

*Water Quality Monitoring Manual  
Sudbury, Assabet, and Concord River*

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## **Background**

The Sudbury, Assabet, and Concord rivers, a federally-designated Wild and Scenic River system, flow 88 river miles from the headwaters of the Assabet and Sudbury in Westborough to Lowell, where the Concord River joins the Merrimack River flowing to the sea. Despite their proximity to the urban populations of Boston, Lowell, and Worcester, the rivers flow through significant natural areas: the Assabet National Wildlife Refuge, Great Meadows National Wildlife Refuge, and Minuteman National Park. These rivers should be a tremendous asset to their region, but they are impacted by point- and non-point source pollution and reductions in natural flow. The Assabet River, in particular, receives the discharges from four municipal wastewater treatment plants and at times during the summer over 80-90% of the river's flow can be wastewater. The Sudbury and Concord rivers receive wastewater discharges from two additional municipal wastewater treatment plants. Downstream of five discharges, the town of Billerica draws its drinking water from the Concord River.

*Eutrophication, mercury, and invasive plants:* The over-growth of aquatic plants, termed "eutrophication," is caused by an over-abundance of nutrients (mainly phosphorus and nitrogen) in the river acting as fertilizer for the plants. During the growing season this over-growth creates problems for fish and other aquatic creatures by affecting dissolved oxygen concentrations and pH in the water column. After the growing season, the plants and algae decay, lowering dissolved oxygen levels and producing a distinctive bad odor. The main source of nutrient pollution to the rivers (particularly the

Assabet) has been the wastewater treatment plants that discharge to the rivers. Upgrades to the wastewater treatment plants in Westborough, Marlborough, Hudson, and Maynard were completed in 2012, reducing summertime effluent phosphorus concentrations from 0.75 mg/L to 0.10 mg/L. Since 2013, mean summer total phosphorus (TP) concentrations in the Assabet River Mainstem have almost always been below the EPA "Gold Book" recommendation (0.05 mg/L) and have often been below the Ecoregion reference condition for TP of 0.025 mg/L. This is an important achievement, since phosphorus is considered the limiting nutrient in freshwater systems, however the impoundment sections of the Assabet River remain overgrown, perhaps feeding on the accumulation of phosphorus remaining in the sediments. Nitrogen levels are still high, with mean summer nitrate concentrations in the Assabet averaging more than 3 times the Ecoregion reference condition of 0.34 mg/L. Nitrogen is considered the limiting nutrient in marine estuaries where rivers meet ocean water, so this is still a large concern for downstream communities on the Merrimack.

The Sudbury River is not significantly eutrophied, receiving wastewater only from the small treatment plant in Wayland and, indirectly from Marlborough Easterly which discharges to a



**Figure 1: Hudson Impoundment, Aug 2017**

tributary of the Sudbury, Hop Brook (which is eutrophied). However, sediments along the Sudbury are contaminated with mercury from the Nyanza superfund site in Ashland and the Mass Department of Public Health advises against eating fish from the Sudbury River. The Concord River, with more flow (thus more dilution), has slightly elevated nutrient concentrations, but is not significantly eutrophied. All three rivers suffer infestations of invasive water chestnut, Eurasian milfoil, and other invasive aquatic plants.

*Streamflow:* “Streamflow” or “flow” refers to the amount of water moving down the river. The rivers need not only good-quality water but also enough flow to provide habitat for a healthy population of fish, to support recreational uses (canoeing, kayaking, fishing), and to dilute pollutants in wastewater discharges and storm water. The rivers’ problems are exacerbated by low flows. During the natural low flow periods in the summer and early fall, upper sections of the Assabet River can consist largely of treated wastewater and the upper Sudbury River has been known to run dry. Summertime flows in the rivers and their tributaries depend on “baseflow,” the cool, clean water coming from groundwater aquifers of the watershed. Groundwater availability can be reduced by withdrawals from wells and by impervious cover that directs rain directly to the rivers.

## **OARS' water quality and quantity monitoring program**

OARS started collecting water quality data on the Assabet River in 1992. In 2002, we extended our baseline program to include water quality and streamflow measurements on the major tributaries of the basin. In 2004, we added monitoring sites on the Concord River and River Meadow Brook, the largest tributary to the Concord. In 2009 we added sampling on the lower Sudbury River (from Saxonville, Framingham, to the confluence of the Sudbury with the Assabet in Concord).

The main goals of the program are (1) to document summertime water quality and streamflow conditions and long-term trends in the rivers and their larger tributaries and (2) to provide timely accurate information to the public and decision makers on the local, state, and federal levels.

Toward these goals we will work to:

- Provide sound scientific information to support OARS' advocacy for the rivers.
- Assess whether the rivers meet the state's Water Quality Standards.
- Assess the effect of changes in the management of point and non-point pollution sources as the state's TMDL recommendations and NPDES permits are implemented.
- Identify problem spots for further investigation.
- Raise awareness of the rivers to influence individuals' decisions (like whether to install rain barrels at home) and build long-term capacity for making decisions that will protect the ecological integrity of the watershed (like influencing towns to pass protective regulations).

Monitoring is done in three parts:

- Winter sampling in November and March at the sampling sites with gages and headwaters/outlets of the rivers.
- Monthly sampling during the summer in May, June, July, August, and September.
- Monthly sampling for chlorophyll-*a* in June, July, and August (Sudbury River sites only).

Other parts of OARS' monitoring program include: visual estimates of the aquatic plant biomass in the large impoundments at the height of the growing season, invasive plant mapping, and water temperature monitoring on tributaries.

