

WACCAMAW WATERSHED ACADEMY

# Volunteer Water Quality Monitoring Handbook

EDITION 1.0  
PRINTED MARCH 2021



# Table of Contents

## 02 OVERVIEW

- 04 What is Citizen Science?
- 05 Why Volunteer Water Quality Monitoring?
- 06 Waccamaw Watershed Academy
- 08 Where We Monitor
- 11 What Happens to the Data?
- 12 Volunteer Roles
- 13 Volunteer Code of Conduct

## 14 SAMPLING HANDBOOK

- 15 Sampling Equipment and Supplies
- 16 Sampling Event Overview
- 17 Field Sampling Overview
- 18 Sampling Information and Site Observations
- 19 Determining Water Flow
- 20 General Meter Care
- 20 Field Checks
- 25 Water Collection Protocol
- 27 Probe Equilibration
- 28 Nutrient Strips
- 31 Turbidity and Bacteria Sample Water Collection
- 33 Meter Measurements
- 36 Final Steps
- 38 Data Entry to Online Database

## 40 ORION CALIBRATION PROCEDURES

- 41 Orion Calibration Overview
- 43 pH Probe Calibration
- 45 Conductivity Probe Calibration
- 46 DO Probe Calibration

## 48 TURBIDITY ANALYSIS

- 49 Turbidity Overview
- 50 Turbidity Analysis Procedure
- 51 Calibration Check
- 52 Sample Measurement

## 56 FECAL BACTERIA ANALYSIS

- 57 Bacteria Overview
- 58 Bacteria Supplies
- 59 Preparation Before Sampling
- 60 Plating the Bacteria
- 62 Incubation
- 64 Colony Counts and Calculations
- 69 Plate Disposal

## 70 APPENDIX

- 71 Troubleshooting
- 73 Riverkeeper's Quick Reference Table
- 75 Frequently Asked Questions
- 76 Acceptance Ranges
- 77 Glossary
- 77 Thanks to Our Volunteers!

*Recommend Citation:*

Green, V., Schildtknecht, C., Hall, K. and S. Libes. 2021. Waccamaw Watershed Academy Volunteer Water Quality Monitoring Handbook. Waccamaw Watershed Academy, Coastal Carolina University, Conway, SC.

EDITION 1.0

PRINTED MARCH 2021

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P.O. Box 261954  
Conway, SC 29528-6054  
[coastal.edu](http://coastal.edu)

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# Welcome to the WACCAMAW WATERSHED ACADEMY



This handbook is a resource for the Waccamaw Watershed Academy's Volunteer Water Quality Monitoring Programs to guide collection of water quality data in the rivers, streams, ponds, and inlets located in the coastal counties of northeastern South Carolina.

The data are used by local municipalities to meet various needs, such as compliance with local stormwater management programs as required by the federal Clean Water Act. The City of Conway, Town of Surfside Beach, and Horry and Georgetown Counties work closely with the volunteer monitoring programs to make use of the diverse benefits provided by the data. These municipalities also provide financial support to ensure long-term continuity, which is essential to successful water quality monitoring programs.

The data are also used by nongovernmental organizations, such as Murrells Inlet 2020 and the Waccamaw RIVERKEEPER™, to meet their organizational goals. These groups provide important support activities including volunteer recruitment. Another important partnership is provided through the Coastal Waccamaw Stormwater Education Consortium which coordinates public outreach and public involvement activities to help local municipalities reduce polluted stormwater runoff.

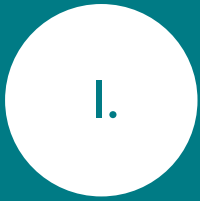
Of all the partnerships that make the volunteer monitoring program successful, the most important comes from the long-term commitment of time and careful work provided by our volunteer water quality monitors.

Thank you for your good fellowship and dedication to this program.

Sincerely,

**Susan Libes**

*Founding Director of the Waccamaw Watershed Academy*



# Overview

What is Citizen Science?

Why Volunteer Water Quality Monitoring?

Waccamaw Watershed Academy

Where We Monitor

What Happens to the Data?

Volunteer Roles

Volunteer Code of Conduct





## What is Citizen Science?

The National Geographic Society defines citizen science as “the practice of public participation and collaboration in scientific research to increase scientific knowledge. Through citizen science, people share and contribute to data monitoring and collection programs.”

Citizen science programs around the world have improved the understanding of complex natural processes and ecological responses to a changing climate. Examples of citizen science projects include backyard bird counts, rain gauge monitoring, and water quality monitoring.

The U.S. Environmental Protection Agency (EPA) has been promoting volunteer monitoring since the 1970s because it provides numerous benefits to policy makers and communities. Volunteers collect data that many state agencies are too underfunded to obtain on their own. Due to the special connection volunteers have with their monitoring sites, they provide unique insights that enhance interpretation of the data. Additionally, citizen science engages the community and promotes environmental awareness and responsibility.



# Why Volunteer Water Quality Monitoring?

Starting in 2006, the federal Clean Water Act expanded its National Pollution Discharge Elimination System (NPDES) to require that even relatively small municipalities reduce polluted stormwater runoff by developing and implementing local stormwater management plans.

In South Carolina, compliance activities are implemented by local municipalities referred to as small Municipal Separate Storm Sewer Systems (MS4s). Horry and Georgetown counties collectively contain eight regulated MS4s – each with a stormwater program approved by the South Carolina Department of Health and Environmental Control (SC DHEC).

Two of their priority requirements are public outreach and involvement. The volunteer monitoring programs support both and provide additional data that addresses other permit requirements including the effectiveness of construction nonpoint pollution controls and illicit discharge detection. Hence, many local MS4s initiated volunteer water quality monitoring as a vital component of their stormwater management programs, with the earliest dating back to 2006.

The MS4s in Horry and Georgetown counties collaborate on many parts of their stormwater programs, including volunteer monitoring, to best address the movement of pollutants across jurisdictional boundaries. This is termed “the watershed approach” and was formally recommended in 1997 by the EPA as a best management practice for identifying and controlling sources of waterborne pollution. The volunteer monitoring programs covered in this handbook are conducted within the Waccamaw River and Coastal watersheds as illustrated in Figure 1.

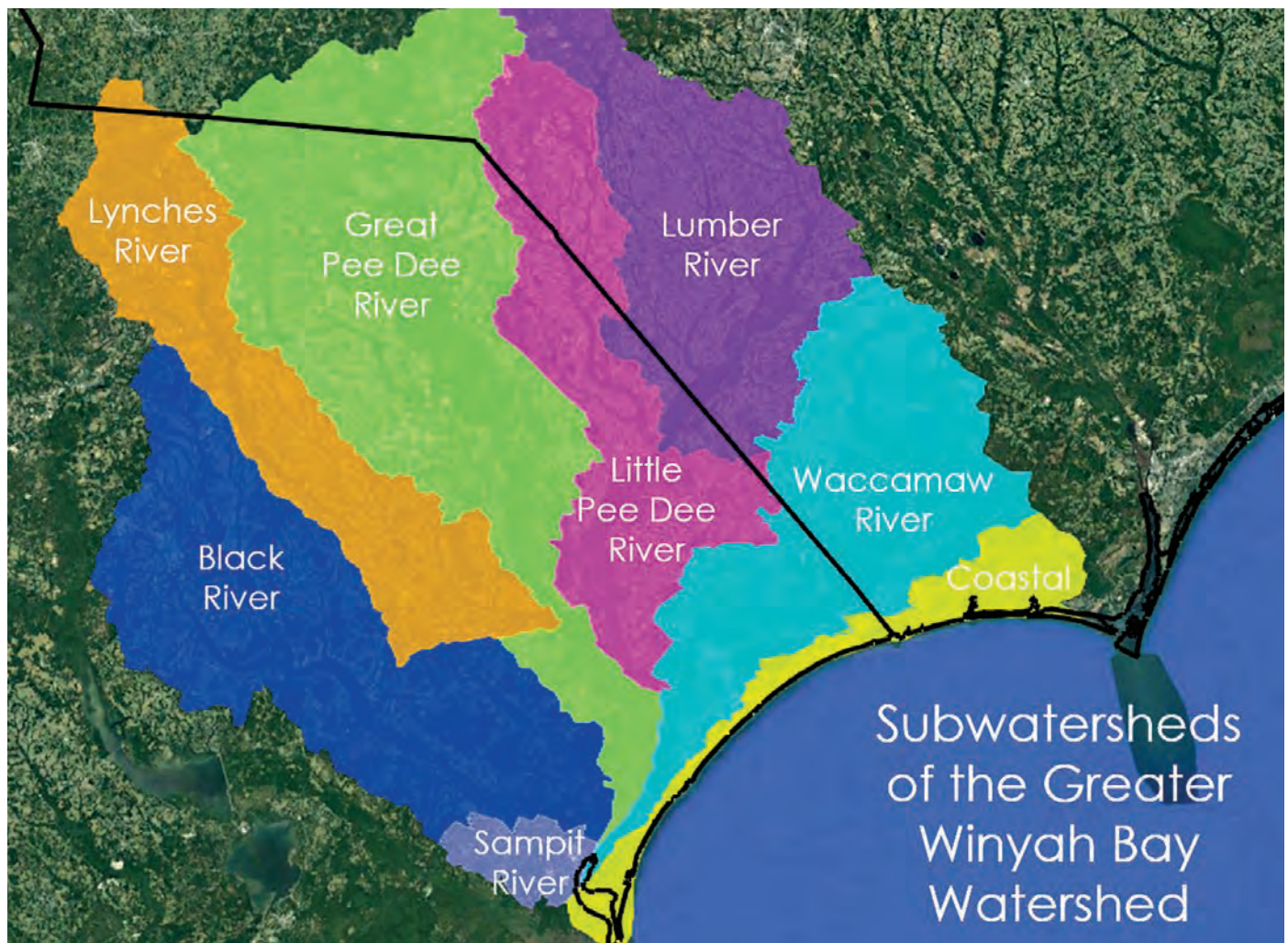


Figure 1: Subwatersheds of the Greater Winyah Bay Watershed. Map courtesy of Cara Schildtknecht.

# Waccamaw Watershed Academy

The Waccamaw Watershed Academy (WWA) was established in 2004 under the aegis of Coastal Carolina University's Burroughs and Chapin Center for Marine and Wetland Studies to deliver educational, research, and public outreach services to the University and the local region. The WWA's Volunteer Water Monitoring Programs help local municipalities satisfy their stormwater permit requirements under the Clean Water Act for public involvement as well as for public education and outreach.



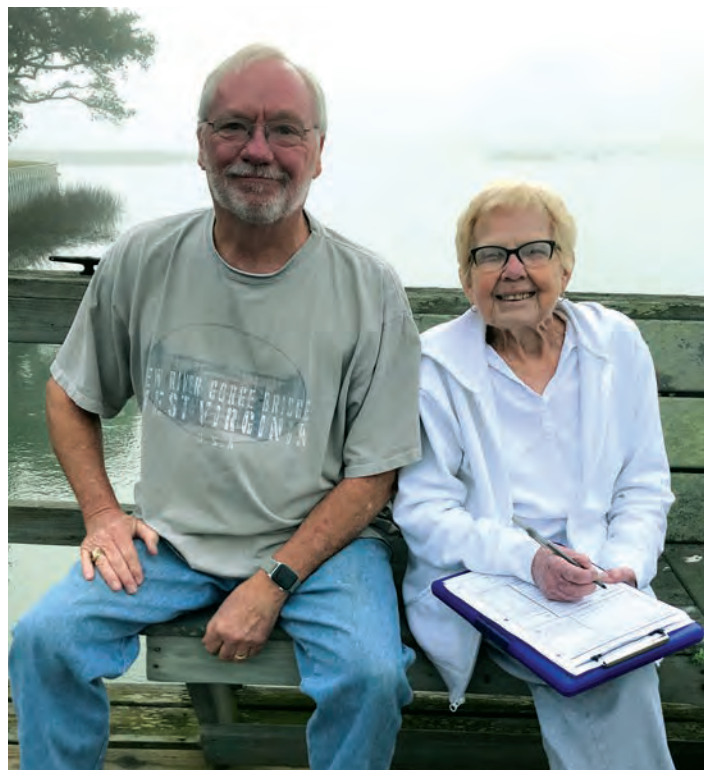
## The data collected by volunteer monitors:

- Assists local municipalities in identifying pollution "hot spots" and detecting illicit discharges.
- Increases geographic and temporal coverage of water quality monitoring in the region beyond what is covered by other entities, including regulatory work conducted by SC DHEC and CCU's Environmental Quality Lab.
- The additional data help detect trends over time, including improvements from implementation of stormwater management activities.



## The WWA's Volunteer Operations and Logistics Team (VOLT) provides technical support for the volunteer monitoring programs that includes:

- Initial and continuing volunteer training and proficiency tests.
- Quality Assurance Project Plan that guides data collection and data use.
- Monitoring equipment and kits that are resupplied quarterly.
- On call equipment support and replacement.
- Quality control and validation of all data.
- Online data entry portal and long-term data archiving of electronic and paper records.
- Project website with online interactive data delivery and data download.
- Annual data conference for the community and annual appreciation luncheon for volunteers.
- Presentations to the MS4's stormwater advisory boards, committees, and commissions.
- Rapid response reports to the MS4's stormwater managers to facilitate illicit discharge detection.





The following organizations are important partners in the volunteer monitoring programs:



Winyah Rivers Alliance provides a field coordinator, the Waccamaw Riverkeeper for the Waccamaw River's Volunteer Monitoring Program.



Murrells Inlet 2020 provides a field leader and outreach support for the Murrells Inlet Volunteer Monitoring Program.

Funding and technical assistance to support the volunteer monitoring programs is provided by the following partners:

Funding Partners



INTERNATIONAL



Community Partners



# Where We Monitor



## WACCAMAW RIVER

The volunteer monitoring program on the Waccamaw River was established in 2006 with six teams monitoring 12 sites biweekly along the Waccamaw River in South Carolina. In 2011, the program was extended to three additional teams sampling six sites in North Carolina along the river and in Lake Waccamaw. Today, there are nine teams sampling 18 sites, spanning four counties in two states from Lake Waccamaw in North Carolina to Winyah Bay in South Carolina.

In the Waccamaw River, water quality concerns include low oxygen levels and occasional contamination by fecal bacteria and sediment. The oxygen concern has led to the implementation of a Total Maximum Daily Load (TMDL) for the river downstream of Conway. The implementation activities include permitted discharges of treated effluent from publicly owned treatment works and reduction of nonpoint source pollution through the small MS4's stormwater management plans. An important question being answered through monitoring the Waccamaw River is whether oxygen levels are being adequately controlled. Additionally, turbidity monitoring evaluates whether sediment and erosion control management through construction and post-concentration permits are adequate. Occasional contamination in fecal bacteria is associated with stormwater runoff with controls to be implemented through the MS4's stormwater management programs.

