensor is checked; enter "Temperature (deg C)" as the label.

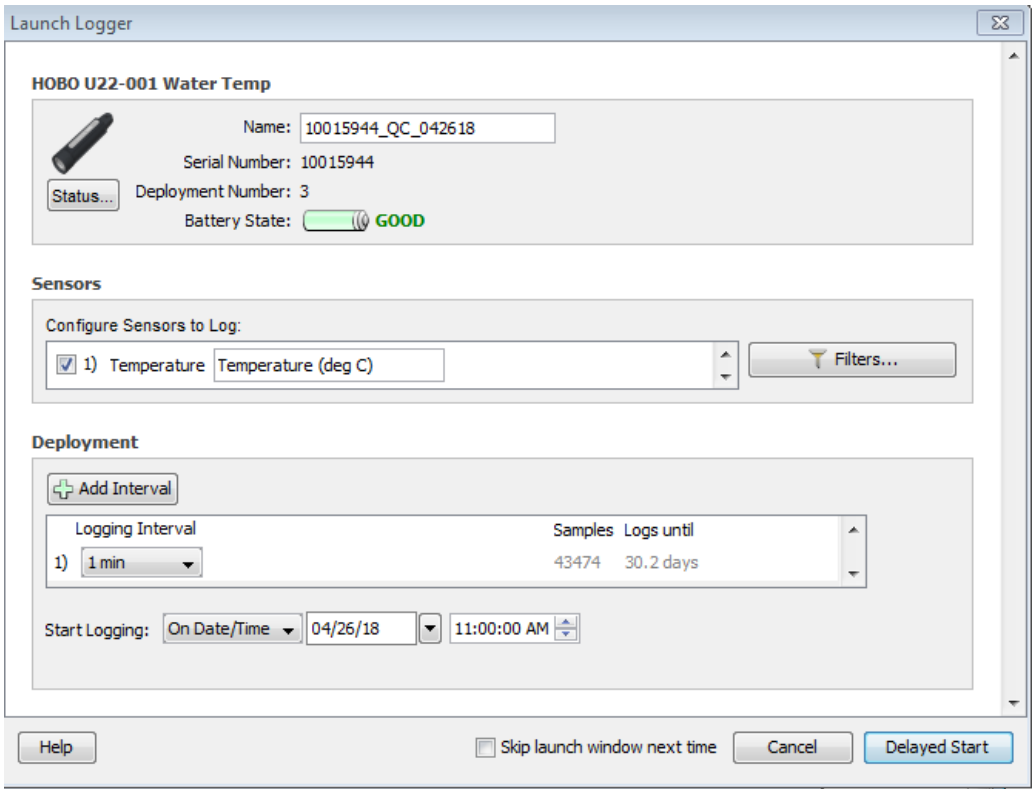

Figure 7. Launch logger screen with settings for a delayed QC check launch...

Set the logging interval to 1 minute

e. Set the Start Logging (i.e. "launch") time to a time <u>at least one hour from when the logger will be placed in the ice bath.</u> (This allows the logger adequate time to acclimate to the water temperatures before recording.)

f. Click "Delayed Start."

A launch status bar will appear. Once the status bar disappears the logger is launched and can be removed from the coupler.

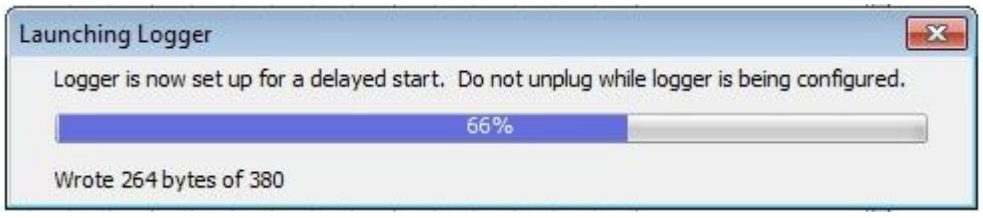

Figure 8. Logger launch status bar

6. Repeat steps 3 &4 for any additional loggers to be QA checked.

7. Check the ice bath temperature in several locations with an NIST certified thermometer. If the temperature is uniformly 0 degrees Celsius, continue with the QA checks. (If not you will need to mix the bath, add ice as needed, and wait until a

uniform 0 degrees Celsius is achieved; this may require relaunching your loggers to a later start time to insure they sit in the bath at least 1 hour prior to recording data.)

8. Place the launched data loggers in the perforated basket in the ice water bath (Figure 9a). Take care not to crowd the basked; do not check more than 20 HOBO Pro v2 or Conductivity loggers at the same time. The loggers have a tendency to float, so if needed, manually adjust the loggers to ensure the sensors are submerged (Figure 9b).

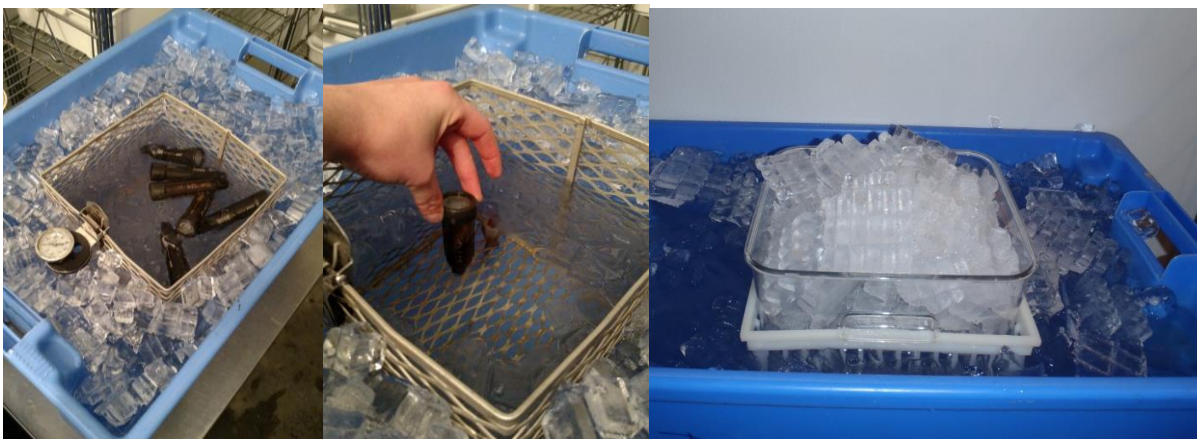

Figure 9a-c. Data loggers in an ice water bath without (a, left) and with (c, right) the small plastic container with weight placed on top of the logger basket. Image 10b shows a logger being held in an ice bath with the sensor submerged; the optical communication window is the circular end exposed above the water.

Place a weight in the small plastic container and fill with ice and then fill halfway with water. Place the small plastic container (with weight, ice and water) inside the perforated container (Figure 9c). Ensure that the data loggers are completely submerged in the ice water bath with the sensor end down.

9. Using a NIST certified thermometer that has an accuracy of 0.2 degrees Celsius or smaller, record the ice water bath temperature:
    a. at the start of data logger recording,
    b. 30 minutes after recording starts, and
    c. prior to removing the data logger from the ice water bath (1 hour after recording starts).

    Record the temperature check times and results (to the nearest 0.1°C) in the electronic Temperature Logger QA/QC Calibration Log as shown below.

    <u>NOTE: If the bath is not uniformly 0 degrees Celsius then the QA check will need to be repeated.</u>

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Year	QA_DATE	QA_Staff	PROBEID	PROBE_TYPE	Owner	New Logger?	BATTERY_STATUS	StartTime	StartTemp	MidTime	MidTemp	EndTime	EndTemp	QCResult	QCFlag
	2018	4/25/2018	M Lally	10324585	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324586	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324587	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324588	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324589	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324590	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10324591	HOBO ProV2	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
	2018	4/25/2018	M Lally	10767215	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
)	2018	4/25/2018	M Lally	10767216	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
1	2018	4/25/2018	M Lally	20298111	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
2	2018	4/25/2018	M Lally	20298117	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
3	2018	4/25/2018	M Lally	20298113	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
4	2018	4/25/2018	M Lally	20298089	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
5	2018	4/25/2018	M Lally	20142135	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
6	2018	4/25/2018	M Lally	20298105	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
7	2018	4/25/2018	M Lally	20298120	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
8	2018	4/25/2018	M Lally	20298081	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
9	2018	4/25/2018	M Lally	20298083	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
0	2018	4/25/2018	M Lally	20298073	HOBO ProV2	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C		
1	2018	4/25/2018	M Lally	10498702	HOBO ProV2	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C		
2	2018	4/25/2018	M Lally	10498701	HOBO ProV2	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C		

Figure 10. Highlighted location of ice bath temperature check data in the QC check log.

10. One hour after the scheduled delayed launch time (set in step 4), remove the data logger(s) from the ice bath. Place the loggers on clean paper towels or towel in a plastic bin.

3.4 Quality Assurance Check Evaluation

1. Create a folder in the M:\Monitoring Field Data by Year\Year Field Work Downloads\HOBO\HOBO Downloads and QA folder with the date of the QA check in mmddyy format. (Example: a QA check conducted on April 25, 2018 would be created as "042518").

2. Download the logger data:
   a. Open the HOBOware® software.
   b. Using the appropriate HOBO base station and coupler, connect the first logger to the computer.
   c. Select 'Readout' from the 'Device' menu. When prompted, select 'Stop' to stop the logger from logging.
   d. Save the QA data file to the M:\Monitoring Field Data by Year\[Year] Field Work Downloads\HOBO\HOBO Downloads and QA\HOBO QA [Season Year]\MMDDYY folder as an Onset HOBO data file (Example: 2229157_QA_042518.hobo).
   e. When the Plot Setup window appears, check the Temp Series to insure the units is set to degrees C (if not change to degrees Celsius) and then click "Plot".
   f. Export the table data as a .csv file. Click "File" then "Export Table Data" and then "Export." Use the same naming convention as the HOBO raw data

file (HOBOware should do this by default) and save to the same location on the M-drive (Example: 2229157_QA_042518.csv).

3. Click the "x" on the tab above the data table to close the current logger's file. Repeat step 2 for any remaining loggers that were in the ice bath.