**Table 1: Sudbury, Assabet and Concord Sampling Sites & Schedule**

	Site #	Location	Approximate street address for GPS or Google Maps	Jun/Jul /Aug	May / Sept	Nov/ Mar	Jun/Jul/Aug (Chl-a)
Assabet	ABT-026	Assabet by Rt. 2 bridge, Concord	83 Assabet Ave., Concord (parking)	x	x	x	
	ABT-062	Assabet by Rt. 62 bridge nr. Acton Ford, Acton	69 Powdermill Road, Acton	x			
	ABT-077	Assabet by USGS gage, Rt. 27/62, Maynard	10 Waltham Road, Maynard	x	x	x	
	ABT-144	Assabet, Rt. 62, Stow	475 Gleasondale Road, Stow	x			
	ABT-237	Assabet, Robin Hill Rd., Marlboro	55 Robin Hill Road, Marlborough	x			
	ABT-301	Assabet by Rt. 9 East bridge, Westboro	285 Turnpike Road, Westborough	x	x	x	
	ABT-312	Assabet at Mill Road, Westboro	48 Mill Road, Westborough	x	x	x	
Concord	CND-009	Concord at Rogers Street bridge, Lowell	33 Merrill Street, Lowell	x	x	x	
	CND-036	Concord at Bristol and Amherst St., Billerica	10 Amherst Street, Billerica	x			
	CND-110	Concord at Rt. 225, Bedford	274 Carlisle Road, Bedford	x			
Sudbury	SUD-005	Sudbury at Rt. 62, Concord	500 Main Street, Concord	x	x	x	x
	SUD-064	Sudbury at Sherman Bridge, Wayland	65 Sherman's Bridge Rd, Wayland	x	x		x
	SUD-086	Sudbury at River Road, Wayland	11 River Road, Wayland	x	x		x
	SUD-096	Sudbury at Rt. 20, Wayland	450 Boston Post Road, Wayland	x	x		x
	SUD-144	Sudbury at Danforth Ct, Framingham	3 Sudbury Landing, Framingham	x	x	x	x
	SUD-236	Sudbury at Chestnut St, Ashland	60 Chestnut St., Ashland	x			
	SUD-293	Sudbury at Fruit St., Southborough	254 Fruit Street, Hopkinton	x	x	x	
Tributaries	DAN-013	Danforth Brook, nr. Rt. 85 bridge, Hudson	150 Lincoln Street, Hudson	x	x	x	
	ELZ-004	Elizabeth Br., nr. White Pond Rd., Stow	75 White Pond Road, Stow	x	x	x	
	NSH-002	Nashoba Br., Commonwealth Ave, W. Concord	152 Commonwealth Ave., Concord	x	x	x	
	NSH-047	Nashoba Brook site at Wheeler Lane, Acton	75 Wheeler Lane, Acton	x	x	x	
	HBS-016	Hop Brook at Landham Road, Sudbury	220 Landham Road, Sudbury	x	x	x	x
	HBS-095	Hop Brook at Hager Street Bridge, Marlborough	24 Hager Street, Marlborough	x			
	HOP-011	Hop Brook, nr. Otis Street, Northboro	75 Otis Street, Northborough	x	x	x	
RVM-005	River Meadow Brook at Gorham Street, Lowell	1 Chambers Street, Lowell	x	x	x		

\* Mainstem sites are designated by “ABT” (for Assabet River sites), “CND” (for Concord River sites), or “SUD” (for Sudbury River) plus a three digit number measuring rivermiles to the tenth upstream from the confluence of the Assabet with the Sudbury or the Concord with the Merrimack. E.g. ABT-237 is the mainstem site 23.7 miles upstream of the confluence. Tributary sites are designated by a three letter code plus rivermiles upstream from the confluence of that tributary and the mainstem. Sites designated by “m” are meter sampling only.

## **Sampling Sites / Directions**

**Detailed driving directions and site descriptions are in each sampling kit.** “Left” and “Right” banks are left and right as you stand looking downstream, as if you were boating downstream.

**OARS’ Office** – (not a sampling site)

The office is at 23 Bradford Street off Rt. 62 (Main Street) in West Concord. From Rt.. 2, take Rt.. 62 West (toward West Concord), bearing right onto Commonwealth Avenue/Main Street at the “99 Restaurant.” Cross the railroad tracks and take a left onto Bradford Street. Park in the lot for #23. The office is on the second floor.

**Quality control site for meter readings (all sections): ABT-033 (Rt. 62/Pump Station; QC site only)**

From Bradford Street, turn right on Commonwealth Ave., joining Rt. 62 east. Go 0.25 miles and turn right into the parking lot for the dry cleaners and pet supplies. The sampling site (quality control sampling for the meters only) is from the upstream side of the bridge over the Assabet River.

### **Online Driving Directions**

Access the online version of this manual and links to driving directions on the OARS website:

*Take Action → Volunteer → Water Quality Sampling → Information for Volunteer Samplers*

<http://oars3rivers.org/our-work/monitoring/wq-testing/for-volunteers/>

## Safety

***OARS volunteer and staff safety is the top priority. Please read the following safety precautions carefully. Do not put yourself in harm's way to complete the sampling.***

### Automobiles and Roadways

Many sites are located on bridges and busy roadways, which are not commonly used by pedestrians. Your presence may be a surprise to motorists. Warn approaching traffic of your presence by parking on the same side that you're working on, if possible, and use caution when crossing the street.

### Personal Protective Equipment

Wear high-visibility clothing such as reflective jogging vests or hunter's vests when sampling. Always wear long pants and closed boots or closed shoes (not sandals) when wading into the river to protect from poison ivy and sharp objects.