This volunteer-based program is administered by Coastal Carolina University's Waccamaw Watershed Academy and the Waccamaw RIVERKEEPER® Program of the Winyah Rivers Alliance. The latter is a 501(c)(3) nonprofit organization that monitors, advocates, and protects the Waccamaw River and the greater Winyah Bay Watershed. Funding partners for the program on the South Carolina portion of the Waccamaw River include: U.S. Environmental Protection Agency (through a four-year Wetlands Program Development Grant, 2005-2009); the City of Conway, and Horry and Georgetown Counties. In North Carolina, the program is funded by grants from International Paper, Z. Smith Reynolds Foundation, Friends of Lake Waccamaw State Park, and Columbus County with volunteer support from Lake Waccamaw State Park and Southeastern Community College.



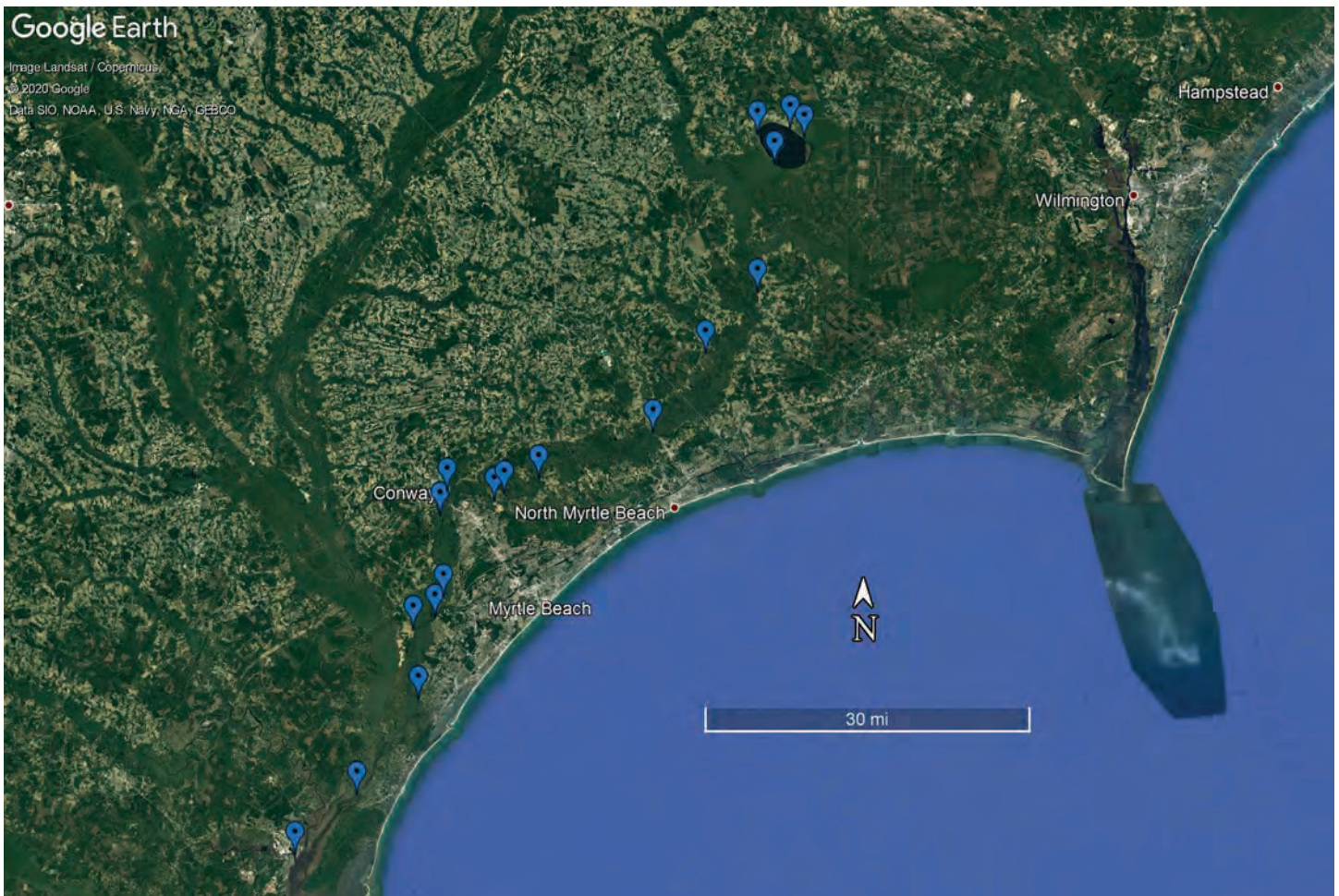


Figure 2: Monitoring sites along Lake Waccamaw (NC) and the Waccamaw River (SC)

## MURRELLS INLET

Since June 2008, four teams of volunteers have been measuring water quality biweekly year-round at eight sites in the Murrells Inlet watershed. This watershed straddles Horry and Georgetown counties that jointly support the volunteer monitoring program.

Two sampling sites are located in the Inlet, two sites are in retention ponds, and four sites are located in small streams that drain into the inlet. The upland sites were selected to characterize pollutants in stormwater runoff that enters Murrells Inlet. The major focus is on fecal bacteria contamination which has caused closures of the public shellfish beds in Murrells Inlet.

In 2014, the volunteer data were used to help develop a watershed-based plan that has been approved by SC DHEC. It contains recommendations for mitigation of fecal bacteria pollution. Since approval of the plan, the counties have been awarded grants from SC DHEC for pilot trials of stormwater treatment practices that could, at scale, reduce the land-based source of fecal contamination to the inlet waters. If successful, this should lead to reopening of the shellfish beds.

The volunteer data are also used to detect potential illicit discharges of sediment through measurements of turbidity. Trends in nutrients and oxygen are used to evaluate concerns of cultural eutrophication in which stormwater runoff of fertilizers can lead to algal blooms, followed by oxygen deficits.





### SURFSIDE BEACH

The primary concern in the town of Surfside Beach is fecal bacteria contamination in its coastal waters that could affect recreational safety. SC DHEC monitors the coastal saltwaters at several locations from May to October for the fecal bacteria indicator, *Enterococcus*, and has identified a few sites that are impaired due to relatively frequent exceedances of health-based water quality criteria. To identify land-based sources of these fecal bacteria, the volunteers have been sampling biweekly, year-round, since 2010 at two sites. These sites are located in retention ponds that discharge into the ocean through channelized tidal creeks. The volunteer data are also used to detect potential illicit discharges of sediment through measurements of turbidity. Trends in nutrients and oxygen are used to evaluate concerns of cultural eutrophication in which stormwater runoff of fertilizers can lead to algal blooms, followed by oxygen deficits.

The volunteers work closely with the town's Stormwater Committee to review water quality results and discuss management strategies in collaboration with Surfside Beach's director of public works.



### BRIARCLIFFE ACRES

The primary concern for the town of Briarcliffe Acres' is similar to Surfside's - frequent contamination of their recreational coastal saltwaters with the fecal indicator bacteria, *Enterococcus*. Horry County Stormwater has been working with the town to determine the source of the contamination and to facilitate a remedy. A watershed-based investigation conducted from 2009 to 2010 identified a human source. Since the community was relying on septic tanks, an effort was made in 2017 to reduce this source by installing a sewer line for the oceanfront homes. Volunteers are now investigating whether this sewer line has reduced fecal contamination in the tidal creek that discharges into the coastal ocean. To provide answers, sampling is conducted at three sites in the tidal creek biweekly, year-round. The volunteers collect data at one of these sites and CCU's Environmental Quality Lab (EQL) performs regulatory level measurements of *Enterococcus* at all three sites.

An additional two sites located in retention ponds that have the potential to discharge into the tidal creek, are also monitored. The major concern in these lakes is cultural eutrophication in which fertilizer runoff can lead to overgrowth of algae, followed by oxygen deficits. This is monitored via nutrient and oxygen measurements. The volunteer data are also used to detect potential illicit discharges of sediment through measurements of turbidity.

This program is supported by Horry County Stormwater with the town of Briarcliffe covering the costs of the regulatory level measurements performed by the EQL. The volunteers work closely with the town's Stormwater Committee to review water quality results and discuss management strategies in collaboration with the town council and Horry County.



## What Happens to the Data?

A member of the volunteer team uploads the data to an online data entry portal and then mails in all the paper records to the Volunteer Operations and Logistics Team at CCU. The data and datasheets are reviewed by the VOLT to verify that quality control procedures were successful. Any data that contravene regulatory water quality criteria to an unusual degree are emailed to local stormwater managers as evidence of a potential illicit discharge that might need immediate investigation.

After data validation, the data are assembled into a spreadsheet report and a sampling summary is drafted. This technical report is emailed within 10 to 14 days of sampling to the stormwater managers and partner organizations for internal use. The data are also uploaded to a database that can be accessed through a public web application. The application can be used to create custom graphs of the data (Figure 3).

Please visit [www.coastal.edu/wwa](http://www.coastal.edu/wwa) to view the data portal.

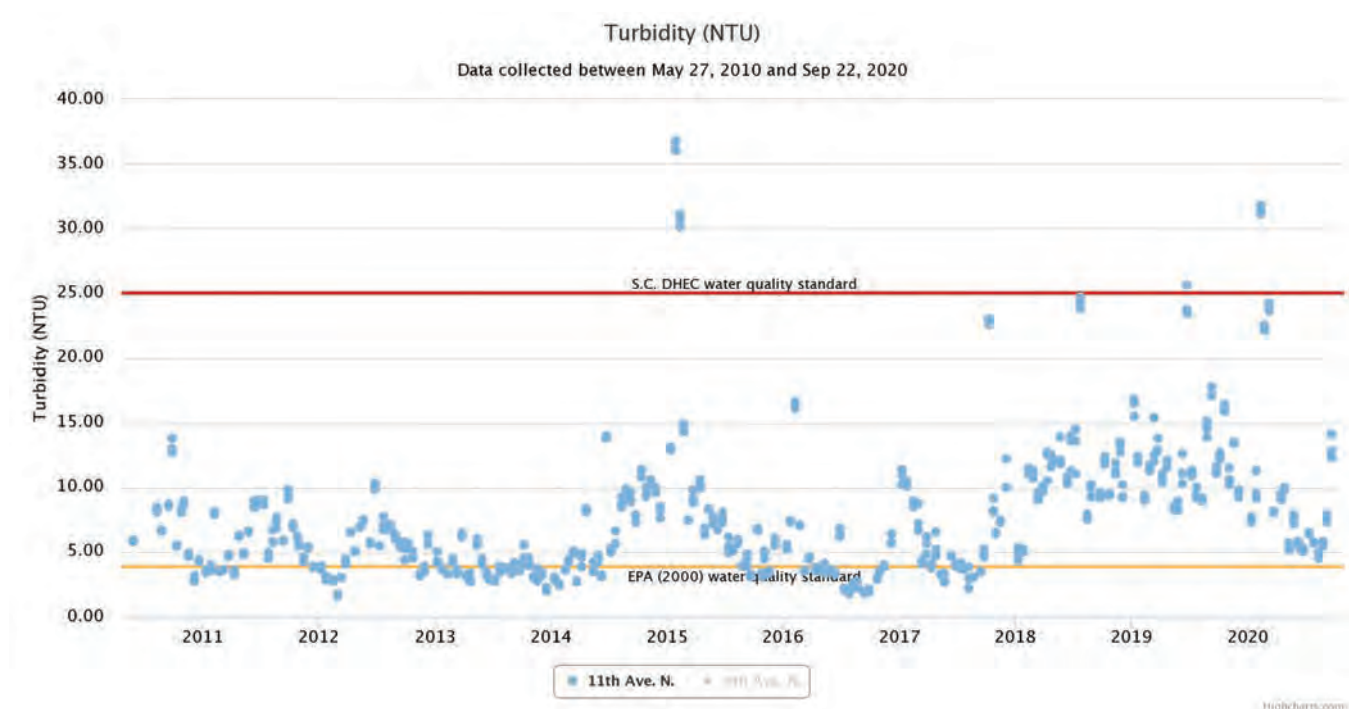


Figure 3: Example graph that can be produced using the online data portal.

# Volunteer Roles

Volunteers work as a team to fulfill all the activities required to collect representative and accurate data. Within each team, activities are covered collaboratively. The activities of individual volunteers depend on their training and interests. With training, volunteers can fill multiple roles (Table 1).

Table 1: Volunteer monitoring roles available with the WWA. Contact the VOLT for more information.

VOLUNTEER ROLE	REQUIRED TRAINING	DUTIES
Field Sampler	Interested volunteers should contact the VOLT for a preliminary conversation about the program and to arrange an opportunity to shadow veteran volunteers during a sampling event. Afterwards, the interested volunteer will attend one laboratory and one field training session to become an official Field Sampler.	Help other monitors with sampling procedures including sample collection, use of multimeter and nutrients strips, and recording of data on field datasheets.  Help maintain safety of all participants.
Master Sampler	Complete all training for Field Sampler AND attend meter calibration training.	Prepare equipment for sampling events including meter calibration and field checks.
Bacteria Analyst	Complete all training for Field Sampler AND attend bacteria analysis training.	Conduct multi-step bacteria analysis over two days in a clean setting.
Turbidity Analyst	Complete all training for Field Sampler AND attend turbidity analysis training.	Conduct turbidity analysis of samples using portable turbidimeter.
Online Data Entry	Complete all training for Field Sampler AND attend online data entry training.	Input data into the online data entry portal in a timely manner for the VOLT to review and approve and mail all datasheets to the VOLT.

# Volunteer Code of Conduct

For the safety of all our volunteers, volunteers with the Waccamaw Watershed Academy must agree to adhere to the following code of conduct.

As a Waccamaw Watershed Academy Volunteer, you agree to:

- Always put your safety and the safety of your fellow samplers as your top priority.
- Follow all emergency guidelines. Take direction from your team leader to follow inclement weather or hazardous conditions decisions that determine whether sampling will be canceled or delayed due to unsafe conditions.
- Commit to collecting and reporting data honestly, following instructions provided in your training and this handbook. Speak civilly to your fellow volunteers and the coordinators.
- Work cooperatively with your team.
- Report any inappropriate conduct to the VOLT.
- Represent your Volunteer Water Quality Monitoring Program to others in a competent, reliable, and respectful manner.