4. Compile all individual logger QA files (.csv files) into a single master QA file for the given QA date:
    a. Open Microsoft Excel. Save the file as "QA ddmmyy Master File." (Example: QA 042518 Master File.xls). Save the file in the same folder as the raw data files. (M:\Monitoring Field Data by Year\[Year] Field Work Downloads\HOBO\HOBO Downloads and QA\HOBO QA [Season Year]\MMDDYY)
    b. Label row 1A of the QA Master File with the date of the QA, label row 1B with "Serial #", and label row 2A with "Time". Label the remainder of column A (3A-61A) with the time period of the QA check in 1-minute intervals.
    c. Open the saved .csv file for the first logger in Excel; record the serial number of this logger in cell 2B in the QA Master File. Copy the data logger data (temperature values) from the .csv files for the 1-hour recording QA period; paste this data into the QA Master File beneath cell 2B.
    d. Open the saved .csv file for the second logger in Excel; record the serial number of this logger in cell 2C in the QA Master File. Copy the data logger data (temperature values) from the .csv files for the 1-hour recording QA period; paste this data into the QA Master File beneath cell 2C.
    e. Continue opening the remaining saved .csv QA files and copying the corresponding serial number and data to the columns to the left of 2B (Figure 11)
    f. Save the QA Master File once all of the logger QA data has been entered.

QA 111912 Master File [Compatibility Mode]

	A	B	C	D	E
1	11/19/2012	Serial #			
2	Time	9715474	9715472	2238856	2238840
3	12:00	-0.06	-0.032	-0.032	-0.06
4	12:01	-0.06	-0.032	-0.032	-0.06
5	12:02	-0.06	-0.032	-0.032	-0.06
6	12:03	-0.06	-0.032	-0.032	-0.06
7	12:04	-0.06	-0.032	-0.032	-0.06
8	12:05	-0.06	-0.032	-0.032	-0.06
9	12:06	-0.06	-0.032	-0.032	-0.06
10	12:07	-0.06	-0.032	-0.032	-0.06
11	12:08	-0.06	-0.032	-0.032	-0.06
12	12:09	-0.06	-0.032	-0.032	-0.06

Figure 11. QA Master File example.

5. Copy the QA Master File into Minitab and graph the data:

    a. Open Minitab® statistical software program. Copy the QA Master File data (serial numbers and QA data values) and paste the data into the Minitab Worksheet (Figure 12).

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6
	9715474	9715472	2238856	2238840	2238837	22388
1	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
2	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
3	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
4	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
5	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
6	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
7	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
8	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
9	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
10	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
11	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
12	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
13	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
14	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0
15	-0.06	-0.032	-0.032	-0.06	-0.032	-0.0

Figure 12. Minitab Worksheet with data logger QA data

b. Graph the data as "Individual Value Plots" (Multiple Y's, Simple). Select the data columns as the "Graph variables" (double-click each serial number at the left of the window to add it to the 'Graph Variables' list) and select OK.

c. Re-label the graph Title (Example: HOBO QA 11/19/12 By J. Smith) and Y-axis label (change to 'Temperature (C)') by double-clicking on each and typing in the new label in the 'Text' field.

d. Set the scale of the Y-axis to 0.1 degree intervals centered on 0 °C to encompass all the data. (Double-click on the y-axis values. Change 'Major Tick Positions' to 'Position of Ticks' and enter the desired values, e.g. -0.3 -0.2 -0.1 0 0.1 0.2 0.3. Click 'OK'.)

e. Add y-axis reference lines at the -0.2C, -0.1C, 0.1C, and 0.2C positions. (Right-click on the y-axis and select 'Add' then 'Reference Lines'. Enter the values -0.2 -0.1 0.2 0.1 in the top line, 'Show reference lines at Y values.' Click OK.)

f. Save the Minitab Project ('File' > 'Save Project As') in the same folder as the raw data files (Example: QA 111912 for a QA check conducted on November 19, 2012.)

g. The final graph should resemble Figure 13. Print and save the "Individual Value Plot" graph. ('File' > 'Print Graph'). Save the file as a .jpg in the same folder as the raw data files. (For example "QA 111912 GRAPH" for the graph of QA checks conducted on November 19, 2012.) File the printed graph in the hard copy Temperature Data logger QA/QC Log book, located next to the logger bins the temperature monitoring station of the Windsor Lab.

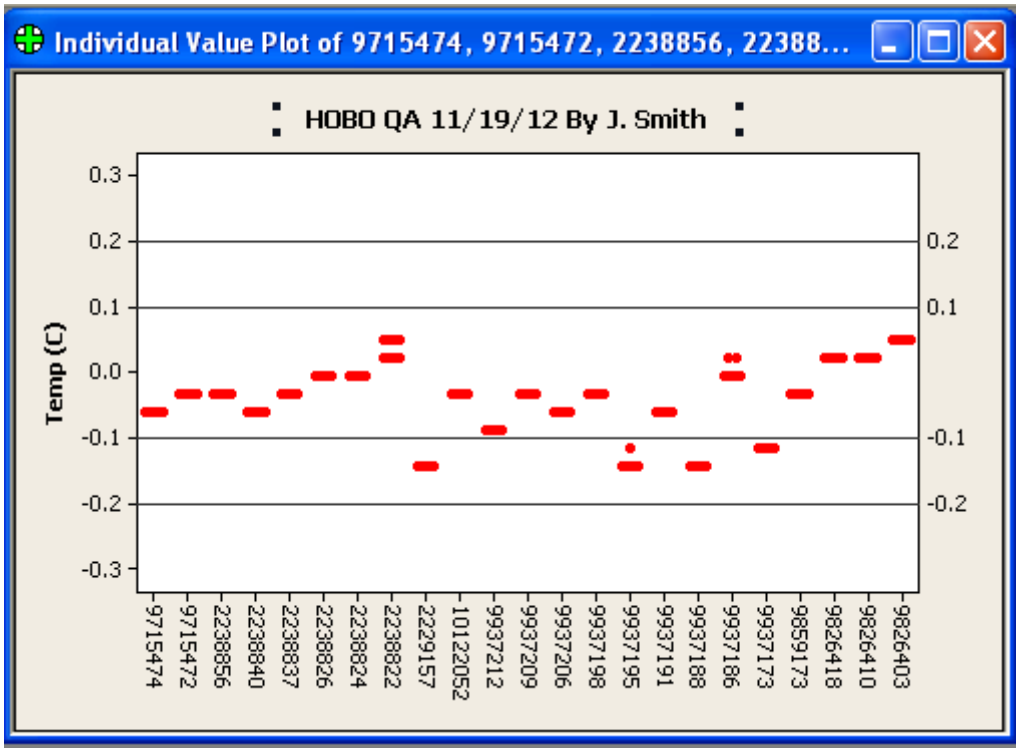

Figure 13. Minitab Individual Value plot example.

6. Using the graph created in step 15, for each logger determine whether the logger measured the ice bath temperature within the acceptable tolerance (accuracy) range per the manufacturer's specifications (+/-0.2C).
    a. Review the "Individual Value Plot" graph; if the logger values fell between -0.2 degrees C and 0.2 degrees C, the values are within the manufacturer's specifications for accuracy. Mark the logger as "pass" in electronic Temperature Data Logger QA/QC log.
    b. If the values were within the acceptable range but not a single straight line, mark as "Pass" but mark "TRUE" in the QC Flag column; make a notation in the comments explaining the flag, e.g. "Values varied but within acceptable limits". Otherwise mark "False" in the QC Flag column.
    c. If any individual logger values were less than -0.2 degrees C or greater than 0.2 degrees C, mark the logger as "Fail" in the electronic Temperature Data Logger QA/QC log. Mark 'TRUE" in the Flag column, and in the comments indicate the presence of high and/or low values (e.g. "Values exceed 0.2 degrees C" or "Values were below -0.2 degrees C.")

7. Upon completion of QC, the electronic Temperature Data Logger QA/QC log. should contain, for each data logger checked, the date of accuracy check, who performed the check, the logger serial number, the three ice bath temperature values (start, 30 minutes, 60 minutes) recorded using the NIST certified thermometer, a

notation of pass or fail, and any additional notes as indicated by a 'true' flag and associated comments (Figure 14).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1									START		Mid-Point		END					
2	Year	Date	Staff	PROBEID	TYPE	Owner	NEW?	BATTERY	Time	Temp	Time	Temp	Time	Temp	Result	Flag	OOS?	QCComment
239	2018	4/25/18	M Lally	10498701	HOBO	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
240	2018	4/25/18	M Lally	10352797	HOBO	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
241	2018	4/25/18	M Lally	10352798	HOBO	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	TRUE	FALSE	Possible drift in data
242	2018	4/25/18	M Lally	10015944	HOBO	VOL	TRUE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
243	2018	4/25/18	M Lally	10015938	HOBO	VOL	TRUE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
244	2018	4/25/18	M Lally	10015954	HOBO	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
245	2018	4/25/18	M Lally	10015952	HOBO	VOL	FALSE	Good	14:45	0.0 C	15:15	0.0 C	15:45	0.0 C	PASS	FALSE	FALSE	
246	2018	4/26/18	M Lally	9725753	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
247	2018	4/26/18	M Lally	10121933	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
248	2018	4/26/18	M Lally	10121937	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
249	2018	4/26/18	M Lally	10121945	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
250	2018	4/26/18	M Lally	10121947	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	Possible drift in data
251	2018	4/26/18	M Lally	10121948	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
252	2018	4/26/18	M Lally	10121952	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
253	2018	4/26/18	M Lally	10121954	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
254	2018	4/26/18	M Lally	10121959	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
255	2018	4/26/18	M Lally	10121962	HOBO	FISH	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	
256	2018	4/26/18	M Lally	9725747	HOBO	FISH	FALSE	Good	17:00	0.0 C	17:30	0.0 C	18:00	0.0 C	PASS	FALSE	FALSE	
257	2018	4/26/18	M Lally	10121953	HOBO	FISH	FALSE	Good	17:00	0.0 C	17:30	0.0 C	18:00	0.0 C	PASS	FALSE	FALSE	
258	2018	4/26/18	M Lally	1183636	HOBO	WPLR	FALSE	BAD	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	BAD BATTERY --> REMOVED FROM CIRCULATION
259	2018	4/26/18	M Lally	1183812	HOBO	WPLR	FALSE	BAD	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	BAD BATTERY --> REMOVED FROM CIRCULATION
260	2018	4/26/18	M Lally	9715469	HOBO	WPLR	FALSE	UNK	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	Unable to connect to logger - tried on 2 computers
261	2018	4/26/18	M Lally	9859173	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	Possible drift in data
262	2018	4/26/18	M Lally	9859187	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	FAIL	TRUE	FALSE	"invalid interval value encountered & replaced by end event" error - no data on readout
263	2018	4/26/18	M Lally	9862223	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	FALSE	FALSE	
264	2018	4/26/18	M Lally	9937180	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE	FALSE	Possible drift in data
265	2018	4/26/18	M Lally	9937181	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	FALSE	FALSE	
266	2018	4/26/18	M Lally	9937184	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	FALSE	FALSE	
267	2018	4/26/18	M Lally	9937187	HOBO	WPLR	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	FALSE	FALSE	

Figure 14. Electronic Temperature Data Logger QA/QC log. Note that new loggers have been highlighted in green. Failing QA check results that resulted in removing the logger from service are highlighted in red; failing results requiring recheck are highlighted in yellow.