### Bridges

Always use extreme caution at the edge of a bridge. Test railings before leaning against them. Do not climb or sit on railings.

### Ticks

Check for ticks on yourself and your clothing, particularly after walking through brushy areas.

### Wading

Wading is necessary at most sites. Wading should only be done when the water is less than waist deep and not fast moving. Do not wade alone. If the river's flow is too high or too fast moving to allow for safe wading, take the samples using the sample collection rod or basket. **Do not wade in the river when river depth (in feet) times velocity (feet per second) appear to equal 5 or greater (e.g. 1.5 foot depth \* 4 feet/second velocity = 6 = unsafe conditions!).**

### Weather Conditions

We do sample in cold and/or rainy conditions. Volunteers should expect to be out for up to three hours and should dress appropriately. If there is lightning, suspend sampling and notify OARS.

### Emergency Numbers

In case of emergency while monitoring, **call 911 first.**

After notifying emergency services, contact OARS at the numbers below.

### Non-emergency Numbers

For non-emergency sampling day problems call the OARS office 978-369-3956 or Ben's cell phone 617-390-3151.

### Liability Waiver Forms

Participation in the water quality sampling is strictly voluntary and is done at your own risk. We require that all volunteers (or their guardians for those under 18) sign a liability waiver form before participating in any sampling events.

## General Sampling Notes

### Water Quality Sampling Kit

1 thermometer	1 cooler with ice and temperature blank bottle
2 pens	1 distilled water (if needed)
2 black Sharpie permanent markers	YSI meter with data logger and cable
1 clip board with plastic cover sheet	extra C-cell batteries and screwdriver
River Observation sheets (one per site)	1 sampling pole
Chain of Custody record sheets	scrubbie for cleaning gages
1 field QC sheet (if doing field QC)	1 Water Quality Monitoring Manual
sample bottle set in Ziploc bag (one bag per site)	1 WQ Volunteer list and monitoring schedule

### Optional:

1 sampling basket with rope

### Keeping Records

Record all observations on the data sheets provided with a permanent pen or marker. Never erase a mistake. Instead cross it out, neatly with a single line, and write the correct entry next to or above it.

### Photographs

If you have a digital camera available, please take photographs of anything unusual at a site and email them to Ben ([bwetherill@oars3rivers.org](mailto:bwetherill@oars3rivers.org)).

### Duplicate samples

A duplicate sample is simply a second sample, collected in the same way. The results are used to check for any problems in the collection or analysis process. Collect duplicate samples right after the original sample, using exactly the same technique each time. A second set of sample bottles will be provided for those dates/sites when a duplicate is needed. The duplicate sample bottles will be inside a second Ziploc bag and will be labeled “DUPLICATE” and the “site” will be designated only as “QC-xx” (QC-01 for example). Do **not** record time or initials on the bottle or on the Chain of Custody form (to ensure that the sample is “blind” to the laboratory).

### Distilled water samples (quality control “blanks”)

Distilled water samples will be collected periodically to check for contamination from the bottles and from collection techniques. A second set of sample bottles will be provided for those dates/sites when a distilled water is needed. The distilled water sample bottles will be inside a second Ziploc bag and will be labeled “DISTILLED WATER” and the “site” will be designated as QC-xx (e.g. QC-04). Pour distilled water directly from the bottle of distilled water (supplied with each kit) into each sample bottle. Do not record time or initials on the bottles.

### Chlorophyll samples

If collecting chlorophyll samples, follow all the procedures for bottle sampling. The only difference is that you will fill up two identical 1L bottles at each site. There is no +/- distinction between the bottles.

### Day before sampling

- 1) Contact your team and agree on meeting place and time! The person picking up the equipment will come to the OARS office at 5:30 am (unless a later start time has been announced). The rest of the sampling team will meet at the arranged meeting place (often the first of their sections' sampling sites). Meeting times may vary a little with travel time, but the Middle Assabet, Lower Assabet, and Sudbury River sections can likely meet by 6:15am and the Upper Assabet and Concord River sections can likely meet at 6:30am. Designate a courier who will return the samples, instrument, and documentation to the OARS office.
- 2) Review which samples you will be collecting and where. Review sampling procedures.
- 3) Make sure that someone in your family knows you are going sampling the next morning.

### Equipment pickup and first meter reading

- 1) Pick up the meter and sampling kit at the OARS office at 5:30 am (unless a later time has been announced). The sampling kit and list of equipment is described above in General Sampling Notes.
- 2) Put the temperature blank (bottle marked "Temp") into the cooler in the ice.
- 3) If conducting a field QC meter test, take the first meter reading at the Rt. 62 bridge by the Concord pump station (aka ABT-033). This is an important quality control reading to check measuring technique and precision between the meters. Compare meter readings among groups and **check your readings with coordinator before setting off** to meet the rest of your sampling team.

## **Observations**

Complete a “River Observations & In-situ Readings” field sheet for each site. Be sure to fill in each field.