## II.

# Sampling Handbook

Sampling Equipment and Supplies

Sampling Event Overview

Field Sampling Overview

Sampling Information and Site Observations

Determining Water Flow

General Meter Care

Field Checks

Water Collection Protocol

Probe Equilibration

Nutrient Strips

Turbidity and Bacteria Sample Water Collection

Meter Measurements

Final Steps

Data Entry to Online Database



# Sampling Equipment and Supplies

Table 2: Current sampling equipment and supplies used for monitoring.

FIELD BIN	SOLUTIONS	BACTERIA	TURBIDITY
<p><b>Orion Star A329 Meter</b></p> <ul style="list-style-type: none"> <li>pH probe</li> <li>DO probe</li> <li>Conductivity probe</li> </ul> <p><b>Hach Nutrient Strips</b></p> <ul style="list-style-type: none"> <li>Ammonia with vials</li> <li>Nitrate Nitrite</li> </ul> <p><b>Miscellaneous</b></p> <ul style="list-style-type: none"> <li>Sampling pole apparatus</li> <li>Permanent Marker</li> <li>Kimwipes</li> <li>Extra battery kit</li> <li>DI water squirt bottle</li> </ul>	<p><b>pH</b></p> <ul style="list-style-type: none"> <li>pH 4.00 calibration standard</li> <li>pH 7.00 calibration standard</li> <li>pH 6.00 calibration check standard</li> <li>Electrode storage solution</li> </ul> <p><b>Conductivity</b></p> <ul style="list-style-type: none"> <li>Calibration standard</li> <li>Calibration check standard</li> </ul>	<ul style="list-style-type: none"> <li>Sterile 30 mL sample bottle</li> <li>Sterile 3 mL (or 1 mL) pipette</li> <li>Coliscan EasyGel media bottle</li> <li>Coliscan EasyGel plate</li> <li>Bleach</li> <li>Bleach wipes</li> <li>Gloves</li> <li>Incubator</li> <li>NIST thermometer</li> <li>UV black light</li> </ul>	<ul style="list-style-type: none"> <li>Hach 2100Q turbidimeter</li> <li>Versa soap</li> <li>Glass vials with lids</li> <li>Silicone oil</li> <li>500 mL sample bottles</li> </ul>

We are always seeking to improve our sampling methods, so equipment and supplies may change at any time.



Figure 4: Field bin with gloves, Kimwipes, DI water squirt bottle, and Orion Star A329 meter.

# Sampling Event Overview

Sampling is usually conducted twice a month. The typical sequence of activities is illustrated in Figure 5.

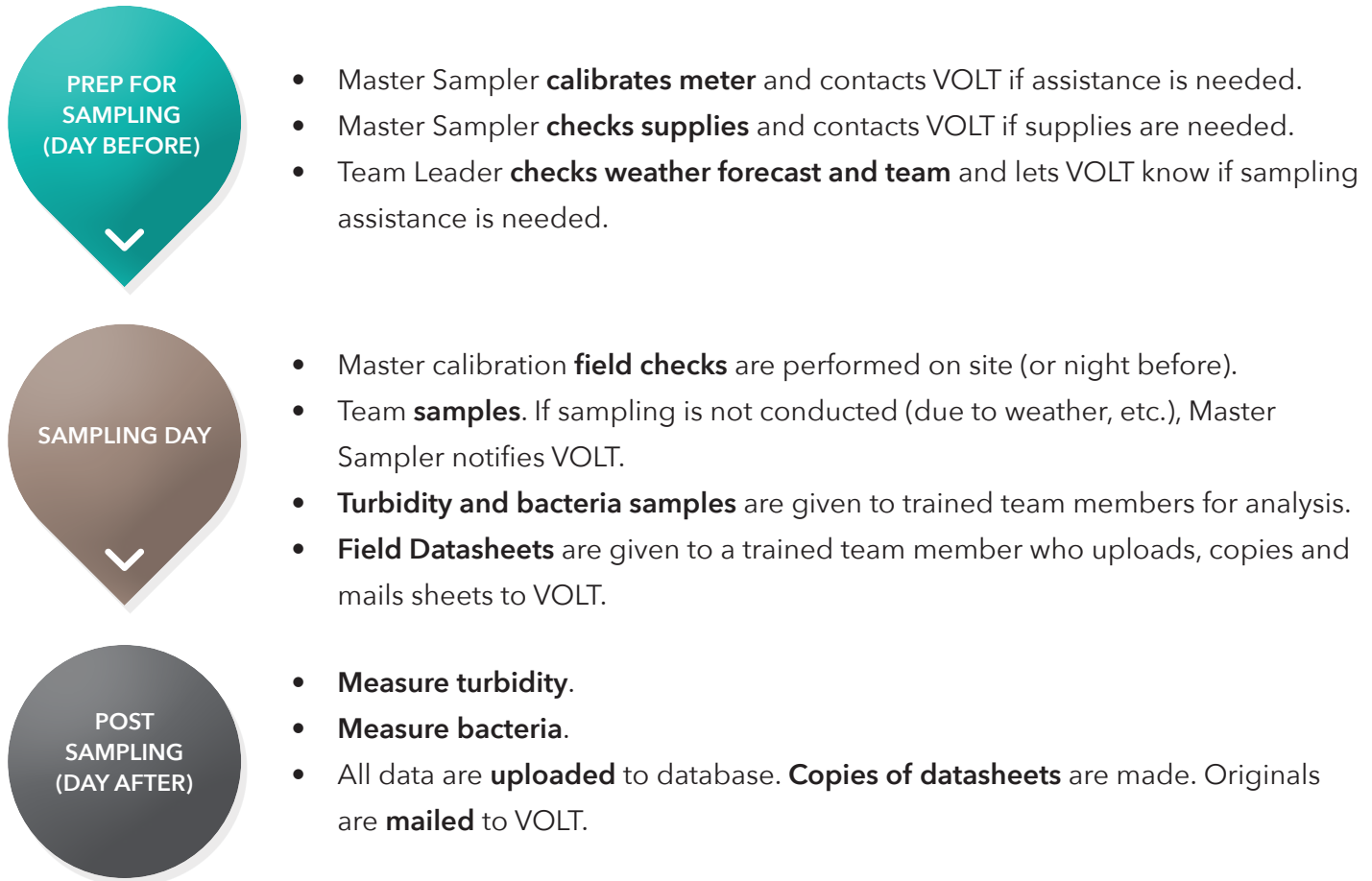


Figure 5: Overview of sampling event activities.

Please let your team leader or the VOLT know if you are unable to perform your usual role. Team leaders should let the VOLT know if they need additional supplies or encounter equipment problems.



Figure 6: A typical sampling day in Surfside Beach (left), on the Waccamaw River (center), and in Murrells Inlet (right).

# Field Sampling Overview

On the sampling day, the Master Sampler is typically responsible for bringing all the sampling supplies and calibrated equipment to the field site. The team then follows the procedure outlined in Figure 7 to make field measurements and collect water samples for off-site measurement of turbidity and bacteria. Details for each step are provided in the following subsections.

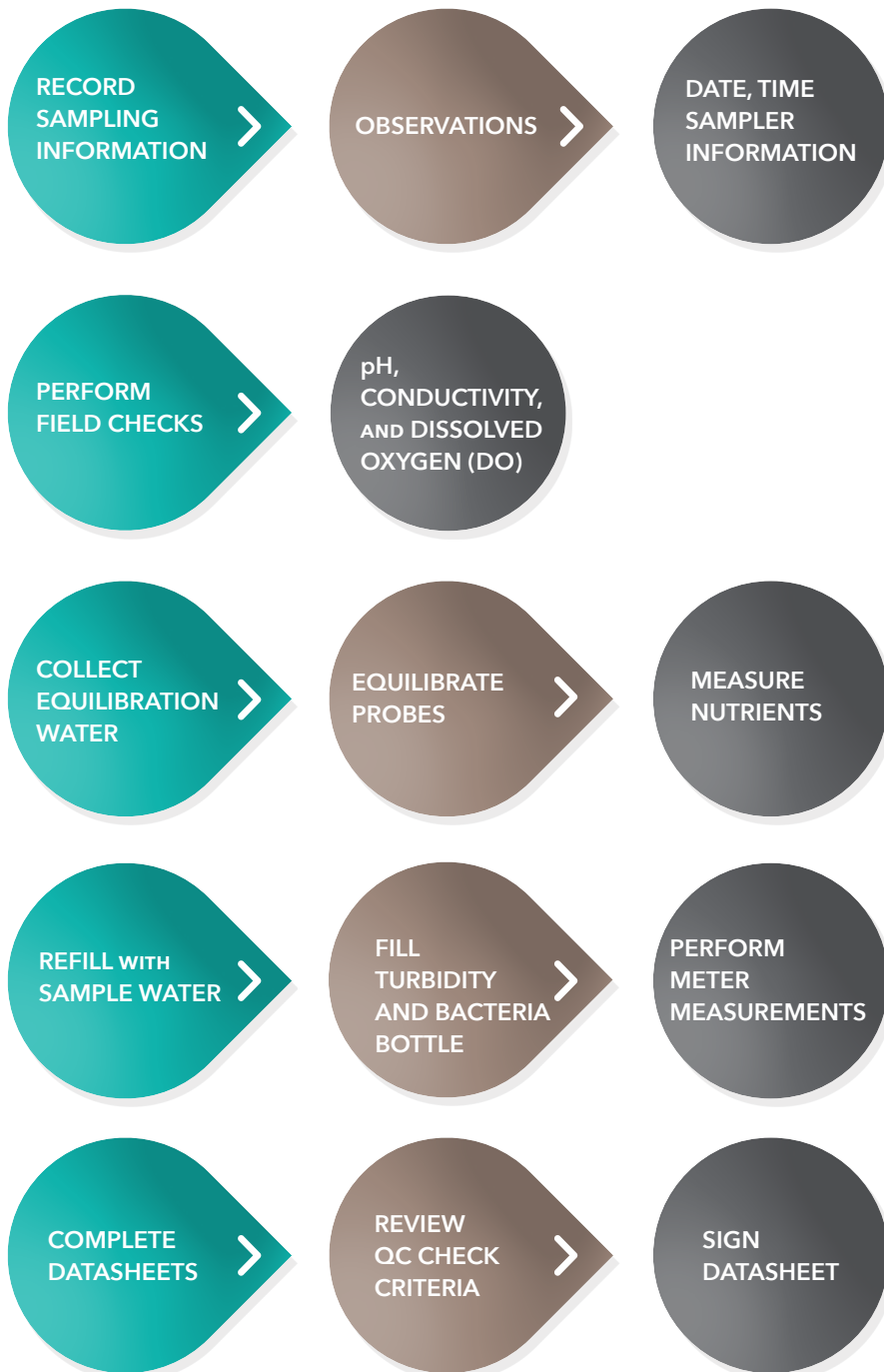


Figure 7: Overview of activities performed on the day of sampling.

# Sampling Information and Site Observations

If you do not feel safe, do not sample.

- When you first arrive at your site, always **look around** for safety hazards such as: dangerous weather conditions, traffic hazards, suspicious persons, wildlife, hazardous waste, etc.
- **Record** the Site, Date, Team, Start Time, and Field Samplers on the Field Datasheet.

WWA Volunteer Water Quality Monitoring Program		Circle One: BA   MI   SB   WR	
<b>Field Datasheet</b> Orion Star A329 Meter			
<b>Site:</b>		<b>Date:</b>	
<b>Team:</b>		<b>Start Time:</b>	
<b>Field Samplers:</b>			

- **Record** site observations to the best of your ability. **Record** observations for Air Temp, Sun, Date of Last Rain and Amount, Water Flow, Water Odor, Water Surface, and Other Observations.
  - o If the date of last rain is unknown, write "N."
  - o This section is used by the VOLT to help interpret your data.
- **Record** any other observations in the box provided. Be on the lookout for things that may contribute to unusual readings including: trash, oil or other surface contaminant, wildlife, etc.
- If ever you observe something unusual, **take a picture!** Share your photo with the VOLT.

Site Observations	<b>Air Temp (°F):</b>	<input type="checkbox"/> Cold (<40)	<input type="checkbox"/> Cool (41-60)	<input type="checkbox"/> Mild (61-80)	<input type="checkbox"/> Hot (80+)
	<b>Sun:</b>	<input type="checkbox"/> Bright Sunny	<input type="checkbox"/> Partially Cloudy	<input type="checkbox"/> Thick Clouds	
	<b>Date of Last Rain:</b>	<b>Amount:</b>		<input type="checkbox"/> Heavy	<input type="checkbox"/> Moderate <input type="checkbox"/> Low
	<b>Water Flow:</b>	<input type="checkbox"/> Down Gradient	<input type="checkbox"/> Up Gradient	<input type="checkbox"/> Slack Tide/ No Flow	
	<b>Water Odor:</b>	<input type="checkbox"/> None	<input type="checkbox"/> Natural	<input type="checkbox"/> Sewage	<input type="checkbox"/> Fishy <input type="checkbox"/> Other:
	<b>Water Surface:</b>	<input type="checkbox"/> Clear	<input type="checkbox"/> Oily	<input type="checkbox"/> Algae	<input type="checkbox"/> Foam <input type="checkbox"/> Other:
	<b>Other Observations:</b> <i>wildlife, security concerns, changes from last sampling</i>				



Figure 8: Bob S. shared photos of unusually high water at his site in November 2019 (left). Victoria G. snapped a picture of flooding at Wachesa Landing (center). Kelly H. documented flooding at Pitch Landing (right).

# Determining Water Flow

- Flow is the movement of a body of water in one direction. This can be obscured by wave action or surface movement caused by wind or disturbances.
- Flow can be determined by watching the motion of bubbles, sticks, or leaves, floating on the surface of the water for a minute or so and determining what direction they are moving.
- The field datasheet provides three options for describing water flow direction at your sampling site: **Down Gradient**, **Up Gradient**, or **Slack Tide/No Flow**. Determining flow is dependent on where your site is located.

---

## FOR SITES LOCATED IN A POND OR LAKE

- If water is leaving the pond, i.e. flowing towards the outlet, check the box for **Down Gradient**.
- If there is no discernible flow, check the box for **Slack Tide/No Flow**.
- In the unlikely event that water is flowing in the opposite direction from **Down Gradient**, check the box for **Up Gradient**. This might occur if winds are strong enough to push the water or if something unusual, like an illicit discharge, is occurring.

---

## FOR SITES LOCATED IN A STREAM OR RIVER

Water flow is generally downstream unless your site is subject to tidal currents. Tidal currents do not necessarily bring saltwater to your sampling site. For example, the Waccamaw River is tidal for about 140 miles upstream of the Atlantic Ocean whereas saltwater never reaches more than 10 miles upstream.