8. For each batch of loggers checked, place all loggers that passed in a clear plastic bag and label with the date of the QA check, initials of who conducted the check, and the number and type of loggers in the bag. Place the bag in the "Ready to Deploy" bin in the temperature monitoring section of the water lab.

9. Any loggers that failed the QC check should be individually tagged and labeled with the logger serial number, date of the check, and reason for fail. If the failure warrants removal from service (e.g. bad battery, cannot connect to computer) place the logger in the "Loggers with Issues" bin. If the failure warrants a recheck, place the logger in the "To be QC checked" bin.

10. At the conclusion of each season, a list of loggers that were removed from service will be compiled (e.g. logger serial number, logger type, date of removal from service, reason for removal from service) and submitted to the database manager. Data collected by these loggers during the season will be flagged if the reason for removal from service was a QC check failure.

3.5 Data Logger Care, Storage & Maintenance

1. Loggers will be cleaned by rinsing in warm water. A soft toothbrush and/or mild dishwashing detergent can be used to remove dirt and algae if needed. Do not use harsh chemicals, solvents, or abrasives, especially on the communications window.

2. Loggers will be labelled using either paint pen or an attached tag with owner and contact information (e.g. "CT DEEP Water Monitoring – 860-424-3061").

3. Loggers will be checked for accuracy according to the QA check scheduled noted in Section 3.2.

4. Loggers are organized in bins in the temperature monitoring station of the Windsor laboratory. Bins are labelled "To be downloaded"-(a), "To be QA checked" (b), "Good to Deploy" (c), and "Loggers with Issues" (d):
    a. Loggers that have been returned from field deployment but need to be downloaded will be placed in the "To be downloaded" bin. Loggers will have a manila tag attached that was completed during field retrieval that includes that monitoring location information, logger serial number, and date and time of removal from the stream.
    b. Loggers that have been downloaded but still need to be QA checked post-deployment are placed in the "To be QA checked" bin. These loggers do not require additional labelling.
    c. Loggers that have been successfully QA checked, with passing results, are to be grouped by QA date and placed in plastic bags. Each bag will be labeled with the QA check date and the contents of the bag (e.g. "QA 04/25/18 – 10 HOBOs, 2 TidBits."). Bags are placed in the "Good to Deploy" bin with the most recently QA'd loggers placed in the rear of the bin.
    d. Loggers that failed the QC check or were unable to be QC checked due to connectivity issues are labelled with a tag containing the logger serial number, QC check date, and a description of the problem or reason for failure (e.g. "could not connect," "bad battery", "failed; measurements outside of accuracy range". These loggers are placed in the "Loggers with Issues" Bin; these loggers will be documented as placed out of service and disposed of according to manufacturer's specifications.

5. Damaged loggers will be reported to the laboratory manager.

3.6 Quality Control Field Check Thermometers

Manual temperature readings are collected several times during the logger deployment period using an NIST certified field thermometer or thermistor thermometer such as that found in a multi-parameter field data sonde.

1. At the start of each field season, the batteries in all QC check thermometers will be replaced and the thermometers will be checked against the lab temperature standard solution for accuracy.
    a. QC field check thermometers that fail the pre-season check will be disposed of immediately. (Record failure in QC log.)

b. QC field check thermometers that fail the post-season QC check will also be disposed of. (Record failure in QC log.) Any field check readings collected with these thermometers will be reviewed and flagged as needed.
c. QA checks of the field QC thermometers will be recorded (e.g. date/time of check, type of equipment, serial number of equipment, standard temperature, equipment reading, pass/fail result) and maintained in a separate tab in the electronic QC file described in Section 3.4.7.

2. YSI data sondes and other multi-parameter field data sondes will be maintained as outlined in the corresponding equipment SOP.

4.0 FIELD METHODS

4.1 Field Training

1. This SOP is to be read by all new project participants prior to conducting work related to the project (i.e. field or laboratory work).

2. Training is conducted by the project lead and/or senior staff (i.e. field lead) for new personnel prior to the beginning of the sampling season. (All other Agency required safety related training is conducted through the Health and Safety Office.)

4.2 Field Safety

1. Crews will consist of a minimum of two individuals.

2. The crew lead is responsible for:
   a. Recording which vehicle the crew will be using and where they will be monitoring on the calendar in the Windsor Lab prior to leaving for the field.
   b. Insuring the crew has at least one cell phone, GPS car unit, and first aid kit.
   c. Notifying any land owners who have requested advance permission.
   d. Ensuring flow conditions are safe for field work by referencing the nearest USGS gage. Save a copy of the hydrograph referenced to the field monitoring data folder on the M drive.

3. Chest waders and long-sleeved rubber gloves are to be worn by personnel entering the stream. Polarized sunglasses are not required but may assist with field retrieval of deployed loggers.

4.3 Field Equipment Preparation

1. A complete field equipment checklist is found in Appendix 3.

2. It is the responsibility of the field crew lead to ensure all required equipment has been packed in the vehicle prior to the leaving for the field.

3. Loggers must be launched in the lab or office prior to being deployed in the field. Loggers are set to 'delay launch' **beginning at midnight the date of deployment**. This serves to ensure that the first reading is a stable water temperature measurement and also prevents collection of partial-day data at the start of the dataset.

   Note: Be certain to have the latest version of HOBOware® software. You can check for the latest version www.onsetcomp.com. You may need to request IT/HelpDesk support to install or update your software.

   Follow these steps to launch the logger:

   a. Connect the logger to the HOBOware® software using the appropriate base station coupler.

   b. Check and record the status of the battery in the log.

      - If conducting a pre-deployment check and the battery is low or bad, do not continue the QC check; mark the logger in the log as having failed the QC check due to a bad battery and place it in the "Loggers with Issue" bin for disposal. Loggers with low/bad batteries are removed from service to avoid partial data sets that might result from placing a logger in the field that did not have enough battery life to record during the entire deployment.
      - If conducting a post-deployment QC check and the battery is low or bad, note the battery condition on the log, and type "TRUE" in the QC Flag column. Then continue with the QC check. A logger can record accurate data with a low battery; the post-QC check is important to validate the data last collected by the logger. Once the QC check is completed, the logger will be removed from service.

   c. Name each logger with Serial Number, Deployment, and Year (Example: 123456_Fall_2018_Deployment).

   d. Set the logger to record temperature in degrees Celsius.

   e. Set the appropriate sampling interval that meets the objectives of your deployment. **Typical sampling interval is every hour**, but special projects may require an alternate interval. (Note: as the sampling interval is increased, the internal memory is used up faster; this needs to be taken into consideration when scheduling retrieval to avoid data gaps.)

   f. Set the logger for delayed launch at midnight on the day it is to be deployed.

4.4 Logger Field Deployment

1. Record the serial number of the logger, the type of logger the date and time of launch, and the date of last QC check on the field data sheet (Appendix 4).

2. Secure the data logger:

a. Data loggers are secured inside a protective PVC pipe housing to shield them from sunlight and to protect them from physical damage. HOBO Pro v2 and HOBO conductivity loggers should have a protective cover placed on the end prior to insertion into the PVC pipe.

b. Secure the PVC tube (with logger inside) to a weight. Weights commonly used by the Monitoring Group include metal railroad plates, window weights, and angle iron (Figure 15). (Special projects may call for the use of a special housing unit attached to an underwater surface using epoxy.)

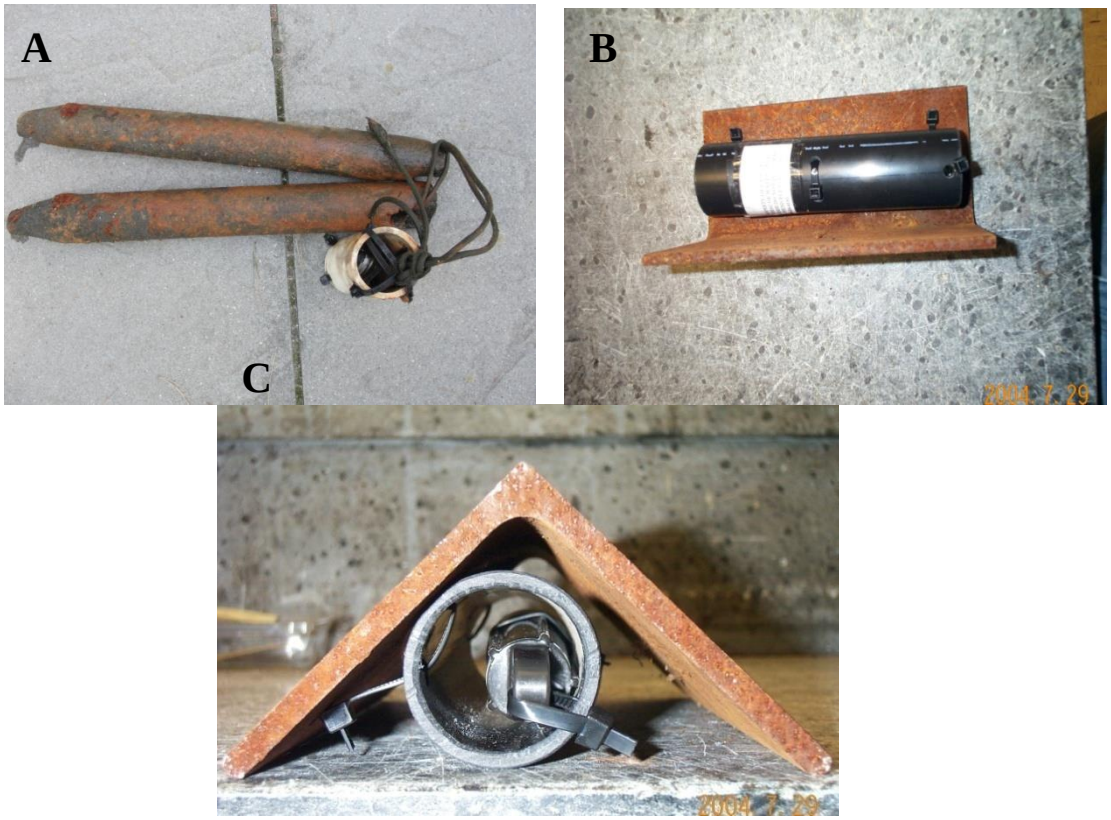

Figure 15. (A) TidbiT® tethered to PVC housing with tie wraps and fastened to window weights with parachute cord. (B) and (C) HOBO® Pro v2 attached to PVC housing with tie wraps and angle iron weight.