- WEATHER & OBSERVATIONS: Fill in as appropriate.
- CHANNEL FLOW STATUS: See directions below on how to estimate channel flow status (page 12).
- SAMPLES TAKEN: Follow the instructions for Taking Bottle Samples on page 13.
  - Circle the appropriate samples for the site (sample, duplicate, distilled water). The + bottle has preservative, and the – bottle does not.
  - POSITION IN RIVER: Note the position of the bottle sampling as you face downstream.
  - WATER DEPTH: Measure the total water depth at the bottle sampling site using the markings on the pole. Estimate the depth to the half foot.
- AIR TEMP: Take the air temperature reading in a shaded area near each sampling site. Make sure the thermometer is dry. Hang the thermometer on a branch and let reading stabilize 3 – 4 minutes. At one site per section, take a second reading by having a second person read the thermometer. Record the result to the nearest degree. Record the thermometer number (from the tag).
- IN-SITU READINGS: See directions below for In-situ Sampling Procedures (page 17). Record in-situ readings from the YSI meters on the field sheet and log the readings in the data logger’s memory.
- STREAMFLOW: **If** there is a staff gage, take a reading to the nearest 1/100<sup>th</sup> of a foot (directions below on page 21) and note the condition of the river just below the staff gage. There are OARS gages at ABT-312, HOP-011, NTH-009, DAN-013, NSH-002 and USGS gages at ABT-077, NSH-047, SUD-144, CND-009. It is not necessary to read the USGS gages, but it doesn’t hurt.
- GENERAL SITE COMMENTS: Add any General Comments about the site.

**Estimating Channel Flow Status**

“Channel flow status” estimates the amount of the streambed covered with water at a given cross-section. Estimate Channel Flow Status at a cross-section near the bottle sampling site. Read the descriptions on the field sheet and circle the number below the description that best describes the current condition of the channel.

		Channel Flow Status																			
		Optimal					Suboptimal					Marginal					Poor				
SCORE	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.						Water fills 76-99% of the available channel; or 1-24% of channel substrate is exposed.					Water fills 25 – 75% of the available channel, and/or riffle substrates are mostly exposed.					Very little water in channel and mostly present as standing pools.				
		20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1



Danforth Brook cross-section at flow status = 20.

Water reaches base of both banks, and no “channel substrate” (rocks, sand, gravel that form the stream bottom) is exposed.

*If the stream is above flood level, write 20+ on the sheet.*



Danforth Brook cross-section at flow status = 2.

Very little water in the channel, mostly present as standing pools.

## **Taking Bottle Samples**

### Supplies:

- One Ziploc bag per site with all sets of sample bottles needed for the site (including any field duplicates and distilled water samples). Each set of bottles includes:
  1. Plastic bottle (top labeled “+”) with sulfuric acid preservative.  
*Caution: The sulfuric acid is somewhat corrosive. If you get it on your hands or clothes, rinse immediately.*
  2. Plastic bottle (top labeled “-”) without preservative.
- Field Sheet, and Chain of Custody form

### Sampling:

- 1) BEFORE COLLECTING SAMPLES, write the time (to the nearest 5 minutes of sampling) and your initials on all bottles EXCEPT the Quality Control (QC) samples.
- 2) Leave the “+” bottle with preservative on shore.
- 3) Take the “-” bottle (without preservative) and wade into the river, face upstream, wait for any sediment to settle. Put the closed bottle 6 – 12” below the surface of the water. Uncap the bottle underwater and allow to fill, recap underwater. Pass the bottle to your on-shore partner.
- 4) On shore, fill the “+” bottle from the “-” bottle. Do not overfill. Leave some airspace in the bottle. Cap the bottles.
- 5) Refill the “-” bottle (without preservative) as described in Step 3 and cap.
- 6) Check that bottles are properly labeled (time and initials) and place in cooler.
- 7) Complete the Chain of Custody (time of sample, initials, comments if needed).

### Field Duplicates (labeled on bag only):

- 1) Repeat the steps above exactly for the duplicate set of bottles. Collect the duplicates right after the first sample. Bottles for duplicate samples will be inside a second Ziploc bag with the original field samples. The Ziploc bag will be labeled “DUPLICATE” and the bottles will be labeled “QC-xx” (e.g. QC-01).
- 2) Do NOT record a sampling time or initials on the field duplicate bottles or on the chain of custody (to make sure that the QC sample is “blind” for the laboratory).

### Distilled water samples (labeled on bag only):

- 1) To collect a distilled water sample, at the river bank, pour directly from the bottle of distilled water (supplied with each kit) into each sample bottle. The distilled water sample bottles will be inside a second Ziploc bag with the regular samples for the site. The Ziploc bag will be labeled “DISTILLED WATER” and the sample bottles will be marked as “QC-xx” (e.g. QC-04).
- 2) Do NOT record a sampling time or initials on the distilled water sample bottles or on the chain of custody.

## General Bottle Sampling Procedure - Wading

- 1) *Never sample alone!*
- 2) Wade in carefully, moving upstream until you get to the main flow of the stream so that any sediments disturbed don't interfere with the sampling. Sample from midstream if the stream is small. If the stream is larger, go only as far out from shore as is safe. Establish a solid footing before filling a sample (i.e. try not to fall over, it stirs up a lot of sediment and gets your seat wet).
  - *If it is not safe to wade (too fast-flowing or too deep), use the sample collection pole described on page 15. If the site is not safe for either wading or using the sample collection pole, use the basket sampling method from a bridge described on page 16.*
- 3) Stand facing upstream (the water moving towards you). Stand still for a few seconds to allow any disturbed sediments to be carried away by the current. Always collect from your upstream side. Collect samples with the “-“ bottle only.
- 4) Representative samples are best collected 6 - 12” below the surface, or at 1/2 depth if the river is shallower than 6”. Sediment or surface debris in the sample can interfere with the accuracy of the laboratory analyses. Therefore, to take a sample, position the collection bottle, lid on, 6-12” below the surface (or 1/2 depth for shallower flows). Uncap underwater, allow the bottle to fill, recap underwater and finally bring to the surface.
  - *After collecting each sample hold it up and inspect it for sediment or debris. If there is debris, redo the sample using the large (1L) bottle in your kit. Allow the water to settle in the large bottle and then decant from the large bottle to the 500ml bottle, trying to avoid sediment or debris.*