- If water is moving downstream, flows are considered to be **Down Gradient**.
- If water is moving upstream, flows are considered to be **Up Gradient**. This can happen at tidal sites especially when river discharge is low, such as during a drought. It can also happen from backwater effects. For example, when the Pee Dee River discharge is high, it can cause water to back up into the Waccamaw River.
- If water is not moving up or down stream, check the box for **Slack Tide/ No Flow**. This can be discerned by watching movement of floating debris, such as leaves or insects.

---

## FOR SITES LOCATED IN TIDAL SALTWATERS

Water flow will generally follow the tides unless overwhelmed by runoff from extreme rainfall, such as after hurricanes. Predictions of the timing of high and low tide on sampling day is available at NOAA's website. Your observations may differ from these predictions depending on your location, recent rainfall, and other weather conditions.

- Water flows occurring on an outgoing (ebbing) tide are considered to be **Down Gradient**.
- Water flows occurring on an incoming (flooding) tide are considered to be **Up Gradient**.
- **Slack Tide/ No Flow** conditions occur at high and low tides when water is at its highest and lowest levels, respectively.

# General Meter Care

- Protect your meter by not leaving it in a hot car for more than a few minutes and keeping it out of direct sunlight.
- Be careful with the probe cords and connection ports at the top of the meter. Improper handling will damage the probes and meter.
- Give the meter and sensors time to adjust to ambient temperatures at the sampling site. This step is especially important during times of the year when temperatures indoors are quite different from outdoor temperatures.
- If you encounter issues with your meter, try the troubleshooting steps in the Appendix (page 71).



Figure 9: Orion Star A329 Meter.

The Team Leader is responsible for calibrating the meter before sampling (see page 41 for full calibration procedure). Field checks are essential to verifying that the meter is correctly calibrated. If the meter is not calibrated correctly, you cannot collect accurate field data with the meter.

# Field Checks

Field checks must be performed within eight hours prior to sampling. They can be performed at home immediately prior to sampling or at the first sampling site.

- If conducting field checks at the sampling site, allow several minutes for the probes and field check solutions to stabilize to the ambient temperature before performing field checks.
- **Record** the name of the person conducting the field checks and the time on the field datasheet.

Field Calibration Check	Checked by:					Time:			
	pH 6.00			Conductivity 1000 µS/cm			Dissolved Oxygen %		
	Rep	pH	Temp °C	Rep	Cond.	Temp °C	Rep	DO	Temp °C
	1			1			1		
2			2			2			
3			3			3			
(4)			(4)			(4)			
	pH readings within 5.90 to 6.10?		<input type="checkbox"/> Y <input type="checkbox"/> N	Cond. within 950 to 1050 µS/cm?		<input type="checkbox"/> Y <input type="checkbox"/> N	DO% readings within 90% to 110%?		<input type="checkbox"/> Y <input type="checkbox"/> N
	pH drift ≤ 0.10 between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N	Conductivity drift ≤ 1% between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N	DO% drift ≤ 5 between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N
	Temp drift ≤ 0.1 between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N	Temp drift ≤ 0.1 between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N	Temp drift ≤ 0.1 between reps?		<input type="checkbox"/> Y <input type="checkbox"/> N
	Lot #:			Lot #:					

## PREPARE THE PROBES

### Dissolved oxygen (DO) probe

- Check the DO sponge.
  - If adequately moist, **reassemble** the calibration sleeve with the clear cap attached.
  - If not, **rewet** the DO probe sponge with deionized water and squeeze out excess water. Let the DO probe equilibrate in the white calibration sleeve with the clear cap attached for five minutes.

### pH probe

- **Completely unscrew** the pH storage bottle from its cap before taking the probe out of the solution bottle.
  - If you do not remove the cap from the bottle before attempting to remove or insert the probe from the bottle, you can create a vacuum or pressure and damage the probe (see Figure 10).
- **Rinse** the pH probe thoroughly with deionized water to remove pH storage solution.
- **Dry** probe with a Kimwipe.

### Conductivity probe

- **Rinse** the conductivity probe with deionized water.
- **Dry** the probe with a Kimwipe including the interior of the sensor as shown in Figure 11.

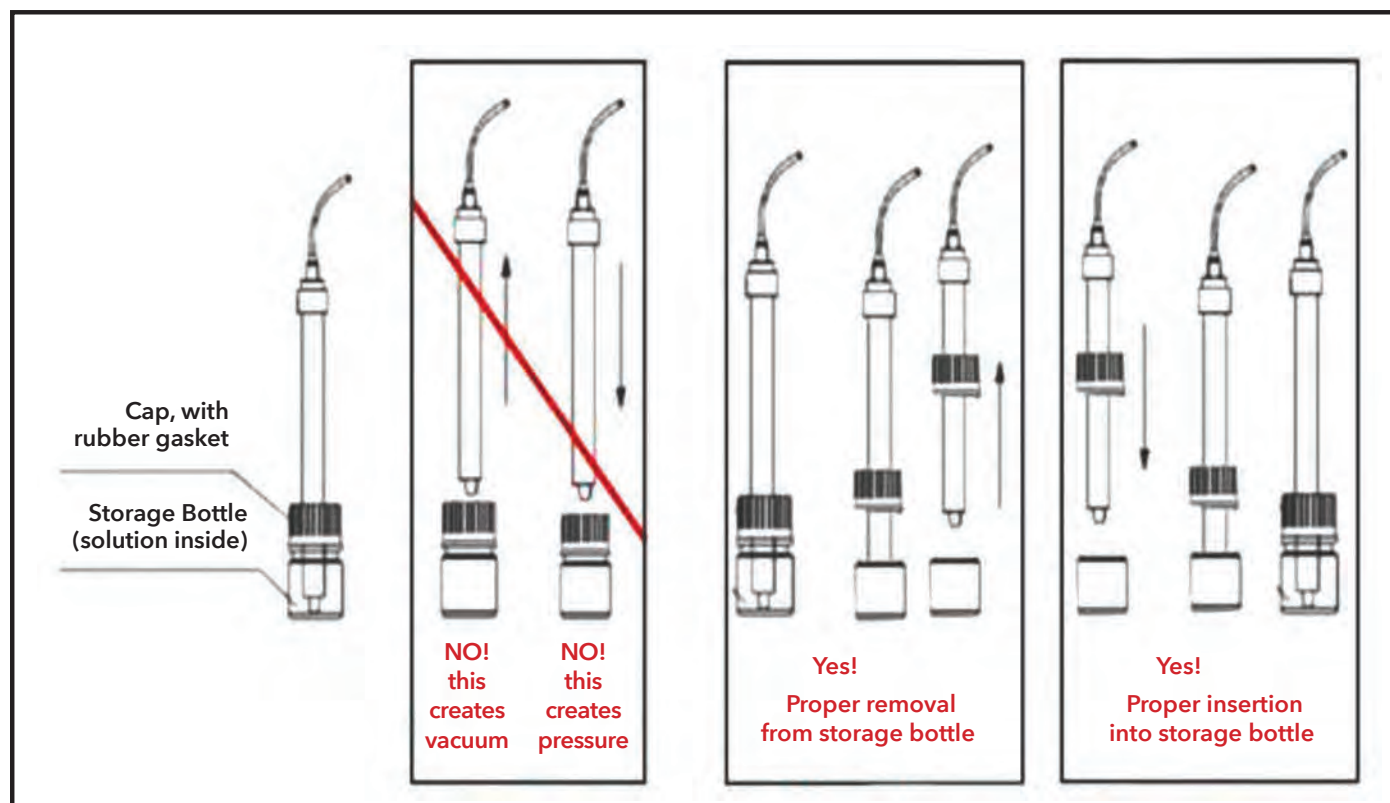


Figure 10: Proper removal of the pH electrode from its storage bottle.



Figure 11: It is important to dry the interior portion of the conductivity probe.

### CONDUCT FIELD CHECKS

- **Fill** appropriate containers with fresh pH and conductivity field check solutions to the line indicated.
  - **Place** pH and conductivity probes in the appropriate field check solution.
  - **Gently stir** the probes for a few seconds to dislodge any bubbles.
  - **Allow** several minutes for the probes and solutions to stabilize to ambient temperatures before performing Field Checks. This helps ensure the drift criteria will be met.
- **Hold** the **POWER** button until the measurement screen appears.
- **Navigate** to the display of all three field check parameters (pH, conductivity, and DO) by pressing the **f3** button.
  - If the correct parameter units are not displayed, press the **f3** button to navigate to the separate parameter screen and press the **MODE** key until correct unit is displayed.
- **Press** the **MEASURE** button. Wait until "Ready AR" stops flashing for ALL probes and **record** the measurement and temperature for each check parameter.
- **Collect** at least three measurements for each parameter.
  - If drift and QC criteria are not met, **collect** a fourth or fifth measurement.
  - In the Field Calibration Check section on the Field Datasheet, you should be able to answer yes for all QC questions.



- **Evaluate** measurements and answer all QC questions.
  - If you answer **“Yes”** to all QC questions, **continue** with sampling procedure.
  - If you answer **“No”** to any QC questions, **see below AND contact** the VOLT for guidance.
- **Remove** conductivity and pH probes from field check solutions.
- **Remove** white plastic sleeve from the DO probe.
- **Rinse** all three probes with DI water.
- **Dry** all probes and continue to Probe Equilibration.

If a parameter fails a field calibration check (you answer “No” for any of the QC questions), try the following:

- Repeat the procedure with fresh check solutions.
- If check continues to fail, recalibrate that parameter if possible.
- If you cannot fix the problem in the field, call the VOLT for assistance. If the problem is with pH or conductivity, the water you collect in your turbidity bottle can be saved for later analysis by the VOLT.

Let the VOLT know what is going on!



Photo by Bob Steffens. A Great Blue Heron catches breakfast at Bob's sampling site.



### **DID THE FIELD CHECKS PASS?**

Field checks are essential to verifying that your data are valid. If a field check fails and you are unable to resolve the issue in the field, you should notify the VOLT as soon as possible.

In order to avoid data loss, you may be asked to try the field check again using fresh solutions after the sampling event. You should also hold onto to your turbidity sample. The VOLT may decide to pick up your meter and turbidity sample for testing at CCU.

# Water Collection Protocol

Use your sampling pole to collect water for your meter, nutrient measurements, and to fill bottles for later turbidity and bacteria analyses. The typical sequence for water collection is shown in Figure 12.

This sequence makes sure that you:

- Make meter measurements on sample water as soon as possible after collection. Pre-equilibrating the sensors prior to measurement is important as it minimizes sensor drift.
- Do not contaminate the sample water used to fill the turbidity and bacteria bottles.
- Minimize the time elapsed between collection for the meter, nutrient, turbidity, and bacteria measurements.
- Minimize the number of times the pole is used to collect water.

Experienced volunteers may have a slightly different order than this, especially if a unique sampling pole is needed or if they are able to put the meter sensors directly into the waterbody at their sampling site. If your water collection procedure deviates from the sequence described here, please discuss with the VOLT to ensure consistency at your site. Record any deviations from your regular sample collection procedure in the notes section of your datasheet.

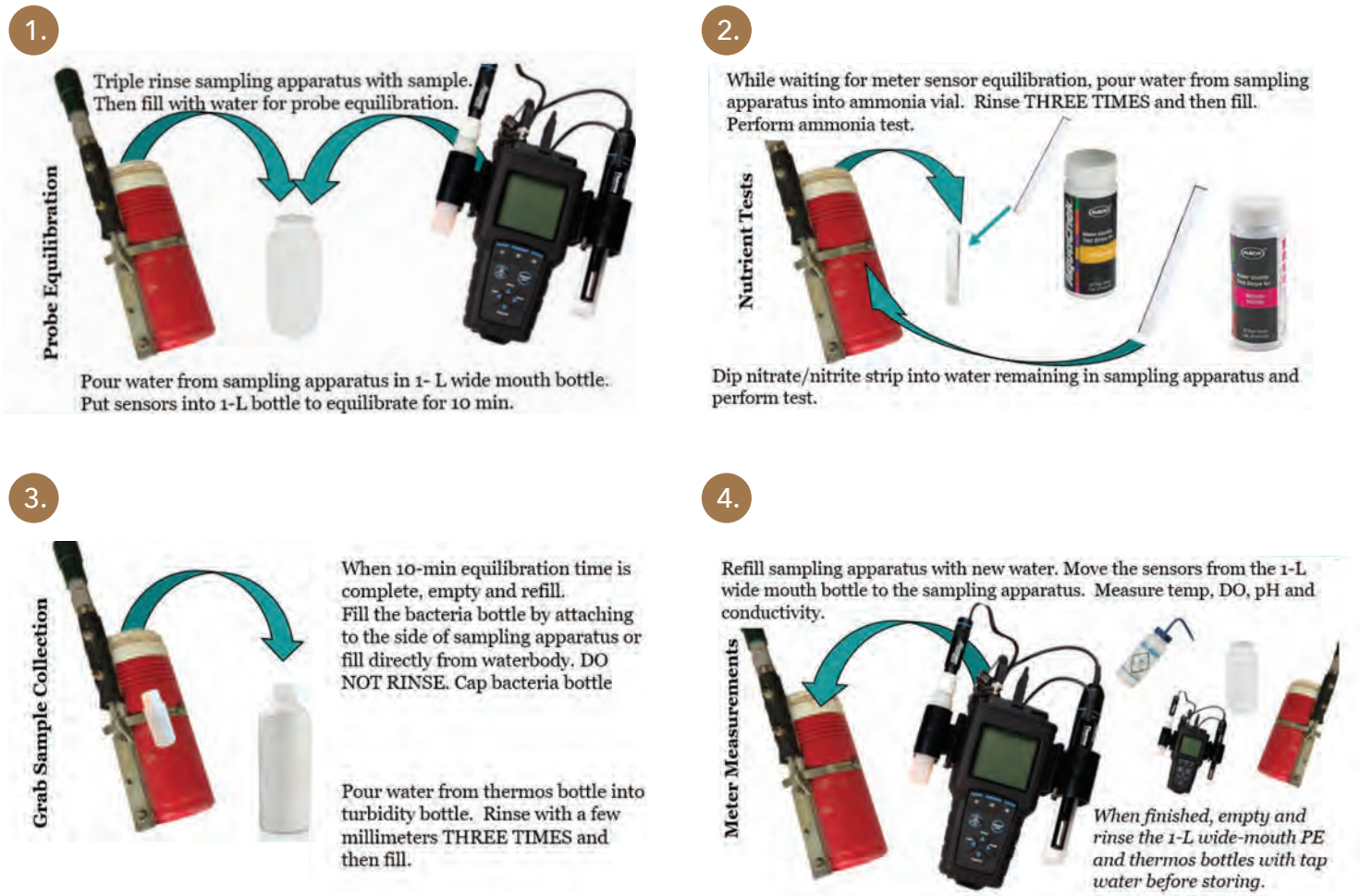


Figure 12: Recommended sampling order: equilibrate probes, conduct nutrient tests, collect grab samples, and conduct meter measurements.