3. If monitoring a new site, identify a suitable logger deployment location:

   a. The data logger should be deployed near the area of interest in a part of the stream that is most likely to stay inundated throughout the sampling period.

   b. In general, select a site for the temperature logger that is in an away from the influence of tributaries and any human generated thermal influences.

   c. Avoid popular areas, particularly fishing access points and near swimming areas, as vandalism can be a problem in these locations.

d. If there is potential impact from moving debris during high flow events, locate the logger in a protected area such as the area behind a large boulder or in front of a large boulder.

e. Build a rock pile around the weight/PVC/logger set up to conceal the equipment and to protect it from movement and damage.
Note: If the site does not have sufficient material to build a rock pile, the weight can be secured using a tether attached to a nearby tree or other secure structure. This rock pile method is preferred over tethering.

f. Using an NIST certified thermometer, record the stream temperature at the time of deployment. Record the temperature as close to the deployed logger as possible. Allow sufficient time for the thermometer reading to stabilize.

4. If monitoring an existing station:

   a. Locate the current logger using the last season's field datasheet and photos.

   b. Using an NIST certified thermometer, record the stream temperature. Take the measurement as close to the current logger as possible. Record this value on the field datasheet.

   c. Remove the logger/weight/PVC set up from the stream, noting the time of removal and whether the logger was out of water, buried, or appeared tampered with in the 'Retrieved Probe' section of the field datasheet.

   d. Place the new logger setup in the existing deployment location.

   e. Build a rock pile around the new weight/PVC/logger set up as described in step 3.e. above.

   f. Refer to step 4.7 below for documentation of the retrieved logger.

5. Note the date and time the new logger was placed in the stream (i.e. deployed) on the datasheet. Note the deployment set up used (e.g. window weight, railroad plate, angle iron, etc.).

4.5 Monitoring Location Documentation

The monitoring location is documented through the completion of the field data sheet (Appendix 4) and collection of site photographs:

1. Use a GPS unit and record the latitude and longitude on first time deployments.

2. Use surveyor's tape to mark the vicinity of the logger. In high traffic areas, tape should be located in an area that can be used as a reference point but that does not directly indicate the logger location. If the logger is located in a remote location unlikely to be trafficked by others, then flagging can be placed on the right and left banks immediately adjacent to the logger to facilitate easy recovery.

3. Draw a field sketch of the monitoring site, noting the location of the deployed logger and any key site features or landmarks to be used to assist in retrieval. Provide a narrative description of the logger location above the field sketch. (Figure 16).

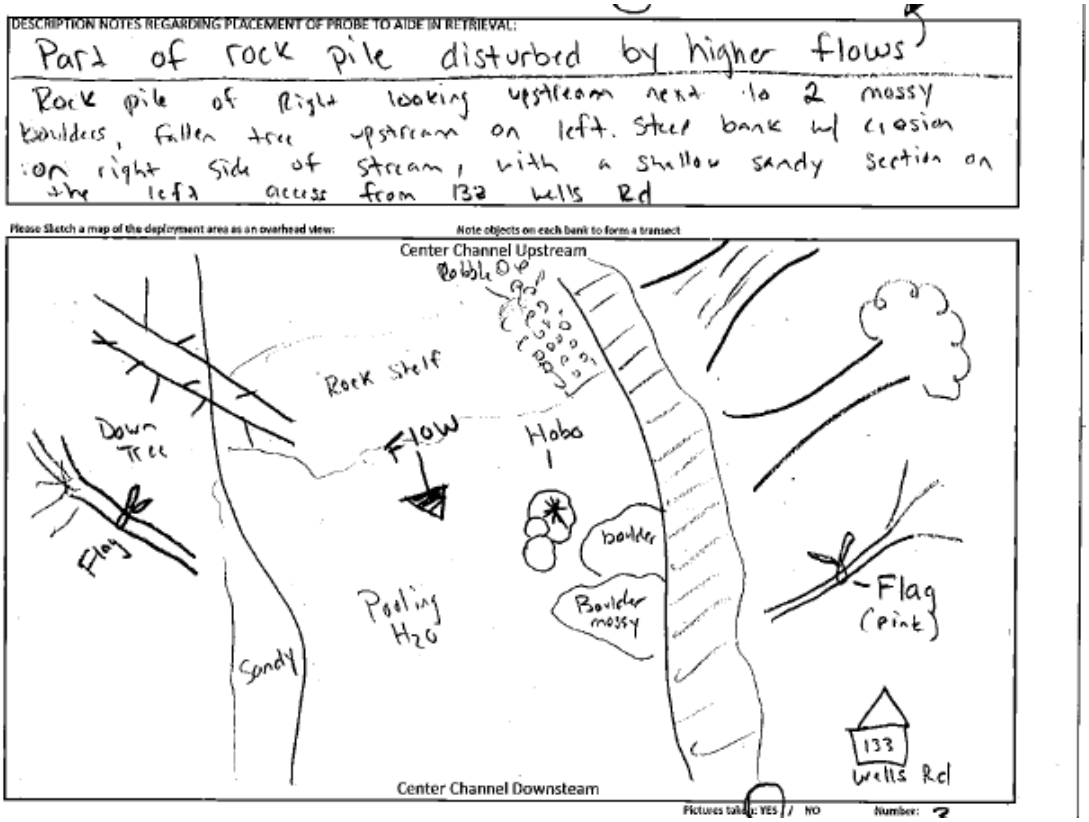

Figure 16. Field sketch and narrative description example.

4. Take digital photos:
    a. Take the first photo standing next to the rock pile, facing upstream. The photo should capture, to the extent possible, both stream banks and the segment immediately upstream of the deployment location. (Figure 17a)
    b. Remain next to the logger, and turn to face downstream. Again, capture both stream banks and the downstream segment. (Figure 17b)
    c. Take a photo of the hobo location. Have one person stand, in the stream, and point to the location of deployed logger and to the nearest flagging (Figure 18).
    d. Take any additional photos to document the logger location in relation to key landscape features (e.g. USGS gage) or other information (e.g. parking, access points).
    e. Record the number of images taken on the bottom of the field data sheet.

Figure 17a-b. Upstream (top) and downstream (bottom) site photos.

Figure 18. Digital photo showing location of a deployed data logger. Note the pink flagging to help facilitate retrieval. The large boulder at right was intentionally included in the photo to be used as a future reference point as well.

4.6 Field Check Temperature Readings

Manual temperature readings are collected whenever possible during the deployment period. These field checks provide a measure of the continuous temperature logger during deployment to a reading from a NIST certified field thermometer or thermistor thermometer such as that found in a multi-parameter field data sonde.

3. At the start of each field season, the batteries in all QC check thermometers will be replaced and the thermometers will be checked against the lab temperature standard solution for accuracy. YSI data sondes and other multi-parameter field data sondes will be maintained as outlined in the corresponding equipment SOP.
    a. QC field check thermometers that fail the pre-season check will be disposed of immediately.
    b. QC field check thermometers that fail the post-season QC check will also be disposed of. Any field check readings collected with these thermometers will be reviewed and flagged as needed.
    c. QA checks of the field QC thermometers will be recorded (e.g. date/time of check, type of equipment, serial number of equipment, standard temperature, equipment reading, pass/fail result) and maintained in a separate tab in the electronic QC file described in Section 3.4.7.

4. During all site visits for biological sampling, record the stream water temperature with a NIST certified thermometer to the nearest 0.5°C or to the nearest 0.2°C for thermistor in close vicinity of the temperature data logger:
    a. When using a liquid in glass thermometer, check the reading three times and record the median on the datasheet.
    b. When using a thermistor thermometer, wait until the reading stabilize to within 0.2 C and record the value on the datasheet.
    c. To prevent false readings caused by solar radiation, take the readings in your shadow out of direct sunlight.
    d. Be sure to let the stream temperature stabilize (refer to manufacturer specifications) before taking the reading.
    e. Record the date, time, and location of the field water temperature for data post processing. Post-processing field checks greater than ± 0.5ºC of the data logger values are questionable and require further investigation

4.7 Logger Retrieval

1. Use the last season's field data sheet and digital photos (compiled into a field photo sheet) to locate the deployed data logger.

2. Remove the logger/weight/PVC set up from the stream, noting the time of removal and whether the logger was out of water, buried, or appeared tampered with.

3. Remove the logger from the PVC housing. Verify the logger serial number against the expected serial number at the top of the field data sheet.

4. Record the logger serial number, station ID, stream name, date and time of retrieval on a shipping tag; attach the tag to the logger. (Figure 19)

Figure 19. Shipping label affixed to PVC housing containing data logger.

5. Place the logger on ice in a cooler for transport back to lab. The ice will create a 0C 'signature' in the data that will serve as a QA check if the date/time of retrieval need to be verified. In the event that a logger is not able to be downloaded on the day that it was removed from the field, this signature will serve to verify the documented removal date/time.

4.8 Post Fieldwork Activities

Upon returning to the lab from the field, the following activities need to be completed:

1. Clean and restock the field equipment. Refer to the equipment list in Appendix 3 and make sure the equipment is fully stocked and ready for the next field day. Clean any equipment that had contact with the waterbody, including waders and gloves.