Flow direction

### Good sampling technique:

- in the main flow of the river
- facing upstream
- mid-depth
- wait for sediments to settle
- uncap & recap “-” bottle underwater
- fill the “+” bottle from the “-” bottle
- refill the “-” bottle

## Using a Sampling Pole

**Use when conditions will not permit safe wading for direct bottle sampling or the stream bottom is too muddy to allow for collection of a clean sample by wading.**

- 1) First rinse the clamp end of the rod in the stream you wish to sample. This will reduce the possibility of contamination from the previous station (or contamination from the trunk of your car!).
- 2) Next, place the “-“ bottle (**without** preservative) or large 1L bottle in the “MegaCuff” and squeeze tightly closed. Remove the cap from the bottle.
- 3) Rotate the pole until the bottle is upside down. Immerse the bottle to the desired depth and then rotate the pole to fill the bottle (see picture). Be careful to avoid catching surface debris or bottom sediments.
- 4) Once the “-“ bottle is full, remove it from the water, and pour it into the “+” bottle. Refill the “-” bottle, repeating step 3, remove it from the water, cap it and remove it from the cuff.
- 5) To take a field distilled water sample: Rinse the clamp three times by pouring a small amount of distilled water (supplied with the kit) over the clamp. Attach the sample bottle to the clamp as usual. Take the distilled water sample by pouring an appropriate amount of distilled water into the sample bottle. Store the sample in the cooler.



**CAUTION:** Do not extend the pole too far when sampling high velocity streams. You’d be surprised at how much force there can be on the pole. To avoid damaging (bending) the pole, it is recommended that you leave at least 1-foot un-extended.

**CAUTION:** Since the pole is aluminum, be extra careful around power lines.

## **Basket Sampling Procedures**

**Basket sampling from a bridge: use ONLY when conditions will not permit safe wading for bottle sampling or use of sample collection pole.**

- 1) Secure the “-” bottle (or large 1L bottle) in the “MegaCuff” of the basket. (Do NOT put the bottle with preservative in!)
- 2) Ensure that the rope is securely tied onto the basket and stand on loose end of rope (or tie to wrist) before lowering the basket.
- 3) Remove cap and lower the basket into water from bridge. Let water fill the bottle.
- 4) Raise basket carefully, making sure it does not bump the bridge abutments or other structures. Do not let loose rope fall into bottle.
- 5) Remove the “-” bottle from the cuff and pour it into the “+” bottle.
- 6) Repeat steps 1 - 4 to refill the “-” bottle.



**Basket sampler**

## In-situ Sampling Procedures

### Data Collection General Notes

#### *Quality control measurements*

At the beginning of the sampling day, duplicate readings with all sensors are taken in a common water body. Readings are compared and recorded on the sensor QC sheet.

#### *Types of Sensors*

We have two types of in-situ sensor units – 6-Series or ProDSS. They are both made by YSI, and we often refer to them as YSIs. There are separate instructions in the following pages for each type.

- **6-Series** – The handheld unit for this series is the 650 MDS. Our 6-Series sensor (sonde) is model 600XL.
- **ProDSS** – This is our newer unit. Both the handheld computer and the sonde are called ProDSS.



Sensors



Sensors

#### *Taking Readings – general*

Readings can be taken at the bottle sampling site if the river is shallow or from a bridge near the bottle sampling site if the water is too deep to safely get into the main flow of the river.

To take readings, position the sensing elements of the sonde at 8 – 12 inches below the surface (or mid-depth if shallower). If the river's current is swift it may be necessary to allow the sonde to lie along the bottom to stay submerged. **Do not lay the sonde on the bottom if the bottom is soft sediments!** (DO readings will be near zero if the probe is in the soft sediments. If conductivity readings are very low, check that the probes are not out of the water.)

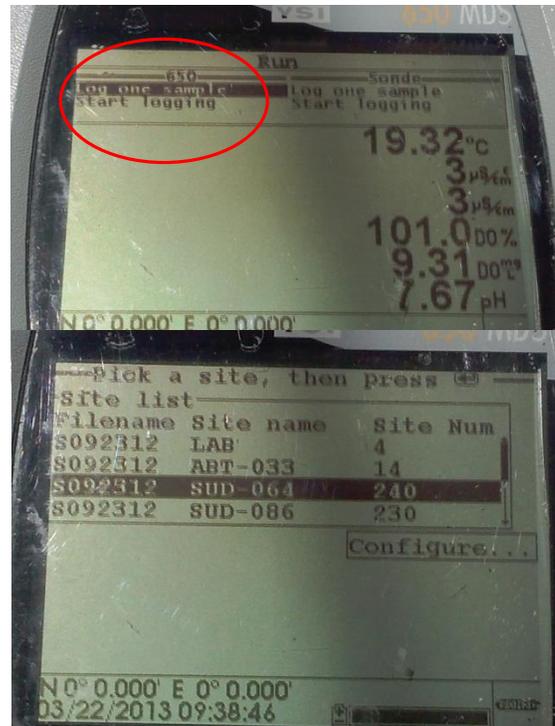
Use the units of measure to distinguish the different parameters:

- °C – temperature
- DO % - dissolved oxygen saturation
- DO mg/L – dissolved oxygen concentration
- $\mu\text{S}/\text{cm}^{\text{C}}$  – specific conductivity
- $\mu\text{S}/\text{cm}$  – conductivity
- pH - pH