### COLLECT WATER FOR EQUILIBRATION

- **Check** that the wide-mouth insulated container attached to the sampling pole is clean.
- **Rinse** the sampling pole apparatus with sample water three times.
  - **Dip** the pole into the water just downstream of your sampling location.
  - **Fill** the attached insulated container.
  - **Pour** out water slightly downstream or on the ground.
  - **Repeat** two more times.
- **Fill** the insulated container completely.
  - You will need to refill the container with fresh sample water once more after the probes are equilibrated and just before you make your meter measurements.

Avoiding outside contaminants is important during sample collection. Take the following into consideration when collecting your sample and rinsing your sampling apparatus:

- Make sure the opening of the container is 4 to 18 inches below the surface to avoid collecting surface contaminants.
- Do not disturb bottom sediments while filling the sampling apparatus or sample bottles as this will increase your turbidity values.
- Rinse downstream of the sampling site to prevent unnecessary disturbance.

# Probe Equilibration

Probe equilibration is a very important step in the sampling process because it reduces the amount of drift and hence time required to make measurements. Sample water is used to equilibrate the meter's probes and takes about five minutes, during which you can work on other field sampling tasks. After approximately five minutes, the equilibration water is dumped out and fresh sample water is collected before recording meter parameters on the field datasheet. This will make your final sensor measurements less prone to drift and hence more accurate.

- **Fill** the 1L wide-mouth plastic bottle about two-thirds full using the water you collected in the sampling pole apparatus.
  - You can also equilibrate the probes by sticking them directly into the water body, if you normally make your measurements in the water body.
- **Submerge** the probes.
  - Take caution not to submerge the pH probe above the blue line.
- **Wait** at least five minutes for the sensors to equilibrate.
- **Press** the **MEASURE** button to activate the meter. Continue monitoring the parameter values until they appear to stabilize around consistent values.
- **Leave** the probes in the equilibration water until you are ready to transfer them into fresh sampling water collected in the sampling apparatus.

While the probes are equilibrating to the sample water temperature, perform the nutrient measurements.



# Nutrient Strips

The test strips enable a quick estimate of nutrient nitrogen concentrations in the field. In order to get the most accurate results, follow the instructions exactly as written on the side of the bottle. Take care not to introduce moisture to the strips or bottle and cap the bottle tightly after use.

## PERFORM AMMONIA TEST

- **Rinse** the plastic vial located in the Ammonia kit with sample water three times.
  - Pour water directly from the sampling apparatus or turbidity sample bottle.
- **Fill** the plastic sample vial to the top line with sample water.
  - The top line is located about three-quarters of the way full or 2 cm from the rim.
- With dry and clean hands, **remove** a strip from the test strip bottle.
- **Conduct** a zero check by comparing the pad to the color chart.
  - If color reads as zero concentration, **record** a zero in the appropriate Pre-Sample (Zero Check) box on the Field Datasheet.
  - If color does NOT read zero, **do not use the strip** and contact the VOLT.
- **Dip** the strip into the water sample vial. Vigorously move the strip up and down in the water sample for 30 seconds, making sure both pads are always submerged.
- **Remove** the test strip and **shake off** excess water.
- **Hold** the test strip level with pad side up, for 30 seconds.
- To read the result, **turn the test strip over** so that both pads are facing away from you.
- **Compare** the color of the **small pad** to the color chart. Read the result through the clear plastic on the test strip (with the pad facing the bottle).
- **Record** result on the field datasheet as the sample reading.
- **Rinse** the sample vial three times with DI water.
  - **Shake** the water out of the vial before putting it back in the cardboard box.
- **Check** that the test strip bottle is tightly capped and store the bottle in the box.

### AMMONIA TIPS

- For the Ammonia strips, it's important to always use the sample vial.
  - The Ammonia strips have a chemical on the larger white pad that increases the pH of the sample to above 10. In order for the strip to effectively raise the pH, the test must be conducted in the sample not the sampling apparatus.
  - Try to fill the vial to the line. However, a little bit above or below is OK.
- It's important to vigorously move the strip up and down so that the chemical in the larger pad is properly dispersed.
  - It is OK if the larger (reagent) pad falls off the plastic strip.
- Read the Ammonia strips **THROUGH** the clear plastic at exactly 30 seconds.
  - The pad side of the strips dry out quickly, so it is important to flip the pad side down and read the color **THROUGH** the clear plastic.

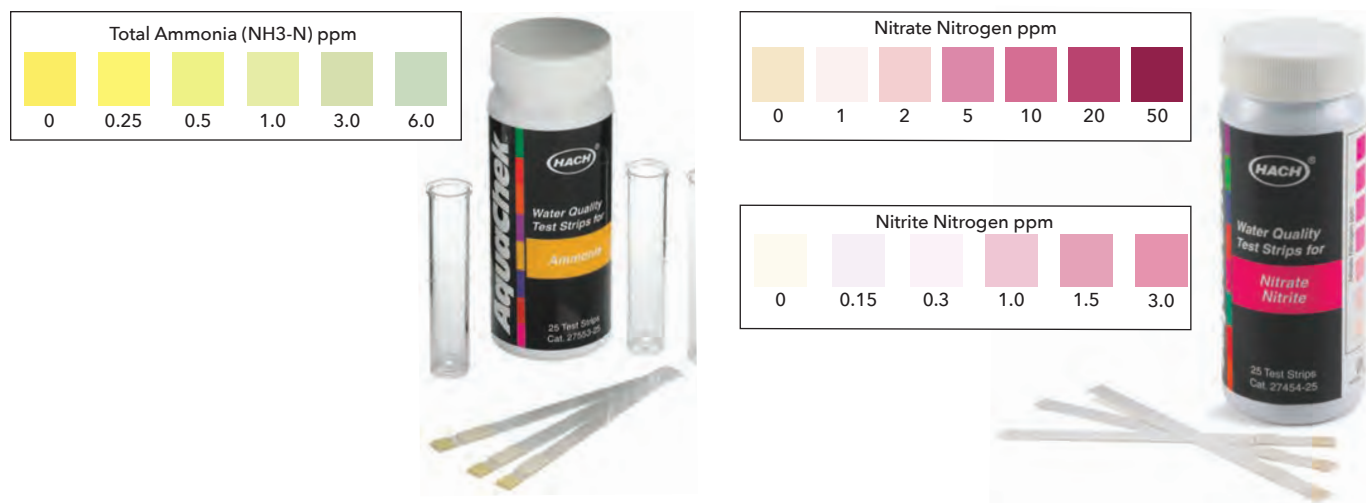


Figure 13: Hach Ammonia and Nitrate Nitrite strips and sample color chart.

## PERFORM NITRATE NITRITE TESTS

- With dry and clean hands, **remove** a strip from the test strip bottle.
- **Conduct** a zero check by comparing the pad to the color chart.
  - If color reads as zero concentration, **record** a zero in the appropriate Pre-Sample (Zero Check) box on the Field Datasheet.
  - If color does NOT read zero, **do not use the strip** and contact the VOLT.
- **Dip** a strip into water for 1 second. **Do not** shake excess water from the test strip.
  - **Do not** use the same water and vial as was used for the Ammonia test.
  - **Do** dip the strip into the remaining water in the sampling pole apparatus.
- **Hold** the strip level, with pad side up, for 30 seconds.
- **Compare** the NITRATE test pad (top pad) and the NITRITE test pad (bottom pad) to the color chart above.
- **Record** result on the field datasheet.
- **Check** that the test strip bottle is tightly capped and **store** the bottle in the box.

### NITRATE NITRITE TIPS

The Nitrate Nitrogen (top pad) test strip measurement is actually the sum of the nitrate and nitrite concentrations. Therefore, it should always be greater than the Nitrite Nitrogen (bottom pad) concentration.

- It is best to use the sampling apparatus to dip the Nitrate Nitrite strips in. **DO NOT** conduct the test from the ammonia sample vial after the ammonia strip has been used as the ammonia strip increases the pH significantly and may affect the Nitrate Nitrite strip readings.
- Always verify that both pads were submerged in sample water.
- Hold strip level with pad side up for at least 30 seconds.
- Please use a watch or a timer to ensure accuracy. Read immediately.

### COMPLETE NUTRIENT SAMPLING

- **Confirm** that all nutrient measurement results have been recorded on the field datasheet in the table shown below.
- **Record** sum of all nutrient measurements.
  - If the sum is less than 1.0 ppm, **check "Yes."**
  - If the sum is greater than 1.0 ppm, **check "No"** and contact the VOLT.

	Strip	Pre-Sample (Zero Check)	Sample Reading
Nutrient Tests	<b>Total Ammonia (NH<sub>3</sub>-N) ppm</b> <i>Always use vial!</i>	ppm	ppm
	<b>"Nitrate" Nitrogen ppm</b> <i>Top pad - Range 0 to 50</i>	ppm	ppm
	<b>Nitrite Nitrogen ppm</b> <i>Bottom pad - Range 0 to 3.0</i>	ppm	ppm
	Is sum of nutrients < 1.0 ppm?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<b>Sum:</b>

**TIPS FOR SAMPLING NUTRIENTS**  
If the strips fail the zero check, contact the VOLT.

- Color differences are easier to detect if you avoid sun glare. View strips in the shade and do not use sunglasses or tinted lenses. To find the best color match, pick the most similar color in consultation with the sampling team.
- If the color on the test pad falls between two color blocks, use the midpoint of the two color blocks as the value.
  - For example, if the color on the Nitrate Nitrogen pad looks to be between 1 and 2 ppm, record the value as 1.5 ppm. Do not estimate values smaller than the midpoint (ex. not 1.2 ppm).

Table 3: Use the following table to help you remember the differences in directions for the two nutrient strips.

DIFFERENCES	AMMONIA	NITRATE NITRITE
<b>Strips</b>	Transparent strip with one small and one large pad	White strip with two pads of equal size
<b>Vial</b>	Always use vial, fill to top line	Do not use vial
<b>Time in water</b>	Dip vigorously for 30 seconds	Dip for 1 second
<b>Shake excess water?</b>	Shake excess water from test strip	Do not shake excess water from test strip
<b>Wait before reading</b>	Hold the strip level, with pad side up, for 30 seconds	Hold the strip level, with pad side up, for 30 seconds
<b>Read strip</b>	Read THROUGH clear plastic, pad side down	Read pad side up





# Turbidity and Bacteria Sample Water Collection

After the probes have equilibrated for five minutes in sample water, you should collect the water that will be used for the grab samples and meter measurements.

- **Check** that the wide-mouth insulated container attached to the sampling pole is clean and has been rinsed (see page 26).
- **Label** all sampling bottles with the site name, date, and sample collection time using the permanent marker provided in your kit.
- **Record** the Sample Collection Time, Sample Type, and any Notes on the Field Datasheet.

Samples	<b>Sample Collection Time:</b>
	<b>Sample Type:</b> <input type="checkbox"/> 500 mL turbidity <input type="checkbox"/> 30 mL bacteria <input type="checkbox"/> <b>Other:</b>
	<b>Notes:</b>

Avoiding contaminants is especially important during bacteria sample collection. Take the following into consideration when collecting your bacteria sample:

- Do **NOT** rinse the bacteria sampling bottle.
- Do **NOT** touch the inside of the cap or the rim of the bottle.
- If you need to set down the cap, place the cap with the opening facing up on a flat surface.



### GRAB SAMPLE COLLECTION

- **Collect** the bacteria sample.
  - **Fill** the bacteria bottle by attaching the bottle to the side of the sampling apparatus or filling directly from water body.
  - Carefully **replace** the cap on the bacteria sample bottle and **place** the capped bottle in the resealable bag provided.
  - **Store** bagged sample bottle on ice in sampling cooler.
  - Begin **analysis** procedure within eight hours of sample collection.
- **Collect** the turbidity sample.
  - **Rinse** turbidity sample bottle three times.
    - To rinse, either use water from the rinsed sampling pole apparatus or directly from the water body.
  - **Fill** the turbidity sample bottle.
  - **Replace cap** and **check** that the cap is tight.
  - **Store** turbidity sample in a cool dark place.
    - If analysis is not performed within two hours of collection, **store** sample on ice or in the refrigerator.
  - **Analyze** samples within 48 hours of collection using the Hach 2100Q turbidimeter.

Table 4: Sample collection and preservation requirements.

	TURBIDITY SAMPLE	BACTERIA SAMPLE
<b>Container Type</b>	500 mL polyethylene screw cap bottle	30 mL sterile polyethylene narrow-mouth screw cap bottle
<b>Storage Temperature</b>	Cool and dark. Place on ice if more than a two-hour delay before analysis.	On ice
<b>Maximum Hold Time</b>	48 hours	8 hours
<b>Analysis Method</b>	Hach 2100Q turbidimeter	Coliscan EasyGel

# Meter Measurements

- **Refill** the sample pole apparatus with a fresh water sample collected from the sampling location.
  - There is no need to triple rinse again unless you notice debris in the sample pole bottle.
- **Transfer** probes to the fresh sample water.
  - Be careful not to submerge the pH probe above the blue line.
- Gently **swirl** the probes for a couple seconds to release any air bubbles trapped on the probes.
- **Do not** continue stirring.

**NOTE ON MEASUREMENT DRIFT**

- Drift is the slow variation in a measured response. Drift can be due to operator error, temperature variation, or other environmental factors.
- To reduce drift be sure to allow the probes to equilibrate in sample water before performing meter measurements.
- Watch for measurement drift by looking at the last two readings and comparing them to the criteria listed on the field datasheet for each parameter.
- If you exceed the drift criteria, take more readings until your last two readings are within the drift criteria. Write the additional readings in the rows for Replicates for (4) and (5) in the space provided.



Measure parameters in the following order: dissolved oxygen, conductivity, and pH.

**TO MEASURE DISSOLVED OXYGEN (DO)**

- Press **f3** to navigate to the dissolved oxygen measurement screen.
  - o If %sat is not displayed in the top left corner, press **MODE** until it is the displayed measurement value.
- Press the **MEASURE** button. Wait until "Ready AR" stops flashing.
- Record the DO (%). Press **MODE** once and **record** the DO (mg/L) on the field datasheet. **Record** the temperature which is always located in the top left corner.
- **Repeat** for at least three replicate measurements and **record** results in the following table.
  - o If drift criteria are met, **check "Yes"** and continue to conductivity measurements.
  - o If not, **collect additional replicates** until drift criteria are met.