2. Update the electronic and hardcopy master file to note that the loop is complete. The file location is:
   M:\Monitoring Field Data by Year\[Year] Field Work Downloads\HOBO\Hobo [Season Year] MASTER.xlsx

3. Use HOBOware to readout the data loggers retrieved and download the data.
   a. Connect the data logger to the HOBOware® software using the appropriate base station coupler. Select readout and stop logger from logging.

b. Rename and save the data file to M:\Monitoring Field Data by Year\[Year] Field Work Downloads\HOBO\HOBO Downloads and QA\HOBO Downloads [Season Year]
(Note: if the data was downloaded from an air sensor, save the file to the "Air" folder.)
c. Rename the file using the naming convention: [Serial Number]_[ProbeType]_Fall 2018 Deployment_[Date removed as DDMMYY]@[Time Removed as HHMM]

Example:
2229157_HOBO_15499_West_Branch_Salmon_Brook_Fall_2017_Deployment_050218@1135

d. Plot the data in °C to verify that the data logger downloaded properly. Export the table data as a .csv file (File-Export Table Data) using the same naming convention as the HOBO raw data file and save to the same location on the M-drive.
e. After download, put loggers in the "To be QCd" bin in back lab

4. Download and label any site photos taken.
   a. Save photos to: M:\Monitoring Field Data by Year\[Year] Field Work Downloads\PHOTO\Hobo Photos [Season Year]
   b. Label Photos as: [Station ID] [Stream Name]_[photo description (e.g. upstream of hobo location)]_[Date as MMDDYY]

5. For any site that a logger was deployed at (i.e. not a 'retrieve only' station), create photo sheets for next season's retrieval.
   a. Save the photo sheets to M:\Monitoring Field Data by Year\[Year] Field Work Downloads\HOBO\HOBO Map Scans and Photo Sheets\HOBO [Season Year] Map Scans and Photo Sheets
   b. Name each file: [Stream Name] [Station ID] _Site Photos_[Season Year]

6. Scan and photocopy the field datasheets. Stamp the original as 'Scanned' and place in the current season's binder. Stamp the photocopy as "Copy" and place in binder for the next season.

7. Print a copy of the site map (or use existing from loop if still in good condition) and a copy of the photo sheet created in step 4 above. Place both in the binder for the next season.

When complete, check with the field lead and/or lab manager to see if any additional tasks need to be completed to wrap-up the current day's field work and prepare for the next day.

5.0 DATA MANAGEMENT

Individual electronic data files are organized by folders corresponding to the contents and field season and stored on the M drive indefinitely. Hard copy files are stored, as noted

below, at the Water Lab (9 Windsor Avenue, Windsor, CT) according to Agency document retention polices.

5.1 Data Logger QA Files

Data logger QA files are processed and managed as described in Section 3.4.

5.2 USGS Gage Flow Graphs

A digital copy of the graph is saved in the corresponding field monitoring data folder on the M drive for future reference if needed.

5.3 Field Photographs

Individual digital photos will be stored in the corresponding monitoring year folder on the M: drive.

Photos will be compiled into photo sheets for easy reference during the following field season. A hard copy of each photo sheet will be printed and placed in the next season's field binder. Electronic copies of the photo sheets will be stored in the corresponding monitoring field data folder on the M drive

5.4 Field Datasheets

Original data sheets are placed in the hardcopy field binder for that monitoring season and stored for long-term record keeping at the Windsor Lab. A copy of each data sheet is printed and placed in the next season's field binder. Scanned copies of the data sheet are labeled with the station information and date and stored in the corresponding field data folder on the M drive.

5.5 Field Temperature Data

Field temperature data will be compiled from project data sheets into an Excel spreadsheet at the end of the season for comparison to logger data records. The file will contain the date of the check, the time of the check, the nearest hour mark to that time, equipment used, station ID, temperature value, temperature unit of measure, and whether the reading was taken adjacent to a temperature logger (true/false). The Excel file will be saved in the corresponding season's field data folder on the M drive.

Those readings that were taken adjacent to a temperature logger will be compiled into a new file and submitted to the database manager for comparison to continuous deployment records for that site. If a field reading and a continuous deployment reading significantly deviate (i.e. the difference between the readings exceeds the manufacturer's accuracy specifications for the equipment), the dataset will be flagged for review.

5.6 Temperature Logger Data Files

Original .hobo temperature data files are offloaded as soon as possible after logger retrieval, renamed and stored in the corresponding field data folder on the M drive. Raw files are also exported as .csv table data files using the HOBOware software and stored on the M drive.

Original .csv files are processed for upload to the monitoring group temperature database by removing data from the file that was recorded after the documented retrieval date/time. If the logger was found out of water, embedded, or apparently tampered with, a flag is added to the dataset. (Refer to Appendix 4)

Prior to upload, the database manager runs a basic suite of QAQC scripts on the data. All data are retained, however data are flagged for use if:

- the number of readings on a given date is less than 24
- the minimum temperature is less than 0 degree C
- the daily temperature flux is greater than 5 degree C, and/or if
- the daily mean is greater than 30 degree C

These flagged data are likely to be excluded from future data analysis projects.

5.7 Season Master Spreadsheet

A master Excel spreadsheet file is maintained for each season. Upon return from a visit to any monitoring station with a temperature logger (e.g. logger deployment, field checks, logger retrieval), logger and site information are updated as noted in Section 4.8.2. At the conclusion of the season the master spreadsheet will be reviewed by the project lead for completion and accuracy. Master spreadsheets are maintained on the M drive in the Monitoring Field Season Data folder for the corresponding season and year.

5.8 Field Check and Retrieval Flag Summary File

Using the master season spreadsheet noted in Section 5.7, a flag summary file is compiled at the conclusion of each season and submitted to the temperature database manager. The flag summary will include, for any loggers found embedded, out of water, or potentially tampered with: the logger serial number, logger type, monitoring station AWQ ID, monitoring station name, date of deployment, date of retrieval, and the flag type (e.g. embedded, out of water, tampered with). The database manager will use this information to flag the data as having potential quality control concerns.

6.0 REFERENCES

Beauchene, M., Becker, M., Bellucci, C.J., Hagstrom, N., & Kanno, Y. (2014) Summer Thermal Thresholds of Fish Community Transitions in Connecticut Streams. North American Journal of Fisheries Management, 34:1, 119-131.

HOBO® Water Temp Pro User's Manual, Onset® Computer Corporation, Bourne, MA http://www.onsetcomp.com/

U.S. Environmental Protection Agency (EPA). (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-13/170F. Available from the National Technical Information Service, Alexandria, VA and online at http://www.epa.gov/ncea

Appendix 1. Data Logger Datasheets and Quick Reference Guides

HOBO® U22-001 Data Logger

Water Temperature Pro v2 Data Logger

The HOBO Water Temp Pro v2 is durable with 12-bit resolution. Complete with a precision sensor for ±0.2°C accuracy, this logger measures temperatures between -40°C and 70°C (-40°F to 158°F) in air and up to 50°C (122°F) in water. Its waterproof, streamlined case allows for extended deployment in fresh or salt water. Moreover, the Water Temp Pro v2's optical USB interface makes it possible to offload data even while the logger is wet or underwater. A solar radiation shield is required to obtain accurate air temperature measurements in sunlight (RS1 Solar Radiation Shield, assembly required; or M-RSA pre-assembled Solar Radiation Shield).

Supported Measurements:

Temperature and Water Temperature

Key Advantages:

- Research-grade measurements at an affordable price
- Waterproof to 120 meters (400 feet)
- Data readout in less than 30 seconds via fast Optic USB interface
- Compatible with HOBOware and HOBOware Pro software for logger setup, graphing and analysis

HOBO U22-001 Data Logger Specifications

Operation range[†]: -40° to 70°C (-40° to 158°F) in air; maximum sustained temperature of 50°C (122°F) in water
Accuracy: ±0.21°C from 0° to 50°C (±0.38°F from 32° to 122°F)
Resolution: 0.02°C at 25°C (0.04°F at 77°F)
Response time: (90%) 5 minutes in water; 12 minutes in air moving 2 m/sec (typical)
Stability (drift): 0.1°C (0.18°F) per year
Real-time clock: ± 1 minute per month 0° to 50°C (32° to 122°F)
Battery: 2/3 AA, 3.6 Volt Lithium, factory-replaceable ONLY
Battery life (typical use): 6 years with 1 minute or greater logging interval
Memory (non-volatile): 64K bytes memory (approx. 42,000 12-bit temperature measurements)
Weight: 42 g (1.5 oz)
Dimensions: 3.0 cm (1.19 in.) maximum diameter, 11.4 cm (4.5 in.) length; mounting hole 6.3 mm (0.25 inches) diameter
Wetted materials: Polypropylene case, EPDM® o-rings, stainless steel retaining ring
Buoyancy (fresh water): +13 g (0.5 oz.) in fresh water at 25°C (77°F); +17 g (0.6 oz.) with optional boot
Waterproof: To 120 m (400 ft.)
Shock/drop: 1.5 m (5 ft.) drop at 0°C to 70°C (32°F to 150°F)
Logging interval: Fixed-rate or multiple logging intervals, with up to 8 user-defined logging intervals and durations; logging intervals from 1 second to 18 hours. Refer to HOBOware software manual.
Launch modes: Immediate start and delayed start
Offload modes: Offload while logging; stop and offload
Battery indication: Battery voltage can be viewed in status screen and optionally logged in datafile. Low battery indication in datafile.
NIST certificate available: for additional charge
Environmental Rating: IP68

The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

[†]**IMPORTANT:** The plastic case will become brittle at temperatures lower than -20°C. If the logger is deployed in a location where the temperature drops below -20°C, make sure the logger remains stationary and is not pulled on or struck. Return the logger to above -20°C before handling.

Contact Us

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- Email sales@onsetcomp.com
- Call 1-508-759-9500
- In U.S. toll free 1-800-564-4377
- Fax 1-508-759-9100

Technical Support (8am to 8pm ET, Monday through Friday)
- Contact Product Support www.onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

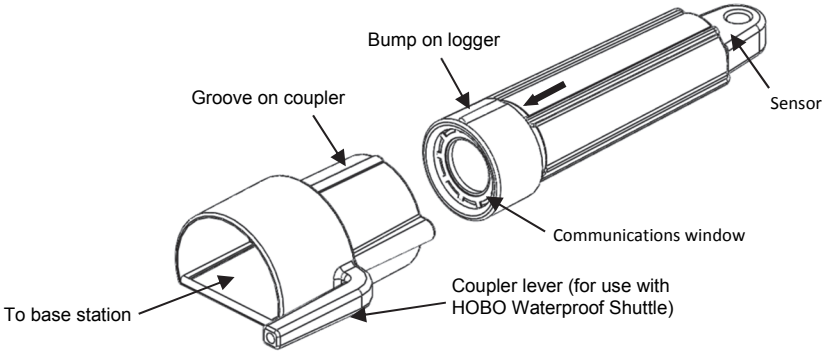
Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

HOBO® Water Temp Pro v2 (U22-001) Quick Start

1 Open HOBOware software. (Get the latest software at www.onsetcomp.com/hoboware-free-download.)

2 Attach the USB Optic Base Station (BASE-U-4) or HOBO Waterproof Shuttle (U-DTW-1) to a USB port on the computer (refer to the hardware manual at www.onsetcomp.com/support/manuals for details).