6-Series

***Taking in-situ field measurements with the 650 MDS:***

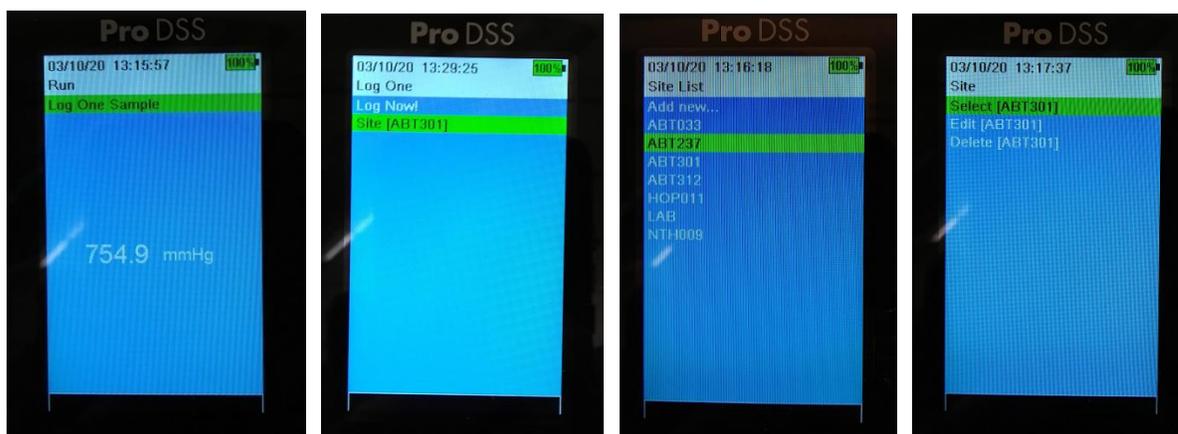
- 1) Check that the sampling cap (slotted) is on the sonde and make sure that cable connections are tight. Turn the data logger on by pressing and releasing the on/off button on the top left of the instrument keypad. The “650 Main Menu” will be displayed. Use the ▲ ▼ keys to highlight “Sonde Run” and press Enter (the ↵ key) to display the real-time sonde readings.
- 2) Wait for the readings to stabilize (sometimes as much as 2-3 minutes) and record reading position, time, and readings in the “In-situ Readings” section of the River Observation field sheet.
- 3) Record data on the data logger as follows:
  - a. In Run mode there is a box displaying the logging options at the top of the data logger screen. Use the ◀ ▶ keys to highlight “Log one sample” under the “650” section of the box (left side). Press Enter (↵) to log a sample.
  - b. The site list will be displayed automatically. Use the up and down arrow (▲ ▼) keys to highlight the appropriate site and press enter.
  - c. The logger will automatically return to Run mode and will briefly flash “Data logged” near the top of the screen.
  - d. Repeat the process to log a second sample from the same site after 30 seconds to ensure that the readings were stable.
- 4) Keep the probes moist when not in use. For transport between sites during sampling, the instrument can be carried with its sampling cap on. A damp towel will help keep it moist. If the instrument will be left longer than 1 hour, replace the sampling cap with the storage cap (the clear solid one) with some water in it.



## ProDSS

**Taking in-situ field measurements with the ProDSS:**

- 1) Check that the storage cap (clear plastic) has been removed from the sonde and the sampling cap (slotted) is on the sonde, and make sure that the cable connections are tight. Turn the data logger on by pressing and releasing the green on/off button on the bottom right of the instrument keypad. The main screen with sensor readings will be displayed.
- 2) Press the ◀ button to view real-time graphs of the data, and the ▼ button to scroll through the data. Use the graphs to wait for the readings to stabilize (sometimes as much as 2-3 minutes) and then record reading position, time, and readings in the “In-situ Readings” section of the River Observation field sheet.
- 3) Record the data on the data logger as follows:
  - a. “Log One Sample” should already be selected in green. Press Enter (↵) to log a sample.
  - b. To change the site, use the up/down (▲ ▼) keys to highlight “Site [...]” and press Enter. Select the current site from the site list and press Enter. On the confirmation screen, select “Select [site name]” and press Enter again to return to the “Log One” screen.
  - c. On the “Log One” screen select “Log Now!” and press Enter. Logger will beep and return to the Run mode and briefly display “Sample Logged” at the bottom.



- 4) Keep the probes moist when not in use. For transport between sites during sampling, the instrument can be placed loosely in the empty clear plastic storage cup or wrapped in a damp towel. If the instrument will be left longer than 1 hour, add water to the cup and tighten the seal.

### Troubleshooting

If the 650 MDS **data logger display locks** up, unscrew the battery compartment on the back of the data logger, remove one of the C-cell batteries, wait 30 seconds, and then replace the battery and replace the logger compartment lid. This should restore function and does not interfere with logger memory.

**Low logger batteries (650 MDS):** If the batteries run out, unscrew the battery compartment on the back of the data logger and replace the batteries. Extra batteries and a small screwdriver are supplied with the kits for this purpose. This does not interfere with the logger memory.

**Very low dissolved oxygen readings:** check that the sonde is not in sediments; try to take the readings at half-depth in the water column. Some sites do have very low DO readings, so don't assume that the reading is wrong.

**Fluctuating dissolved oxygen readings** (fluctuating by more than 5% DO): could indicate a problem with the probe. Check that the probe end is clear of debris and that the cable connection is tight. Call the OARS office if there are continued problems.

**Low conductivity readings:** very low readings (<50  $\mu\text{S}/\text{cm}$ ) could indicate that the sonde is out of the water. Check that it is completely submerged.