WWA Volunteer Water Quality Monitoring Program Site: \_\_\_\_\_

Dissolved Oxygen	Meter Start Time:				Drift QC
	Rep	DO (%)	DO (mg/L)	Temperature (°C)	<i>Last two readings</i>
	1				DO% drift ≤ 5%?
	2				<input type="checkbox"/> Yes <input type="checkbox"/> No
	3				DO mg/L drift ≤ 0.20?
	(4)				<input type="checkbox"/> Yes <input type="checkbox"/> No
	(5)				Temp drift ≤ 0.1?
Are all DO values within percentile ranges?					<input type="checkbox"/> Yes <input type="checkbox"/> No

**TO MEASURE CONDUCTIVITY**

- Press **f3** six times to navigate to the conductivity measurement screen.
  - o If COND is not displayed in the top left corner, press **MODE** until it is the displayed measurement value.
- Press the **MEASURE** button. Wait until "Ready AR" stops flashing.
- **Record** the Conductivity on the Field Datasheet in the table shown below.
  - o Check the box for the appropriate units (µS/cm or mS/cm).

Conductivity	Rep	Cond	TDS	Salt (psu)	Temperature (°C)
		<input type="checkbox"/> (µS/cm) <input type="checkbox"/> (mS/cm)	<input type="checkbox"/> (ppm) <input type="checkbox"/> (ppt)		
	1				
	2				
	3				
	(4)				
	(5)				
Drift QC		Drift ≤ 1% (µS/cm) or ≤ 0.1 (mS/cm)?		Temp drift ≤ 0.1?	
<i>Last two readings</i>		<input type="checkbox"/> Yes <input type="checkbox"/> No		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Are all conductivity values within percentile ranges?					<input type="checkbox"/> Yes <input type="checkbox"/> No

- Press **MODE** once and **record** the TDS value on the field datasheet.
  - Check the box for the appropriate units (ppm or ppt).
- Press **MODE** again and record the Salinity value (psu). **Record** the temperature which is always located in the top left corner.
- **Repeat** for at least three replicate measurements and **record** results.
  - If drift criteria are met, **check "Yes"** and continue on to pH measurements.
  - If not, **collect additional replicates** until drift criteria are met.

**TO MEASURE pH**

- **Press f3** six times to navigate to the pH measurement screen.
  - If pH is not displayed in the top left corner, press **MODE** until it is the displayed measurement value.
- **Press** the **MEASURE** button. Wait until "Ready AR" stops flashing.
- **Record** the pH on the field datasheet in the table shown below. **Record** the temperature which is always located in the top left corner.
- **Repeat** for at least three replicate measurements and **record** results.
  - If drift criteria are met, **check "Yes"** and complete post sampling wrap up and perform remaining QC checks on collected data.
  - If not, **collect additional replicates** until drift criteria are met.

	Rep	pH	Temperature (°C)	Drift QC
pH	1			<i>Last two readings</i>
	2			pH drift ≤ 0.10?
	3			<input type="checkbox"/> Yes <input type="checkbox"/> No
	(4)			Temp drift ≤ 0.1?
	(5)			<input type="checkbox"/> Yes <input type="checkbox"/> No
Are all pH values within percentile ranges?				<input type="checkbox"/> Yes <input type="checkbox"/> No



# Final Steps

## PERFORM PERCENTILE CHECKS

- For each parameter, **compare** your results to the site specific 10<sup>th</sup> to 90<sup>th</sup> percentile range chart located on the side of your field bin and in your field clipboard or binder.
  - If percentiles are within range, **check "Yes"** for the parameter on the datasheet.
  - If percentiles are out of range, **check "No"** and note in the Notes section on the back of the Field Datasheet and contact the VOLT as soon as possible since something unusual is happening at the sampling site.

## PERFORM FINAL REVIEW

- **Review** the field datasheet.
  - **Check** that all sections have been completed entirely. There should be no blank sections on the sheet. If blanks exist, complete with appropriate information or with NA.
- Once complete, **review** the final Quality Control (QC) question.
  - If all QC questions have been answered "Yes," **check** the box next to "Check when complete to verify that all questions are answered Yes, otherwise note below."
  - If any questions have been answered "No," **do not check** the box and **note** why in the Notes section.
- **The reviewer then signs and records the End Time** (or time you completed field sampling at the site).
  - **Do not write** on the EQL QA Reviewer line.

<input type="checkbox"/> Check when complete to verify that all questions are answered Yes, otherwise note below	
<b>Signature:</b>	<b>End Time:</b>
<b>Notes:</b>	

Form VM2020 Rev 1 (02/03/2021)

EQL QA Reviewer: \_\_\_\_\_ Date: \_\_\_\_\_

## POST SAMPLING WRAP UP

- **Remove** probes from the sample water.
- **Rinse** each probe with DI water. **Dry** the probes with a Kimwipe.
- Prepare probes for storage.
  - **Dissolved oxygen probe.**
    - **Replace** the white sleeve onto the DO probe. **Check** to ensure the sponge is damp.
  - **pH probe**
    - Completely **unscrew** the pH storage solution bottle from its cap, **insert** the pH probe into the cap, and **screw** on the storage solution bottle. **DO NOT** try to force the probe into the cap without fully unscrewing the cap from the bottle.
  - **Conductivity probe**
    - No additional prep is required for the conductivity probe.

When in doubt: keep your leftover turbidity sample and contact the VOLT.

- Carefully **return** probes and meter back to the kit. Be careful not to kink the wires near where the probes plug into the meters.
- **Pour** used sample water on the ground or back into the waterbody.
- **Ensure** that equipment is clean and properly stowed in the sampling kit bucket for transport.
- When you arrive back at your home, **rinse** the sampling apparatus with tap water before storing.

## CONGRATULATIONS!

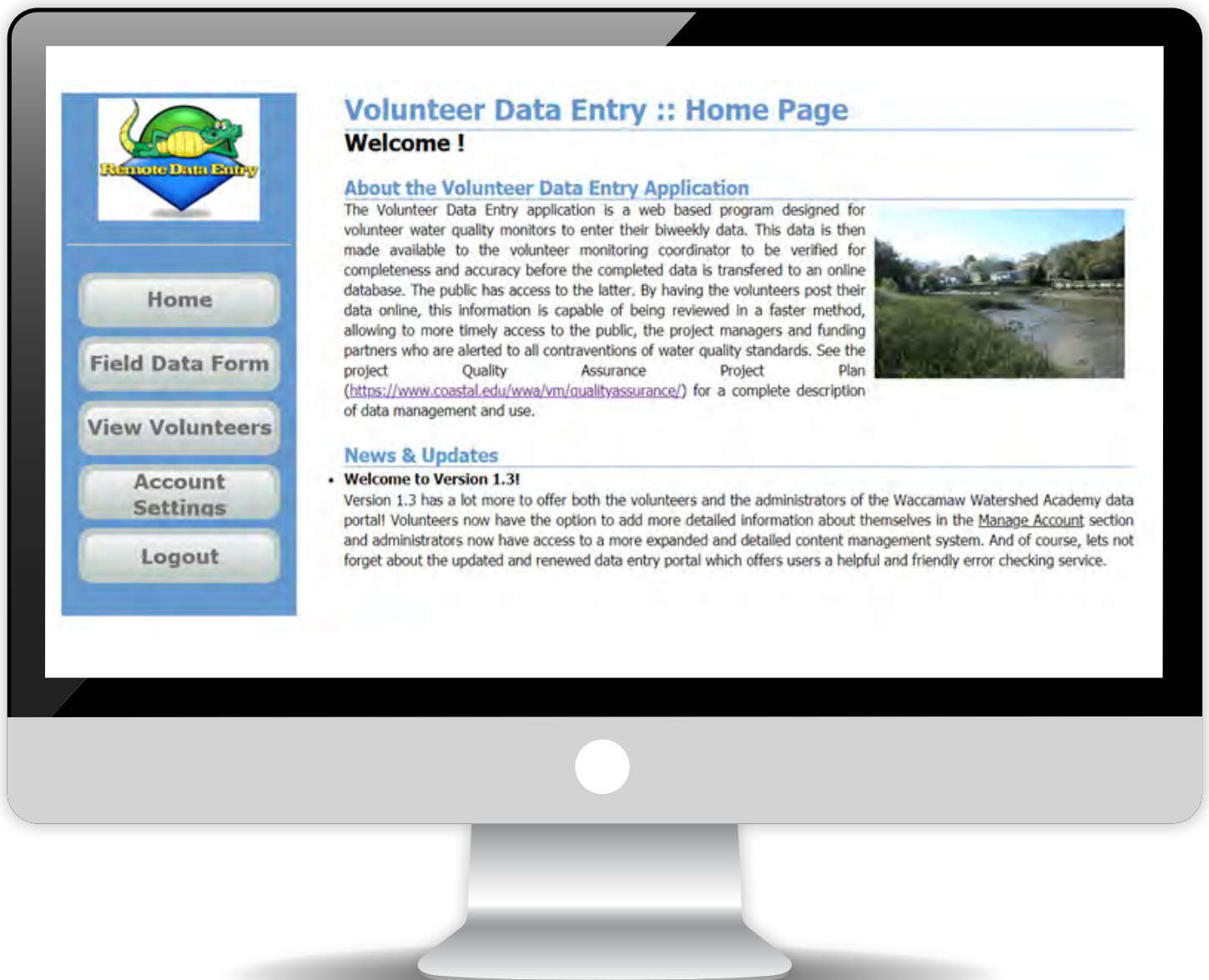
- You have now completed all field activities. You have obtained water quality measurements in the field for the following parameters:
  - Dissolved Oxygen, Temperature
  - pH, \*Temperature (measured by conductivity sensor)
  - Conductivity, TDS, Salinity, Temperature
  - Nutrients - Ammonia, Nitrate, Nitrite
- You have collected samples for the following parameters:
  - Turbidity (analysis to be completed within 48 hours of sample collection)
  - Bacteria (to be plated and incubated within eight hours of sample collection)



# Data Entry to Online Database

The Online Data Entry Portal allows for quick submission of volunteer data to the VOLT. For each field, there is guidance on the acceptable values to ensure proper entry of data. Fields marked with a red asterisk are required.

- Go to the Data Entry Portal using the link on the volunteer monitoring website.
- Enter User Name and Password. Then click the "Login" button.
- Click on the "Field Data Form" button.
- Use the drop-down menu to select a Sampling Site. Enter the Collection Date as MM/DD/YYYY or by clicking on the calendar icon. Then click Submit.
- This brings you to a page where you can type in your data. The order matches that of the Field Datasheet.
- The first rows are automatically populated with the Project, Team Number, Site Location, Site Number, and Submitted By information.







- Fill out the rest of the General Sampling Information including: Other Samplers and Collection Time as HH:MM and select a.m. or p.m.
- Fill out the Site Observations Section. This section is not required but is useful for data interpretation.
  - Use the drop-down menus to select the proper descriptors for the amount of rain, sun, and water flow. If known, enter the Date of last rain in the format MM/DD/YYYY.
- Enter nutrient strip results.
- For each meter parameter, type in the values of all three replicates. Enter the last three values if you measured more than three replicates in the field.
- Enter three turbidity replicates. Enter the last three values if you measured more than three replicates.
- Enter your *E. coli* and Total Coliform results as a whole number.
- Type in any Additional Comments about your sampling including:
  - Unusual observations such as the presence of an illicit discharge, wildlife, or trash at your sampling site and meter or equipment problems or QC questions that were answered "No."
- Save or Submit Your Data.
  - You will now have the option to "Save for Future Edits" or "Submit for EQL Review." Either is acceptable and will save your data for future review by the WWA.
  - After saving or submitting your data, a message will appear at the top of the screen telling you that the data have been accepted or prompts you to address data errors.
    - If needed, make corrections and then click on "Save for Future Edits" or "Submit for EQL Review" again.
- Once data are submitted or saved, you can continue to enter data for another sampling site or you can log out. Congrats! The VOLT can now use your data!

# III.

## Orion Calibration Procedures

Orion Calibration Overview

pH Probe Calibration

Conductivity Probe Calibration

DO Probe Calibration

# Orion Calibration Overview

These instructions will walk you through a full calibration of the meter. You will calibrate pH, conductivity, and dissolved oxygen.

The manufacturer recommends calibrating within eight hours of use for the DO and pH probes. However, if calibration is not possible within eight hours of sampling, field calibration checks conducted immediately before sampling will validate the accuracy of the meter calibration.

Careful calibration of the meter allows for accurate measurements in the field.



Press the **f1**, **f2** and **f3** function keys to perform the action shown above each key on the display.



Press to turn the meter on.

When the meter is on, press and quickly release to turn the display backlight on or off or hold down to turn the meter off.



In the measurement mode, press to take a measurement.

In the setup, calibration and other menus, press to escape the current menu and return to the measurement mode.



In the measurement mode, press to enter the setup menu.

In the setup, calibration and other menus, press to scroll up through a list of options.



In the continuous measurement mode, press to hold (freeze) the displayed measurement and press again to release (unfreeze) the measurement.

In the setup, calibration and other menus, press to scroll left through a list of options.



In the single channel measurement modes, press to change the displayed measurement mode. Options for channel 1 are pH, mV, RmV (relative mV), ORP and ISE. Options for channel 2 are Cond (conductivity), TDS, Salinity and Res (resistivity). Options for channel 3 are %sat (dissolved oxygen in percent saturation), mg/L (dissolved oxygen in milligrams per liter) or °C (probe membrane temperature).

In the setup, calibration and other menus, press to scroll right through a list of options.



In the measurement mode, press to log or print a measurement.

In the setup, calibration and other menus, press to scroll down through a list of options.

Figure 14: Meter keypad from the Orion Star A329 Meter Reference Guide.

Start off meter calibration procedure by rewetting the DO Sponge (see page 46). By the time you finish pH and conductivity calibration, the DO probe has likely had enough time to reach equilibration and is ready to calibrate.

### PREPARE FOR CALIBRATION

- **Record** Team, Date, Analyst, and Start Time on the Calibration Datasheet.
  - The grey box is filled out by the VOLT.
- **Hold** the **power** button until the meter powers on.