3 Attach the coupler (COUPLER-C) to the base station or shuttle, then insert the logger into the coupler so that the bump on the logger slides into the groove of the coupler. There is also an arrow etched on the logger case showing the direction the logger should be inserted into the coupler. If you are using the HOBO Waterproof Shuttle, make sure it is connected to the USB port on the computer and briefly press the coupler lever to put the shuttle into base station mode. It may take a few seconds for new hardware to be detected by the computer.



4 From the Device menu, select Launch. Select the logging options and click Start. Logging will begin based on the settings you selected.

5 Deploy the logger. Depending on water conditions and desired measurement location, the logger should be appropriately weighted, secured, and protected. Place the included cap over the communications window to protect it from fouling and abrasion or use the optional boot (BOOT-BLK or BOOT-WHT) for high fouling environments and for protection against very cold temperatures (which can make the case brittle and prone to fracture) or repeated pounding and abrasion caused by turbulent flow. See the logger manual at www.onsetcomp.com/support/manuals/u22-001 for complete deployment details.

6 To read out the logger, remove it from the water. Follow steps 1–3 and select Read Out from the Device menu in HOBOware or use the Waterproof Shuttle. Refer to the HOBOware Help for complete details on reading out and viewing data.

For more information about this logger, scan the code at left or go to www.onsetcomp.com/support/manuals/u22-001.

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21827-B MAN-U22-QSG

UTBI-001 Data Logger

TidbiT v2 Water Temperature Data Logger

Only 3x4 cm, this tiny data logger measures temperatures over a wide temperature range. The TidbiT v2 provides 12-bit resolution and has ±0.2 °C accuracy. It is designed for outdoor and underwater environments and is waterproof to 300 m (1000 ft). An optical USB interface allows users to offload data in seconds. Please note, a solar radiation shield is required to obtain accurate air temperature measurements in sunlight (RS1 Solar Radiation Shield, assembly required; or M-RSA pre-assembled Solar Radiation Shield).

Supported Measurements:

Temperature and Water Temperature

Key Advantages:

- Onset's smallest temperature data logger
- Waterproof to 300 meters (1,000 feet)
- Data readout in less than 30 seconds via fast Optic USB interface

UTBI-001 Data Logger Specifications

Temperature Sensor
Operation range:* -20° to 70°C (-4° to 158°F) in air; maximum sustained temperature of 30°C (86°F) in water*
Accuracy: ±0.21°C from 0° to 50°C (±0.38°F from 32° to 122°F)
Resolution: 0.02°C at 25°C (0.04°F at 77°F)
Response time: 5 minutes in water; 12 minutes in air moving 2 m/sec; 20 minutes in air moving 1 m/sec (typical to 90%)
Stability (drift): 0.1°C (0.18°F) per year

Logger
Real-time clock: ± 1 minute per month 0° to 50°C (32° to 122°F)
Battery: 3 Volt lithium, non-replaceable
Battery life (typical use): 5 years with 1 minute or greater logging interval
Memory (non-volatile): 64K bytes memory (approx. 42,000 12-bit temperature measurements)
Weight: 19.6 g (0.69 oz)
Dimensions: 3.0 4.1 1.7 cm (1.2 1.6 0.68 in.); mounting bail 4.6 mm (3/16 in.) diameter hole
Wetted materials: Epoxy case
Waterproof: To 305 m (1000 ft.)
Logging interval: Fixed-rate or multiple logging intervals, with up to 8 user-defined logging intervals and durations; logging intervals from 1 second to 18 hours. Refer to HOBOware software manual.
Launch modes: Immediate start, delayed start
Offload modes: Offload while logging; stop and offload
Battery indication: Battery level can be viewed in status screen and optionally logged in datafile. Low battery indication in datafile.

Environmental Rating: IP68

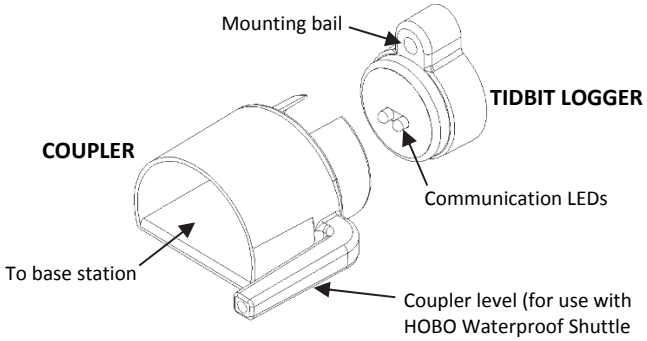
NIST certificate: Available for additional charge
The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).
* To guarantee accuracy, the TidbiT v2 Temp must not be used in condensing environments and water temperatures higher than 30C (86F) for more
than eight cumulative weeks over the life of the logger. Frequent or prolonged exposure will lead to measurement drift and eventual failure.

HOBO® TidbiT® Temp Data Logger (UTBI-001) Quick Start

1 Open HOBOware® software. (Get the latest software at www.onsetcomp.com/hoboware-free-download.)

2 Attach the USB Optic Base Station (BASE-U-4) or HOBO Waterproof Shuttle (U-DTW-1) to a USB port on the computer (refer to the hardware manual at www.onsetcomp.com/support/manuals for details).

3 Attach the coupler (COUPLER2-D) to the base station or shuttle, then insert the logger into the coupler with the communication LEDs facing into the coupler as shown. If you are using the HOBO Waterproof Shuttle, make sure it is connected to the USB port on the computer and briefly press the coupler lever to put the shuttle into base station mode. It may take a few seconds for new hardware to be detected by the computer.



4 From the Device menu in HOBOware, select Launch. Select the logging options and click Start. Logging will begin based on the settings you selected. To use a magnet to trigger the logger to start logging, launch the logger with Using Coupler selected in HOBOware. Once the software indicates the logger has been successfully launched, remove the logger from the coupler.

5 Deploy the logger. Depending on water conditions and desired measurement location, the logger should be appropriately weighted, secured, and protected. The mounting bail on the logger accepts 1/8 inch (4 mm) diameter nylon cord or other strong cable. If wire is used to secure the logger, make sure the wire loop is snug to the bail. Any slack in the loop may cause excessive wear. See the logger manual at www.onsetcomp.com/support/manuals/10385-man-utbi-001 for complete deployment details.

If using a triggered start, bring an empty coupler or strong magnet to the deployment location. When you are ready for the logger to start logging, insert the logger into the empty coupler (or place a strong magnet near the face of the logger) and remove it after three seconds. The red LED on the logger will blink rapidly four times to indicate a successful triggered launch.

6 To read out the logger, remove it from the deployment location. Follow steps 1–3 and select Read Out from the Device menu in HOBOware or use the Waterproof Shuttle. Refer to the HOBOware Help for complete details on reading out and viewing data.

For more information about this logger, refer to the product manual. Scan the code at left or go to www.onsetcomp.com/support/manuals/10385-man-utbi-001.

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This product has been manufactured by Onset Computer Corporation and in compliance with Onset's ISO 9001:2015 Quality Management System.

Patent # 6,826,664

22137-B MAN-UTBI-QSG

HOBO® UA-002-08 Data Logger

Pendant Temperature/Light 8K Data Logger

This HOBO Pendant® data logger is a miniature, waterproof two-channel temperature and relative light level data logger. The 8K model comes at a great value and is suitable for indoor, outdoor, and underwater applications. This logger holds approximately 6.5K of 10-bit readings. Use a solar radiation shield for accurate temperature measurement in sunlight.See RS1 Solar Radiation Shield (assembly required) and M-RSA (pre-assembled) Solar Radiation Shield. Note that using a solar radiation shield prevents the use of the light sensor.

Supported Measurements:

Light Intensity, Temperature and Water Temperature

Key Advantages:

- Low-cost temperature with alarm indication or light intensity
- Waterproof housing for wet or underwater use
- Data readout in less than 30 seconds via fast Optic USB interface

HOBO UA-002-08 Data Logger Specifications

Measurement Range

Temperature: -20° to 70°C (-4° to 158°F)

Light: 0 to 320,000 lux (0 to 30,000 lumens/ft^2)

Accuracy

Temperature: ± 0.53°C from 0° to 50°C (± 0.95°F from 32° to 122°F), see Plot A in manual
Light intensity: Designed for measurement of relative light levels, see Plot D in manual for light wavelength response

Resolution

Temperature: 0.14°C at 25°C (0.25°F at 77°F), see Plot A in manual
Drift: Less than 0.1°C/year (0.2°F/year)

Response Time

Airflow of 2 m/s (4.4 mph): 10 minutes, typical to 90%
Water: 5 minutes, typical to 90%
Time accuracy: ± 1 minute per month at 25°C (77°F), see Plot B in manual

Operating Range

In water/ice: -20° to 50°C (-4° to 122°F)
In air: -20° to 70°C (-4° to 158°F)
Water depth rating: 30 m from -20° to 20°C (100 ft from -4° to 68°F), see Plot C in manual
NIST traceable certification: Available for temperature only at additional charge; temperature range -20° to 70°C (-4° to 158°F)
Battery life: 1 year typical use
Battery Type: CR2032

Memory

UA-002-08: 8K bytes (approximately 3.5K combined temperature and light readings or events)
UA-002-64: 64K bytes (approximately 28K combined temperature and light readings or events)

Materials: Polypropylene case; stainless steel screws; Buna-N o-ring
Weight: 18 g (0.6 oz)
Dimensions: 58 x 33 x 23 mm (2.3 x 1.3 x 0.9 inches)
Environmental Rating: IP68

The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).

HOBO® Pendant® Data Logger (UA-00x) Quick Start

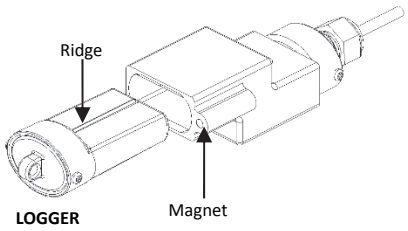
1 Open HOBOware® software. (Get the latest software at www.onsetcomp.com/hoboware-free-download.)

2 Attach the Pendant Optic USB Base Station & Coupler (BASE-U-1), the USB Optic Base Station (BASE-U-4), or HOBO Waterproof Shuttle (U-DTW-1) to a USB port on the computer (refer to the hardware manual at www.onsetcomp.com/support/manuals for details).