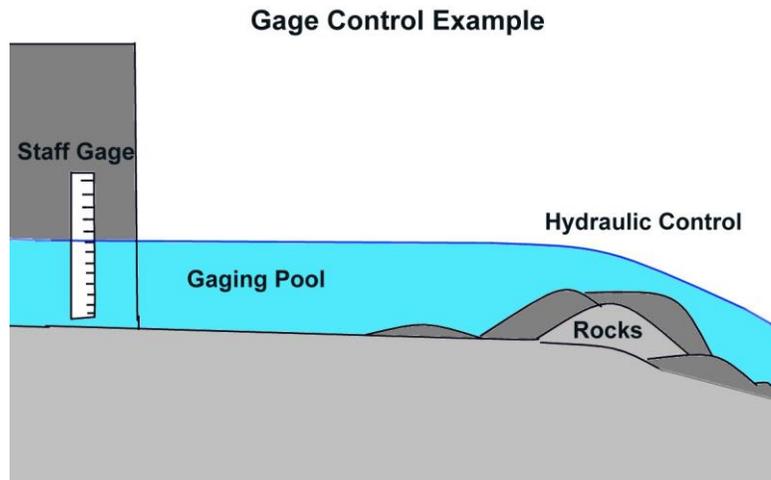
For other problems with the instrument, call the OARS office for help.

## Staff Gage Readings

(not all sites have staff gages; check the site descriptions for gage locations)

### *Observations*

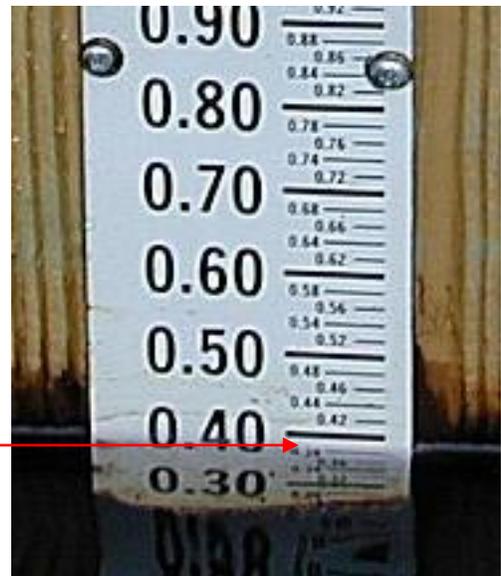
Site descriptions include descriptions of the staff gage location and “gage control” for that site. When you first get to the site, look at the rocks or stream channel that control the height of the water at the gage (a.k.a. the gage’s “control”). Note whether there are any changes. Have rocks been moved? Are there leaves, branches, or other debris on the control or gage? Is there increased siltation around the site? Have more weeds grown in the channel? If necessary, remove any debris from the control and wait 10 – 15 minutes for the gage pool to drop to its normal height. Note any changes in the field record and, if possible, take a picture to document the conditions.



### *Reading the Staff Gage*

The staff gages installed by USGS are graduated in feet. Read the water level to the nearest 1/100<sup>th</sup> of a foot. The graduations between the smallest markings are 0.02 ft. If there are waves or surface disturbances, estimate the level as closely as you can and note the problem in the comments section of the field record. The gages are best read standing at the level of the gage, either close enough to read the graduations or with binoculars - please note in the comments where you’ve read the gage from.

For example, on this staff gage the water level is at about 0.39 ft, half way between 0.38 ft and 0.40 ft.



### *Documentation*

Take the clipboard and field sheet when you read the gage and record your observations on the spot.

## **After Collecting All Samples**

- 1) Make sure all samples are properly labeled, all observations are recorded on the River Observation sheets, and times are entered on the Chain of Custody forms. Make sure that readings for all sites have been recorded on the in-situ readings sheet.
- 2) When you bring the samples and meter to the office, the designated check-in person will check all samples against the Chain of Custody forms. Sign your Chain of Custody forms.

## **Sample Check-In**

- 1) Check sample bottles against Chain of Custody and River Observation forms:
  - a. Bottles: Are the bottle labels consistent with Chain of Custody forms? All samples taken? Times written on the bottles and Chains (except for QC samples)?
  - b. Remove the QC samples from their identifying Ziploc bags and return the bottles to the cooler. (These bottles should NOT have sampler's initials or time recorded on the bottle.)
  - c. Cooler temperature: using the NIST thermometer, measure the temperature of the temperature blank in cooler and record the result on Chain of Custody forms.
  - d. Chain of Custody Forms: First courier and then Check-in person each sign the form.
  - e. River Observation Forms: One for every site? Complete? Gage readings recorded for all tributary sites? In-situ readings recorded and seem reasonable? Good comments?
- 2) Samples for Nashoba Analytical: When all samples are in, put a temperature blank bottle into the cooler, and sign the C of C forms over to the courier. Samples will be stored, on ice in the coolers, overnight until they can be delivered to the lab on Monday morning (by 9am). At the lab sign the C of C forms transferring the samples to the lab, measure the cooler temperature from the temperature blank bottle and bring back completed forms (the lab will keep a copy for their records) and empty cooler.