WWA Volunteer Water Quality Monitoring Program

Circle One: BA | MI | SB | WR

Calibration Datasheet Orion Star A329		
Team:		Date:
Analyst:		Start Time:
Meter ID:	Serial #:	DO Cap Last replaced:
pH 4:	pH 7:	Cond:

### REFILL CALIBRATION SOLUTION BOTTLES

- **Prepare small solution bottle.**
  - **Invert** old solution in small bottle to reincorporate evaporated droplets. After mixing, **discard** old solution into waste container.
- **Gently invert** bulk solution about five times.
- **Rinse** small solution bottle with new solution.
  - **Pour** about 1 cm of liquid into the small bottle. **Cap and invert** about five times.
  - **Discard** rinse into waste container. **Fill** small solution bottle to top of bottle label.
- **Repeat** for all calibration and field check solutions.
- **Dispose** of discarded solutions in a household sink while tap water is running.

To reduce errors and accidental dilution of pH standards, we recommend calibrating the pH probe while having the conductivity probe in the conductivity standard. This reduces the amount of rinsing and drying necessary as you only have to switch the pH probe between the pH solutions. This method is only acceptable if the pH and conductivity solutions are the same temperature (stored and prepared in the same conditions).



# pH Probe Calibration

## PERFORM pH PRE-CALIBRATION MEASUREMENTS

- **Completely unscrew** the pH storage bottle from its cap before taking the probe out of the solution bottle.
  - If you do not remove the cap from the bottle before attempting to remove or insert the probe from the bottle, you can create a vacuum or pressure and damage the probe.
- **Remove** the pH probe from the storage solution cap.
- **Rinse** the pH and conductivity probes with DI water. **Blot dry** with Kimwipe.
- **Place** pH probe in the 7.00 pH standard. Place the conductivity probe in the conductivity standard. **Gently stir** the probes to dislodge any bubbles.
- **Press** the **f3** button to navigate to the pH display.
  - If pH is not the measurement displayed, **press** the **MODE** key until it displays.
- **Press** the **MEASURE** button. **Wait** until "Ready AR" stops flashing and **record** the pH value and temperature as the 7.00 pH pre-reading value.
- **Remove** the pH probe from the standard and **rinse** probe with DI water. **Blot** dry with a Kimwipe. Keep conductivity probe in the conductivity standard.
- **Place** pH probe in the 4.00 pH standard. **Gently stir** the probe to dislodge any bubbles.
- **Press** the **MEASURE** button. **Wait** until "Ready AR" stops flashing and record the temperature and pH value as the 4.00 pH Pre-Reading value.

## CALIBRATE pH PROBE

- **Press f1** to begin pH calibration procedure.
- **Press f3** while the pH probe is still in the pH 4.00 standard.
- **Wait** for the value on the meter to stop flashing.
  - If the value reads 4.00, **press f2** to accept.
  - If the value does not read 4.00, **press f3** and enter the correct value using the keypad and **f3 to select**. **Press f2** when done editing. Then, **press f2** to accept.
- **Rinse** the pH probe with DI water. **Blot dry** with a Kimwipe.
- **Place** the pH probe in the 7.00 pH standard. **Gently stir** the probes to dislodge any bubbles.
- **Press f2** to proceed to the next standard. **Press f3** to start the calibration reading.
- **Wait** for the value on the meter to stop flashing.
  - If the value reads 7.00, **press f2** to accept.
  - If the value does not read 7.00, **press f3** and enter the correct value using the keypad and **f3 to select**. **Press f2** when **done** editing. Then, **press f2** to accept.
- **Press f3** to save and complete the calibration.
- **Record** the average slope as % Calibration Slope and mV values for each standard on the calibration sheet.

pH	Standard	Temp	Pre-Reading	Post-Reading	Acceptance Range	In Acceptance Range?
	7.00				6.90 to 7.10	<input type="checkbox"/> Yes <input type="checkbox"/> No
	4.00				3.90 to 4.10	<input type="checkbox"/> Yes <input type="checkbox"/> No
			Cal. Screen	% Calibration Slope		92 to 102%
		Standard 4.00 mV			150 to 210 mV	<input type="checkbox"/> Yes <input type="checkbox"/> No
		Standard 7.00 mV			-30 to +30 mV	<input type="checkbox"/> Yes <input type="checkbox"/> No

### PERFORM pH POST CALIBRATION MEASUREMENTS

- Press **f1** or **MEASURE** to return to the measurement screen.
- Press the **MEASURE** button. **Wait** until "Ready AR" stops flashing and **record** the pH value and temperature as the 7.00 pH Post-Reading value.
- **Remove** the pH probe from the standard and **rinse** probes with DI water. **Blot dry** with a Kimwipe.
- **Place pH probe** in the 4.00 pH standard. **Gently stir** the probe to dislodge any bubbles.
- Press the **MEASURE** button. **Wait** until "Ready AR" stops flashing and **record** the pH value and temperature as the 4.00 pH Post-Reading value.
- **Verify** that all Post-Reading and Cal. Screen values were in the acceptance range.
  - o **Check "Yes,"** if value is in acceptance range.
  - o If not, get fresh calibration solutions and try the calibration again. Contact the VOLT if the problem persists.
- **Remove** the pH probe from the standard and rinse probe with DI water. **Blot dry** with a Kimwipe.
  - o **Leave** the conductivity probe in its standard to calibrate in the next step.
- Completely **unscrew** the pH storage solution bottle from its cap, **insert** the pH probe into the cap, and **screw** on the storage solution bottle.
  - o **DO NOT** try to force the probe into the cap without fully unscrewing the cap from the bottle.



Figure 15: The Orion A329 pH probe (left), conductivity probe (center), and dissolved oxygen probe with optional protective metal cage (right).

# Conductivity Probe Calibration

## PERFORM CONDUCTIVITY PRE-CALIBRATION MEASUREMENTS

- Press **f3** to navigate to the conductivity measurement screen.
  - If COND is not displayed in the top left corner, press **MODE** until it is the displayed measurement value.
- Place rinsed and dried conductivity probe in the conductivity standard. **Gently stir** the probe to dislodge any bubbles.
  - If you rinsed and dried conductivity probe during the pH calibration, you do not need to remove the probe from the calibration standard.
- Press the **MEASURE** button. **Wait** until "Ready AR" stops flashing and **record** the conductivity and temperature as the conductivity Pre-Reading value.

Cond	Standard	Temp	Pre-Reading	Post-Reading	Acceptance Range	In Acceptance Range?
	1413 $\mu\text{S/cm}$				1342 to 1484 $\mu\text{S/cm}$	<input type="checkbox"/> Yes <input type="checkbox"/> No

## CALIBRATE CONDUCTIVITY PROBE

- Press **f1** to begin conductivity calibration procedure.
- Press **f3** while the probe is still in the conductivity standard.
- **Wait** for the value on the meter to stop flashing.
  - **Be careful** not to press f3 (override) before the value is stable.
  - When stable, **press f2** to accept the reading.
- Press **f3** to save and complete the calibration.

## PERFORM CONDUCTIVITY POST CALIBRATION MEASUREMENTS

- Press **f1** to return to the measurement screen.
- **Wait** until "Ready AR" stops flashing and **record** the conductivity as the conductivity Post-Reading value.
- **Verify** that the Post-Reading value was in the acceptance range.
  - **Check "Yes,"** if in acceptance range.
  - If not, get fresh calibration solutions and try the calibration again. Contact the VOLT if the problem persists.
- **Remove** the probe from the standard and **rinse** with DI water. **Blot dry** with a Kimwipe.

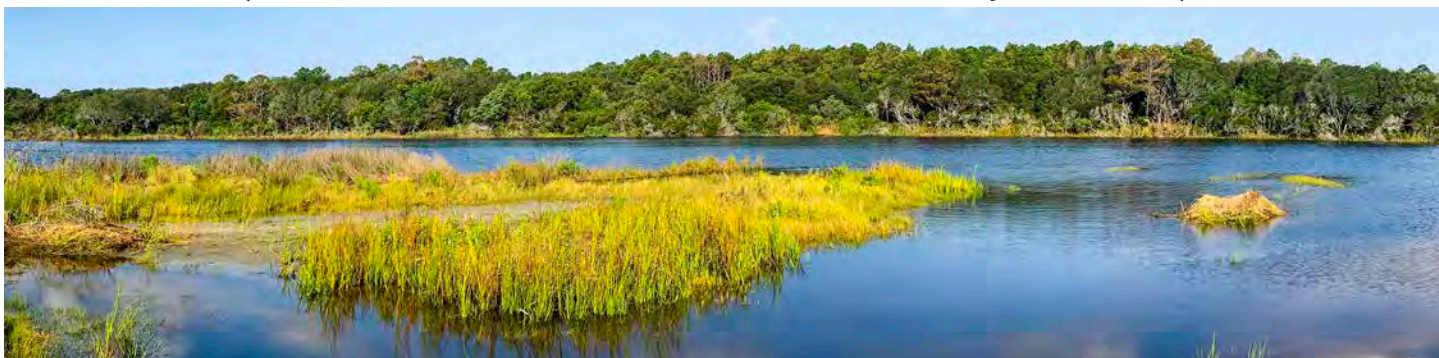


Photo by Bob Steffens.

## DO Probe Calibration

### PERFORM DO PRE-CALIBRATION MEASUREMENTS

- Press **f3** to navigate to the dissolved oxygen measurement screen.
  - If %sat is not displayed, **press MODE** until it is the displayed measurement value.
- **Remove** the cap from the dissolved oxygen tube and **remove** the sponge. **Rinse** with DI water, **squeeze** out excess, **replace** sponge, and **replace** cap.
- **Wait** 10 minutes to allow the probe to reach equilibrium.
- Press the **MEASURE** button. **Wait** until "Ready AR" stops flashing and **record** the temperature and the Pre-Reading dissolved oxygen value.

DO	True Value	Temp	Pre-Reading	Post-Reading	Acceptance Range	In Acceptance Range?
	100%				90 to 110%	<input type="checkbox"/> Yes <input type="checkbox"/> No

### CALIBRATE DO PROBE

- Press **f1** to begin dissolved oxygen calibration procedure. Press **f3** to select Air Calibration Type (Air). Press **f3** to start calibration.
- **Wait** for the value on the meter to stop flashing, then **press f2** to accept.

### PERFORM DO POST CALIBRATION MEASUREMENTS

- Press **f1** to return to the measurement screen.
- **Wait** until "Ready AR" stops flashing and **record** the measurement as the dissolved oxygen Post-Reading value.
- **Verify** that the Post-Reading value was in the acceptance range.
  - **Check "Yes,"** if in acceptance range.
  - If not, rewet the DO sponge and try calibrating again. Contact the VOLT if the problem persists.

### CALIBRATION COMPLETE!

- Once calibration is complete, **review** the final Quality Control (QC) question.
  - If all QC questions have been answered "Yes," **check** the box next to "Check when complete to verify that all calibration readings were within acceptance ranges, otherwise note below."
  - If not, **explain** otherwise in the Notes section and contact the VOLT.
- **Sign** and **record** End Time on the Calibration Datasheet.
- Press the **POWER** button to turn off the meter. Calibration of all meter probes is now complete.

<input type="checkbox"/> Check when complete to verify that all calibration readings were within acceptance ranges, otherwise note below.	
Signature:	End Time:
Notes:	





## IV.

# Turbidity Analysis

Turbidity Overview

Turbidity Analysis Procedure

Calibration Check

Sample Measurement

# Turbidity Overview

Turbidity is an optical property of water that provides a measure of the amount of suspended particles in a water sample. Particles like silt, sand, mud, and algae can impart a cloudy appearance to the water. High levels of particles are a concern because 1) they are harmful to filter-feeding organisms, 2) they can settle and bury bottom-dwelling organisms, 3) they can adsorb and transport pollutants such as trace metals and fecal bacteria, and 4) organic-rich particles decompose and deplete oxygen which can lead to fish kills.

In the WWA’s volunteer monitoring program, we use a turbidimeter that measures light scattering from the particles suspended in your samples (Figure 16). The turbidimeter is calibrated quarterly by the VOLT and our volunteers check this calibration prior to each use with a set of secondary standards (Gelex standards). The turbidimeter reports out in units of NTU’s, which stands for nephelometric turbidity units (nepheo- = cloudiness). Figure 17 shows how increasing turbidity appears as cloudiness to the human eye.



Figure 16: Currently, we use the Hach 2100Q.

Table 5: Turbidity Recreational Water Quality Standards for North and South Carolina.

TURBIDITY	SC WQS	NC WQS	EPA WQS
<b>Freshwater Criteria</b>	50 NTU	50 NTU (Streams) 25 NTU (Lakes and Reservoirs)	4 NTU
<b>Shellfish Criteria</b>	25 NTU	25 NTU	---

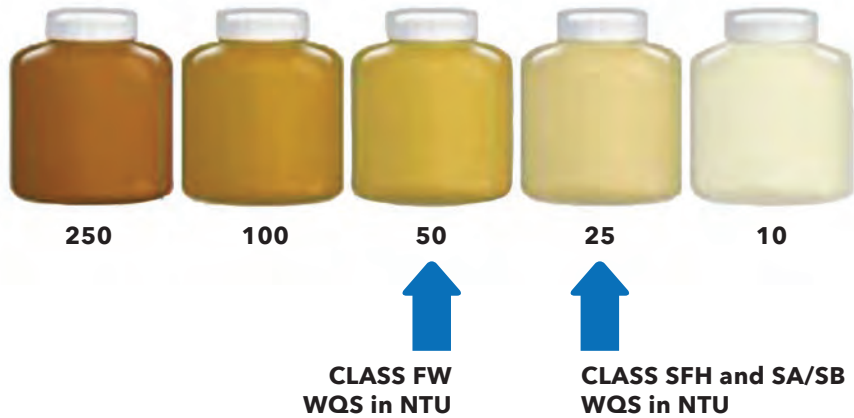


Figure 17: Turbidity values and appearance.

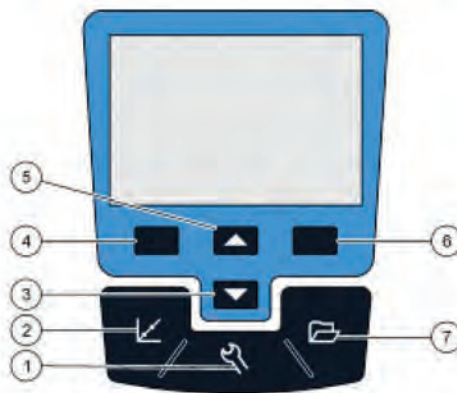
# Turbidity Analysis Procedure

- **Record** Team, Date, Analyst, and Start Time on the Turbidity Datasheet.
- **Remove** the turbidimeter from the storage box and **place** on a flat, sturdy surface.
- **Power on** the turbidimeter.
  - o **Press** the round blue power button to turn the meter on.