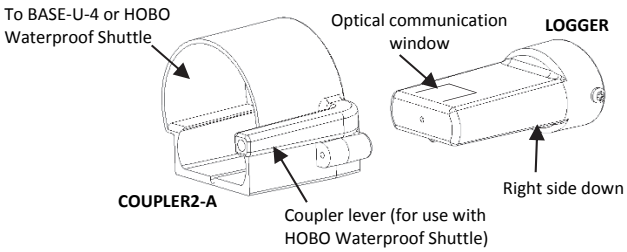
3 Insert the logger and the base station into the coupler, as shown in the following diagrams. If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected.

For BASE-U-1, make sure that the logger is inserted in the end of the coupler that has the magnet, and that the ridges on the base station and logger are aligned with the grooves in the coupler.

BASE-U-1 & COUPLER



For BASE-U-4 or the HOBO Waterproof Shuttle, firmly insert the optical end of the base station into the D-shaped end of the coupler, and make sure that the ridge on the logger is aligned with the groove in the coupler. If you are using the HOBO Waterproof Shuttle, briefly press the coupler lever to put the shuttle into base station mode.



4 From the Device menu in HOBOware, select Launch. Select the logging options and click Start. **For UA-004 models:** When choosing launch settings, use Normal mode for applications involving tilt, activity, and inclination. Use Fast mode for applications involving vibration and shock. Note that connecting the logger to the computer or a shuttle when logging in fast mode will stop the logger.

Logging will begin based on the settings you selected. To use a magnet to trigger the logger to start logging, launch the logger with Using Coupler selected in HOBOware. Once the software indicates the logger has been successfully launched, remove the logger from the coupler.

5 Deploy the logger using these guidelines. Refer to the logger manual at www.onsetcomp.com/support/manuals for complete deployment details.

- The logger can be damaged if the water depth rating is exceeded. The depth rating is approximately 30 m (100 ft) at temperatures below 20°C (68°F), but is less in warmer water.
- Do not store the logger in the coupler. Remove the logger from the coupler when you are not using it.
- If using a triggered start, bring an empty coupler or strong magnet to the deployment location. When you are ready for the logger to start logging, insert the logger into the empty coupler (or place it next to a strong magnet) and remove it after three seconds. Verify that the logger's OK LED is blinking at least every four seconds.
- **For UA-003 models:** Connect the black and white input wires to the relay output of most tipping-bucket rain gauges. If your rain gauge has a counter display and battery, disconnect them and attach the Pendant logger instead. Do not touch the logger's input wires together when connecting or disconnecting the logger while it's logging as this will record a false event.

6 To read out the logger, remove it from the deployment location. Follow steps 1–3 and select Read Out from the Device menu in HOBOware or use the Waterproof Shuttle. Refer to the HOBOware Help for complete details on reading out and viewing data.

For more information about this logger, refer to the product manual. Scan the code at left or go to www.onsetcomp.com/support/manuals.

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Patent # 6,826,664

22136-B MAN-UA-QSG

HOBO® U24-001 Data Logger

Fresh Water Conductivity Data Logger

This high-accuracy conductivity data logger is a cost-effective way to collect water quality data. The HOBO U24 measures and records both conductivity and temperatures in streams, lakes, and other freshwater sources. This logger is recommended for monitoring aquifers for saltwater intrusion and road and agricultural runoff. This product's open access to its sensor simplifies cleaning and maintenance. The HOBO U24's non-contact sensor minimizes measurement errors related to drift. In addition, the logger features software-based drift compensation.

The HOBO U24 Conductivity data logger features a non-contact sensor with a Titanium Pentoxide coating. This coating prevents the sensor from coming in contact with the water, which in turn prevents tarnishing or corrosion associated with traditional electrode sensors. This sensor coating is also inert, enabling fouling to be easily wiped off the sensor.

Supported Measurements:

Conductivity/Salinity and Temperature

Key Advantages:

- Non-contact sensor provides long life and less measurement drift
- Provides easy access to sensor for cleaning and shedding air bubbles
- HOBOware Pro software enables start/end-point calibration to compensate for any fouling and provides easy conversion to specific conductance and salinity
- USB optical interface provides high-speed, reliable data offload in wet environments
- Compatible with the HOBO Waterproof Shuttle for easy and reliable data retrieval and transport

The HOBO U24 Conductivity data logger features a non-contact sensor with a Titanium Pentoxide coating. This coating prevents the sensor from coming in contact with the water, which in turn prevents tarnishing or corrosion associated with traditional electrode sensors. This sensor coating is also inert, enabling fouling to be easily wiped off the sensor.

HOBO U24-001 Data Logger Specifications

Memory: 18,500 temperature and conductivity measurements when using one conductivity range; 11,500 sets of measurements when using both conductivity ranges (64 KB total memory)
Sample rate: 1 second to 18 hrs, fixed or multiple-rate sampling with up to 8 user-defined sampling intervals
Battery life: 3 years (@ 1 min logging)
Maximum depth: 70 m (225')
Operating range: -2 to 36°C (28° to 97°F) - non freezing
Weight: 193 gm (6.82 ounces), buoyancy in freshwater: -59.8 gm (-2.11 ounces)
Size: 3.18 cm diameter x 16.5 cm, with 6.3 mm mounting hole (1.25" diameter x 6.5", " hole)
Calibrated range: *Conductivity*: Low Range: 0 to 1,000 µS/cm; Full Range: 0 to 10,000 µS/cm - *Temperature*: 5 to 35C (41 to 95F)
Accuracy: *Conductivity*: 3% of reading, or 5 µS/cm, whichever is greater / *Temperature*: 0.1C (0.2F)
Resolution: *Conductivity*: 1 uS/cm - *Temperature*: 0.01°C (0.02°F)
Response time: 1 second to 90% of change
Environmental Rating: IP68

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- In U.S. toll free 1-800-564-4377
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- Contact Product Support www.onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

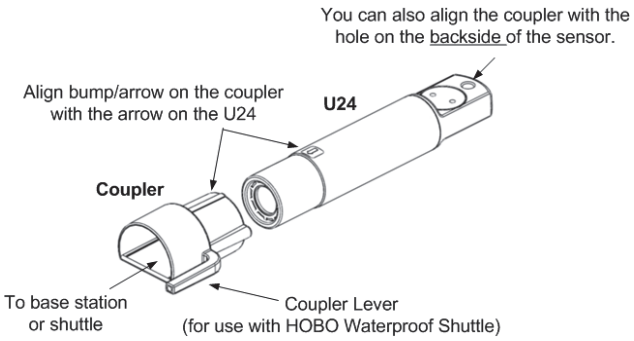
HOBO® U24 Conductivity Logger (U24-001 and U24-002-C) Quick Start

IMPORTANT: This logger can be damaged by shock. Always handle the logger with care. The logger may be damaged if it is dropped. Use proper packaging when transporting or shipping the logger. Do not attempt to open the logger case or sensor housing. Disassembling of the logger case or sensor housing will cause serious damage to the sensor and logger electronics. There are no user-serviceable parts inside the case.

1 Open HOBOware® Pro software. (Install first if necessary; download from www.onsetcomp.com.)

2 Attach the USB Optic Base Station (BASE-U-4) or HOBO Waterproof Shuttle (U-DTW-1) to a USB port on the computer (refer to the hardware manual at www.onsetcomp.com/support/manuals for details).

3 Attach the coupler (COUPLER2-C) to the base station or shuttle, then insert the logger into the coupler aligning the bump/arrow on the coupler with the arrow on the logger arrow on the logger as shown. Be sure it is properly seated in the coupler. If you are using the HOBO Waterproof Shuttle, make sure it is connected to the USB port on the computer and briefly press the coupler lever to put the shuttle into base station mode. It may take a few seconds for new hardware to be detected by the computer.



4 From the Device menu in HOBOware, select Launch. Select the correct range for the deployment. The logger will not record readings outside the extended range selected. If in doubt on the range needed for your deployment or for environments with wide fluctuations, select both ranges. This will shorten the deployment duration from 18,500 samples to 14,400 samples per parameter. Select any other launch settings and click Start. Logging will begin based on the settings you selected.

5 Deploy the logger and follow these guidelines.

IMPORTANT: Take temperature and conductivity calibration readings with a portable conductivity meter at both the beginning and end of a deployment. These readings are necessary for data calibration and to compensate for any measurement drift during deployment. The readings should be the *actual conductivity* without temperature compensation (*not* in specific conductance at 25°C) recorded in a notebook with the time and location of the reading. Use these readings in the HOBOware Conductivity Assistant to calibrate the readings for the corresponding data series offloaded from the logger. For details on the three methods for obtaining accurate calibration readings, see the full manual referenced at the bottom of this page.

- Make sure the logger is located where it will receive a steady flow of the water that is being monitored. When deploying the logger in rivers, streams, and ponds, insert the logger in a PVC or ABS pipe if possible. The PVC pipe should have enough holes to ensure good circulation of water.
- To avoid bubbles collecting on the sensor, make sure the sensor face is vertical and avoid sudden temperature changes. Avoid deploying the logger in freezing water with moving ice.
- Do not place any conductive materials or metals within 2.5 cm (1 in.) of the sensor.
- Use the included cap to protect the communications window in the logger from fouling and abrasion. Place the protective cap over the communications window before deploying the logger.
- Use the U2X Protective Housing (HOUSING-U2X) for added protection to the logger in harsh environments.

6 To read out the logger, measure the actual conductivity and temperature values with the field meter using one of the calibration methods. Remove the logger from the water. Follow steps 1–3 and select Read Out from the Device menu in HOBOware or use the Waterproof Shuttle. Refer to the HOBOware Help for complete details on reading out and viewing data.

For more information about the U24-001 logger, refer to the product manual. Scan the code at left or go to www.onsetcomp.com/support/manuals/15070-man-u24x.

For more information about the U24-002-c logger, refer to the product manual. Scan the code at left or go to www.onsetcomp.com/support/manuals/16844-man-u24-002-c.