Field QC Issue

Date \_\_\_\_\_ Operators Initials \_\_\_\_\_

Meter I.D. (circle one): *Upper*      *Middle*      *Lower*      *Sudbury*      *Concord*

Site ID	Reading Position: Lft/Clr/Right Top/Mid/Bot	Meter Depth (ft)	Time	Temp (°C)	SpCond (µS/cm <sup>c</sup> )	Cond (µS/cm)	DO %	DO	pH
ABT-033 Route 62 Pump Station									
<i>Comments:</i>									

Quality Control Samples:

*QC-01 = duplicate at NTH-009*

*QC-02 = distilled water sample at CND-161*

Using the 650 MDS Data Logger

To turn the logger on, press and release the green on/off button on the top left of the instrument keypad. The "650 Main Menu" is displayed. Use the up/down (▲ ▼) keys to highlight "Sonde Run" and press Enter (the ↵ key) to display the real-time sonde readings.



To record data (log a sample)

In Run mode use the ◀ ▶ keys to highlight "Log One Sample" under the "650" section of the box (left side). Press Enter. The site list is displayed automatically. Use the arrow keys to highlight the appropriate site and press Enter. The logger will automatically return to Run mode and will flash "Data logged" near the top of the screen.



River Observations & In-situ Readings

Site Name: \_\_\_\_\_ Site ID: \_\_\_\_\_  
 Date: \_\_\_\_\_ Time: \_\_\_\_\_ Samplers' initials: \_\_\_\_\_

**1. WEATHER & OBSERVATIONS**

Current Weather (circle one):      *no rain*      *light rain*      *rain*      *heavy rain*

Observed Use (circle one):      *none*      *fishing*      *boating*      *swimming*      *other* \_\_\_\_\_

**2. CHANNEL FLOW STATUS at sampling section or designated section (circle score)**

Optimal	Suboptimal	Marginal	Poor
Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.*	Water fills 76-99% of the available channel; or 1-24% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

\*Write 20+ if flooding.

**3. SAMPLES TAKEN (circle appropriate)**

500 ml bottle with preservative:      *Sample*      *Field Duplicate*      *Distilled Water*

500 ml bottle no preservative:      *Sample*      *Field Duplicate*      *Distilled Water*

Sampling method:      *Grab*      *Pole*      *Basket*

Water Color (circle one):      *clear*      *silty (gray)*      *green*      *cloudy*  
    *light tea*      *tea*      *muddy*      *other* \_\_\_\_\_

Water Odor (circle one):      *none*      *musky*      *gas /oil*      *rotten egg*      *other* \_\_\_\_\_

Position in river (facing downstream):      *left*      *center*      *right*

Total water depth at bottle sampling site (record to the 1/2 foot): \_\_\_\_\_ ft.

**4. AIR TEMP**

Air Temperature: \_\_\_\_\_ °C / °F      Duplicate Air Temp. (take one dup. reading per sampling day) \_\_\_\_\_ °C / °F  
 Thermometer ID: \_\_\_\_\_

**5. IN-SITU READINGS**

Meter ID (circle one):		<i>Upper Abt.</i>	<i>Middle Abt.</i>	<i>Lower Abt.</i>	<i>Concord</i>	<i>Sudbury</i>			
Position in river: Left/Center/ Right	Position in water column: Top/Middle/ Bottom	Reading Depth (ft)	Time	Temp (°C)	Sp Cond (µS/cm)	Cond (µS/cm)	DO %	DO (mg/L)	pH

**6. STREAMFLOW (at sites with permanent staff gage)**

Stage (staff gage reading in feet to the 0.01ft): \_\_\_\_\_ Duplicate gage reading (always): \_\_\_\_\_

Comments on control for staff gage ( e.g. changes to rocky control, siltation, leaves or debris)

**7. GENERAL SITE COMMENTS (invasive plants, trash, safety concerns, navigation hazards, etc.):**

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Chain of Custody

**Nashoba Analytical, LLC, 31A Willow Street, Ayer, MA (Tel. 978-391-4428)**  
 Client Name/Project: OARS Water Quality Sampling 2019 (Tel. 978-369-3956)

Massachusetts Certification: M-MA-1118  
 Sampled by: \_\_\_\_\_

Date	Sample #	Time	Location – LOWER SUDBURY RIVER	Container	TP	MR3	TEN	NO3	Ortho-P	TSS	Checked/ Comments
5/20/18	SUD-064		Sudbury River, Sherman Bridge Rd, Wayland	plastic no preservative				X	X	X	
5/20/18	SUD-064		Sudbury River, Sherman Bridge Rd, Wayland	plastic with H2SO4	X	X	X				
5/20/18	SUD-086		Sudbury River, River Road, Wayland	plastic no preservative				X	X	X	
5/20/18	SUD-086		Sudbury River, River Road, Wayland	plastic with H2SO4	X	X	X				
5/20/18	SUD-098		Sudbury River, Pelham Island Rd, Wayland	plastic no preservative				X	X	X	
5/20/18	SUD-098		Sudbury River, Pelham Island Rd, Wayland	plastic with H2SO4	X	X	X				
5/20/18	HBS-016		Hop Brook, <u>Landham Rd</u> , Sudbury	plastic no preservative				X	X	X	
5/20/18	HBS-016		Hop Brook, <u>Landham Rd</u> , Sudbury	plastic with H2SO4	X	X	X				
5/20/18	SUD-144		Sudbury, Danforth Ct, Framingham	plastic no preservative				X	X	X	
5/20/18	SUD-144		Sudbury, Danforth Ct, Framingham	plastic with H2SO4	X	X	X				
5/20/18	QC-01		QC sample	plastic no preservative				X	X	X	
5/20/18	QC-01		QC sample	plastic with H2SO4	X	X	X				
5/20/18	QC-02		QC sample	plastic no preservative				X	X	X	
5/20/18	QC-02		QC sample	plastic with H2SO4	X	X	X				

Special Notes/Requirements:	Relinquished by:	Date	Time	Received by:	Cooler Temp