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22140-B MAN-U24-QSG

Appendix 2. Temperature Data Logger QA/QC Log Sheet

Temperature Data Logger QA/QC Electronic Log Book

								START		Mid-Point		END					
Year	Date	Staff	PROBEID	TYPE	Owner	NEW?	BATTERY	Time	Temp	Time	Temp	Time	Temp	Result	Flag	OOS?	QCComment
2018	01/13/18	AA	10324584	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	01/13/18	AA	10324585	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	01/13/18	AA	10324586	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	01/13/18	AA	10324587	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS	TRUE		Possible drift in data
2018	03/10/18	ML	10324588	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	03/10/18	ML	10324589	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	03/10/18	ML	10324590	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	03/10/18	ML	10324591	HOBO	VOL	FALSE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			
2018	4/25/18	CB	10767215	HOBO	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			New logger
2018	4/25/18	CB	10767216	HOBO	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			New logger
2018	4/25/18	CB	20142135	HOBO	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			New logger
2018	4/25/18	CB	20298073	HOBO	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			New logger
2018	4/25/18	CB	20298081	HOBO	VOL	TRUE	Good	14:40	0.0 C	15:10	0.0 C	15:40	0.0 C	PASS			New logger
2018	4/26/18	CB	10121953	HOBO	FISH	FALSE	Good	17:00	0.0 C	17:30	0.0 C	18:00	0.0 C	PASS			
2018	4/26/18	CB	1183636	HOBO	ABM	FALSE	BAD	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	BAD BATTERY --> REMOVED FROM CIRCULATION
2018	4/26/18	ML	1183812	HOBO	ABM	FALSE	BAD	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	BAD BATTERY --> REMOVED FROM CIRCULATION
2018	4/26/18	ML	9715469	HOBO	ABM	FALSE	UNK	N/A	N/A	N/A	N/A	N/A	N/A	FAIL	TRUE	TRUE	Unable to connect to logger - tried on 2 computers
2018	4/26/18	ML	9859173	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE		Possible drift in data
2018	4/26/18	ML	9859187	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	FAIL	TRUE		"invalid interval value encountered & replaced by end of file event" error - no data on readout – REPEAT QC check
2018	4/26/18	ML	9862223	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS			
2018	4/26/18	ML	9937180	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS	TRUE		Possible drift in data
2018	4/26/18	ML	9937181	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS			
2018	4/26/18	ML	9937184	HOBO	ABM	FALSE	Good	11:00	0.0 C	11:30	0.0 C	12:00	0.0 C	PASS			

Appendix 3. Continuous Temperature Monitoring Equipment Check Lists

LABORATORY QA CHECK EQUIPMENT LIST:

Equipment	Quantity	Check off
Large plastic bin	1	
Small perforated basked	1	
Small plastic container	1	
Weight	1	
Ice	n/a	
Cold water	n/a	
NIST Certified Thermometer	1	
Computer with HOBOware Pro, Microsoft Excel, and Minitab software installed	1	
HOBO Optic USB Base Station (or waterproof shuttle) w/ USB cable	1	
Coupler(s) for the logger type(s) to be checked	1	

FIELD EQUIPMENT LIST

General Car/Team Supplies:	Quantity	Check off
Car GPS Unit	1	
Digital camera w/ spare batteries	1	
Waders	1 per person	
Shoulder-length gloves	1 per person + 1-2 extra	
Hand wipes (wet)	1 bucket	
Wipes/Towels (dry)	1 bucket	
First Aid/Safety Kit	1	
Road Atlas	1	
Garbage bucket	1	
Field Clipboard	1	
Loggers, Launched	1 per site	
Hoop Loop Field Packet	1	
NIST Certified Thermometer	2	
Spare Datasheets	5-10	
Pencils	4-6	
Sharpie Markers	2-3	
Blank Tags	At least 1 per site	
Hand-Held GPS Unit	1	
Flagging Tape, Pink	2 rolls	
Measuring Tape	1	
Underwater searching tube	1	
PVC Piping	1 per new site + extras	
Weights	1 per new site + extras	
Zip ties, long/large	1 bag	
Zip ties, small/short	1 bag	
Wire cutters	2 pairs	
Surgical gloves – various sizes	Several pairs each	

Last updated 05/30/2017

Appendix 4. Continuous Temperature Monitoring Field Data Sheet

STREAM TEMPERATURE MONITORING FIELD DATASHEET

Revised 06/13/2018

CTDEEP Water Monitoring Group (860-424-3028)

TRIP DATE: _____

CREW MEMBERS _____

SITE INFORMATION

STREAM NAME: _____ AWQ NUMBER: _____

LOCATION: _____

_____

Latitude: _____ Longitude: _____

HOBO Status: NEW / SWAP / RETRIEVE ONLY

LAUNCHED PROBE:

Serial Number: _____ DATE/TIME _____

RETRIEVED PROBE:

Serial Number: _____ DATE/TIME _____

Probe Condition:

Signs of Tampering: YES NO

Signs of Drying Out: YES NO

Level of Embeddedness: HIGH MEDIUM LOW NONE

DEPLOYED LOGGER INFORMATION

Logger Type: HOBO / Tidbit / Pendant / U-24

Pre-Launch QA Date: _____

File location: _____

Logger Launch Information:

Start Date and Time _____

Sampling Frequency _____Sec /Min / Hr / Day

Deployment Method:

Rock Pile Staked Tethered

Weight Type: None Angle Iron

Window Weight Railroad Plate

FIELD QA CHECK

TEMP: _____ TIME: _____

Equipment Used: PROBE / YSI

DESCRIPTION NOTES REGARDING PLACEMENT OF PROBE TO AIDE IN RETRIEVAL:

LANDOWNER CONTACT INFORMATION:

SITE MAP SKETCH - NOTE LOGGER LOCATION RELATIVE TO KEY LANDSCAPE FEATURES

Center Channel Upstream

Center Channel Downsteam

Pictures taken: YES / NO Number:

Appendix 5. Instructions for Reformatting Files for Database Upload

Last Updated 5/3/18

1. Locate Temperature Probe Downloads for Year/Season of Interest.
   Most likely in:
   M:\Monitoring Field Data by Year\Year Field Work Downloads\HOBO\HOBO Downloads and QA
2. Create folder called 'HOBO Data for DB Upload – *Season Year*' (Example: "HOBO Data for DB Upload – Spring 2018")
   (*Use season and year probe was retrieved/downloaded not deployed.)
3. Open the first logger data file. Click File - 'Save As' and save as a comma delimited format (csv) file in the new folder (step 2) with same name as original file. File names should be in the format:
   *Probe ID_SID_Stream_Name_Season_Year*_Deployment_*RetrieveDate[DDMMYY]@Time[HHMM]*
   For example: 1078731_15304_Eagleville_Brook_Fall_2017_Deployment_042717@1137
   If prompted "Do you want to keep using that format?" click "Yes"
4. Check that the logger serial number in cell A1 matches the serial number in the file name. If not flag the file and place in new folder called 'FilesWithIssues'.
5. Delete Row 1 and column A.
   Rename column A as Date_Time and column B as Temp. (Check to insure the data beneath each column is indeed date/time and temperature data!)
   Check to make sure Temp is °C. If not flag the file and place in new folder called 'FilesWithIssues'.
6. Add fields UOM, ProbeID, SID, Collector, and ProbeType in columns C, D, E, F, and G, respectively. Write over info in those columns if present.
7. Type "deg C" under UOM field (cell C2).
8. Extract probe ID # from the file name and copy number under ProbeID field (cell D2).
   1078731_15304_Eagleville_Brook_Fall_2017_Deployment_042717@1137
9. Extract the station ID (SID) from the file name and type it into cell E2.
   1078731_15304_Eagleville_Brook_Fall_2016_Deployment_042717@1137
10. Type "ABM" in cell F2 to indicate the collector was the DEEP WPLR Monitoring Program. (Type "FISH" or "VOL" if data is from the Fisheries Division or Volunteer Monitoring Program, respectively.)
11. Indicate the type of logger used to collect the data in cell G (e.g. HOBO, TIDBIT, U-24, or PEND)
12. Highlight cells C2 through G2. Click the small square at the bottom right of the highlighted cells to copy and paste the text into the cells below. Make sure any numbers copied were not copied in a sequential format (e.g. 1, 2, 3) but rather are the same.

13. Hold and click "Ctrl" and "End" keys (or scroll) to move to the end of the data file. Delete the last rows of the file where it says "Logged".
14. Check the file name to determine when the logger was removed from the water: 1078731_15304_Eagleville_Brook_Fall_2016_Deployment_042717@1137

    Delete all records from this date on. (This eliminates partial-day datasets from the data base.) If the logger was taken out of the stream on or close to the hour mark, delete that data point as well. In the example below, any readings after 4/26/17 would be deleted: 1078731_15304_Eagleville_Brook_Fall_2016_Deployment_042717@1137
15. Hold and click "Ctrl" and "Home" keys (or scroll) to move to the TOP of the data file. Check the first data entry to insure it is midnight of the given date. If not, **delete any partial-day readings** from the start of the dataset.
    For example if the logger was launched at 16:00 on 9/15/17 delete all data from 9/15/17 so that the data file starts at 0:00 on 9/16/17.
16. Check in AWQ database http://depwebs100/ambientwater/StationSearch.aspx that the station ID matches the stream name in the file by searching the number under the AWQ database stationID.
    1078731_15304_Eagleville_Brook_Fall_2016_Deployment_042717@1137

17. **Save the file.** REMEMBER TO CHECK WHEN YOU SAVE THAT THE FILE TYPE IS .CSV (Comma Delimited) or you will lose your work!

Example of Reformatted File

Date_Time	Temp	UOM	ProbeID	SID	Collector	ProbeType
9/16/2017 0:00	17.249	deg C	2229157	15499	ABM	HOBO
9/16/2017 1:00	17.13	deg C	2229157	15499	ABM	HOBO
9/16/2017 2:00	16.987	deg C	2229157	15499	ABM	HOBO
9/16/2017 3:00	16.868	deg C	2229157	15499	ABM	HOBO
9/16/2017 4:00	16.725	deg C	2229157	15499	ABM	HOBO
9/16/2017 5:00	16.582	deg C	2229157	15499	ABM	HOBO
9/16/2017 6:00	16.487	deg C	2229157	15499	ABM	HOBO
9/16/2017 7:00	16.439	deg C	2229157	15499	ABM	HOBO
9/16/2017 8:00	16.487	deg C	2229157	15499	ABM	HOBO
9/16/2017 9:00	16.582	deg C	2229157	15499	ABM	HOBO
9/16/2017 10:00	16.725	deg C	2229157	15499	ABM	HOBO
9/16/2017 11:00	16.892	deg C	2229157	15499	ABM	HOBO
9/16/2017 12:00	17.106	deg C	2229157	15499	ABM	HOBO
9/16/2017 13:00	17.629	deg C	2229157	15499	ABM	HOBO