WWA Volunteer Water Quality Monitoring Program

Circle One: BA | MI | SB | WR

Turbidity Datasheet Hach Turbidimeter	
<b>Team:</b>	<b>Date:</b>
<b>Analyst:</b>	<b>Start Time:</b>



<b>1 SETTINGS</b> key: select menu options for setting up the meter	<b>5 UP</b> key: scroll through menus, enter numbers and letters
<b>2 CALIBRATION</b> key: shows calibration screen, start calibration, select cal options	<b>6 RIGHT</b> key (contextual): read turbidity sample, selects or confirms options, opens/jumps to sub-menus
<b>3 DOWN</b> key: scroll through menus, enter numbers and letters	<b>7 DATA MANAGEMENT</b> key: view, delete or transfer stored data
<b>4 LEFT</b> key (contextual): access for calibration verification, cancels or exits the current menu screen to the previous menu screen	

Figure 18 : Hach Turbidimeter keypad description and screen.



Photo by Bob Steffens

# Calibration Check

The calibration check is performed once daily before sample measurement, using the secondary Gelex standards in sealed glass vials. The 0-10 NTU standard checks the low end of the calibration range and the 0-100 NTU standard checks the high end of the calibration range and verifies that the quarterly calibration done by the VOLT is still accurate. The VOLT also determines the values of the Gelex secondary standards on a quarterly basis. These values are preprinted onto your datasheets and on tape pasted to the inner lid of the meter's storage case.

To prepare Gelex standards for measurement:

- **Apply** ONE small drop of silicone oil to each Gelex standard vial.
- Using the soft black cloth, **spread** the oil evenly around both vials.
- **Wipe** any excess oil off the vials with a Kimwipe.

Keeping your glass vials clean is essential to getting accurate readings. The turbidimeters use a method based on the scattering of light. Dust, fingerprints, dirt can amplify the scatter of light and produce inaccurate turbidity readings.

- Keep the vials clean!
- Less silicone oil is better!
  - Only one small drop is needed to fill in scratches on the vial.
  - Excess silicone oil can cause streaking.
- Keep the velvet cloth clean!
  - Store cloth in a sealed plastic bag when not in use.
- Handle the vial by the black cap to prevent fingerprints.

## CALIBRATION CHECK WITH THE 0-10 NTU GELEX STANDARD

- **Place** the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument.
- **Close** the cell compartment lid.
- **Measure** the NTU value of the standard.
  - **Press** the button under READ.
    - **Wait** for the meter to stabilize. It will beep and display the stabilized turbidity measurement in units of NTU.
- **Record** the turbidity reading on the Turbidity Datasheet.
- **Remove** the 0-10 NTU vial from the cell compartment and return it to its storage case being careful to handle it only by the top cap.

Calibration Check	<input type="checkbox"/> 2100P <input type="checkbox"/> 2100Q	0 to 10 NTU Standard	0 to 100 NTU Standard
	True Value		
	Acceptance Range		
	Reading		
	In Acceptance Range?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

## CALIBRATION CHECK WITH THE 0-100 NTU GELEX STANDARD

- **Place** the 0-100 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument.
- **Close** the cell compartment lid.
- **Measure** the NTU value of the standard.
  - **Press** the button under READ.
    - **Wait** for the meter to stabilize. It will beep and display the turbidity measurement.
- **Record** the turbidity reading on the Turbidity datasheet.
- **Remove** the 0-100 NTU Standard from the cell compartment.
- **Check** the Acceptance Range for the Gelex standards.
  - If the readings are within the acceptance range, **check "Yes"** and continue to sample measurement.
  - If the readings are not within the acceptance range, take the following measures to correct the issue:
    - **Check** the vial for dust, fingerprints, or fibers. If present, **clean** the sample vial and **read** again.
    - **Contact** the VOLT if the problem persists.

## Sample Measurement

- **Warm** sample to room temperature before proceeding to prevent fogging on the vial.
- **Invert** the sample three times to resuspend any particles that may have settled.
- **Rinse** the glass vial three times with the sample water.
  - **Fill** the vial with sample water.
  - Screw on the cap and **invert** the vial.
  - Remove cap and **discard** the sample water after each rinse.
  - Repeat two more times.
- **Invert** the plastic sample bottle again to resuspend particles.
- **Fill** the glass vial with sample water to the thick white line. **Screw** on the vial cap.
- **Prepare** vial for measurement.
  - **Wipe** the glass vial with a Kimwipe to remove water spots and fingerprints.
  - **Apply** a small drop of silicone oil to the vial and wipe with the soft black cloth.
  - **Check** that the vial is free of any visible marks and handle only by the cap.
- **Insert** the glass vial in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument (Figure 19).
- **Measure** the NTU value of the sample.
  - **Press** the button under READ.
    - **Wait** for the meter to stabilize. It will beep and display the stabilized turbidity measurement in units of NTU.
- **Record** the measurement on the Turbidity Datasheet as Replicate 1 for that site.

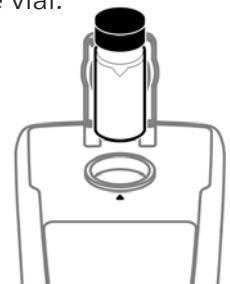


Figure 19: Insertion of the glass vial into the cell compartment.

Sample Turbidity Measurement	Site				
	Sampling Date (MM/DD/YY)				
	Sampling Time (HH:MM)				
	Replicate 1				
	Replicate 2				
	Replicate 3				
	Replicate (4)				
	Replicate (5)				
	Reps in Acceptance range? <small>If NTU &lt; 10, range of reps &lt;1 NTU. If NTU &gt; 10, range of reps &lt;10%.</small>	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

- **Empty** the vial.
- **Repeat** measurement reading procedure with fresh sample water two more times for a total of three replicate measurements.
  - Always **invert** the sample bottle before refilling the glass vial for each measurement.
- **Record** replicate readings.
- **Verify** that the last two replicates are within the Acceptance Range criteria.
- **Check "Yes,"** if replicates are within the Acceptance Range.
  - If replicates are not within the Acceptance Range, take additional replicates until the Acceptance Range criteria is met.

Table 6: Acceptance Ranges for turbidity replicates.

	Readings < 10 NTU	Readings > 10 NTU
Acceptance Range	Last two readings within 1 NTU	Last two readings within 10%

**ACCEPTANCE RANGE CRITERIA**

This is similar to the drift criteria for the Orion multimeter measurements. It checks for adequate precision in your measurement. The most common reason for not meeting these criteria has to do with refilling your vial. Always make sure to refill your vial immediately after inverting your sample bottle. This ensures particles that settled to the bottom are resuspended before you pour out the sample water into the vial.

- For turbidity readings that are less than 10 NTU, the last two replicates need to be within 1 NTU of each other.
  - Replicates of 6.5, 6.6, and 7.5 would be acceptable because the last two replicates are less than 1 NTU of each other.
- For turbidity readings that are greater than 10 NTU, the last two replicates need to be within 10% of each other.
  - For replicates of 19.0, 20.0, and 18.0 NTU: the average of the last two replicates 19.0 and 10% of 19.0 is 1.9. Last two replicates differ by 2.0, so drift is unacceptable and another replicate should be measured.

## IV. Turbidity Analysis

- **Check** the box next to the statement “Check when complete to verify that all readings were within acceptance ranges, otherwise note below” if all readings were within acceptance range.
  - If not, **explain** otherwise in the Notes section.
- **Sign** and record End Time on the Turbidity Datasheet.

<input type="checkbox"/> Check when complete to verify that all readings were within acceptance ranges, otherwise note below	
Signature:	End Time:
Notes:	

Form VM2130 Rev 2 (04/29/2020)

EQL QA Reviewer: \_\_\_\_\_ Date: \_\_\_\_\_

### AFTER MEASUREMENT

- **Rinse** used sample vials with tap water three times.
- After the third rinse, **fill** the glass vials with DI water.
- **Cap** securely.
- **Store** glass vials in the turbidity storage box.

The glass vials are cleaned quarterly by the VOLT. However, if the vials are especially dirty or encounter oil residue between kit maintenances, clean the vials by:

- Make a Versa Clean soap solution by adding three teaspoons of the orange Versa Clean soap to a quarter gallon of tap water.
- Soak the sample cell and the cap in soap solution for 15 minutes.
- Rinse the sample cell and the cap with tap water five to six times.
- Rinse the sample cell with DI water three times (make sure to rinse both the inside and the outside of the sample cell using the DI water bottle for rinsing).
- Fill the glass vial with DI water for storage.



Photo by Bob Steffens





V.

## Fecal Bacteria Analysis

Bacteria Overview

Bacteria Supplies

Preparation Before Sampling

Plating the Bacteria

Incubation

Colony Counts and Calculations

Plate Disposal

# Bacteria Overview

Fecal bacteria are used as a probable indicator of the presence of human pathogens in water. High levels of these pathogens increase the risk of contracting water-borne illnesses, such as gastroenteritis (upset stomach), skin rashes, ear and skin infections. Water quality standards developed by the EPA under the Clean Water Act inform the degree of increased risk for human uses, such as recreation and shellfish harvesting, and are based on the amount of human contact with the waterbody.

While they are a good indicator of water quality, these standards are limited in their ability to predict risk as they are generalized, do not reflect individual special circumstances (ex: immune system, preexisting health issues, etc.), and do not encompass all potential water-borne illnesses.

Volunteers in South Carolina use two bacteria to evaluate the risks based on the state’s regulatory water quality standards: *E. coli* and *Enterococcus*. In freshwater, *E. coli* is used as the fecal indicator bacteria. *Enterococcus* is used as the fecal indicator bacteria species in saltwater because the bacteria survives longer than *E. coli* when exposed to saltwater.

To measure the concentration of fecal indicator bacteria in a water sample, the sample is combined with a medium which serves as “food” for the bacteria and an extended incubation period. These conditions are favorable for replication of the indicator bacteria. As the microbes metabolize the media, a change will occur either by developing colonies or creating a color change. These changes represent the presence of bacteria. Some methods reveal colored colonies which are used to calculate the concentration in colony forming units (CFU) while others reveal a change in color which is used to calculate most probable number (MPN).

The WWA uses Micrology Coliscan® EasyGel® Media for detection and enumeration of *E. coli*. The method relies on the formation of colored colonies as the bacteria metabolizes the media during incubation. *E. coli* is a subset of the fecal coliform species, which are in turn a subset of the total coliform bacteria (see Figure 20). Counts of the colonies are used to compute *E. coli* and total coliform concentrations.

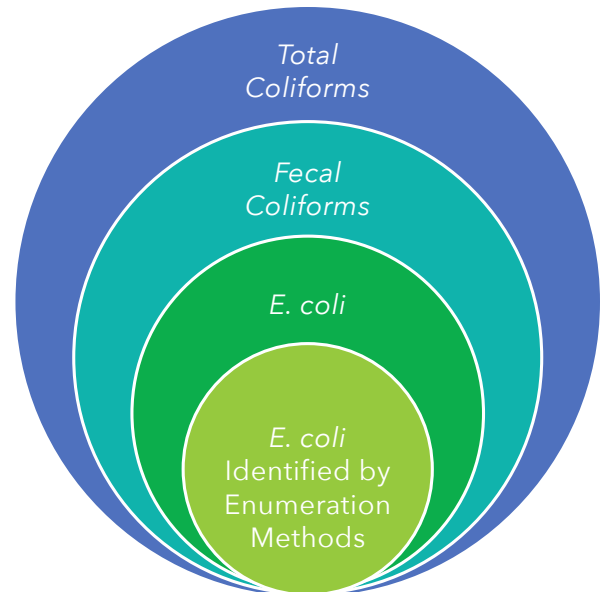


Figure 20: Subset of coliforms resulting in those identifiable by enumeration methods.

Table 6: Fecal indicator bacteria recreational water quality standards (WQS) (the concentration at which a potential health risk may exist). WQS are based on a single sample on any day.

Indicator Bacteria	SC WQS	NC WQS	EPA WQS
<i>E. Coli</i>	349 CFU/ 100mL	---	235 CFU/ 100mL
<i>Enterococcus</i>	104 MPN/ 100mL	104 CFU/100mL	104 CFU/100mL
Fecal Coliform	400 CFU/ 100mL	200 CFU/ 100mL	---

# Bacteria Supplies

Please note that the bacteria monitoring supplies have been provided to you in sterile condition.

- Sterile 30 mL collection bottles with plastic bag.
- 3 mL or 1 mL sterile pipettes.
- Micrology EasyGel Media (plus or regular).
  - Store in the freezer until day of use.
  - Be mindful of the best by date written on the bag!
- Micrology EasyGel Coated Plates
  - Plates should be stored out of direct light at room temperature in a closed bag to prevent contamination or drying out.
- Incubator with NIST thermometer
  - Incubator can be operated in your garage or basement, but sample preparation should be done indoors in a clean setting. Make sure that the incubator is on a sturdy, level surface to ensure an even distribution of media on the plates.
  - NIST thermometer and its storage bottle should be kept upright in the incubator. The storage bottle contains a nontoxic liquid and should not be poured out.
- UV black light (for use with plus media)
  - Avoid looking directly at the black light bulb as it could cause eye damage.



Figure 21: Example Coliscan media and sample plate.

## TIPS ON MAINTAINING STERILITY

Always use a clean surface. Dirty hands (oil, dust, hand moisturizer, etc.), and dust in the air or on the tabletop are common sources of contamination.

- **Keep sterile things sterile!**
  - Keep sterile media, plates, pipettes, etc. covered as much as possible.
  - Only touch the samples and sterile things with other sterile things.
  - Avoid setting lids down; it's better to hold them in your hand as you work.
  - Work at arm's length. This will keep contaminants from falling off you and landing on or in your sterile materials.
  - Breathe, cough, and sneeze away from sterile materials.

*Adapted from: University of Utah Genetics Department.*



## Preparation Before Sampling

- **Turn on** the incubator.
  - By the time you return from sampling, a stable temperature in the range of 33 to 37 °C should be achieved.
  - You should not need to adjust the knob from its initial position between samplings. Only use the switch to turn the incubator on and off. Minor adjustments can be made as described below in the Incubation section.
- **Prepare** cooler with sufficient ice or ice packs to cover the samples and ensure that they are kept below 10 °C.
- **Remove** the necessary bottles of media from the freezer and let **thaw** to room temperature.
  - Tightly capped media bottles can be placed in warm water to speed up thawing.

# Plating the Bacteria

- Before beginning, **check** the read back time.
  - Bacteria plates must be read 18 to 20 hours after incubation begins. Confirm you will be available at the appropriate time the following day.
- **Prepare** your clean work environment.
  - **Disinfect** work surface with a bleach wipe.
  - **Reduce** contamination by identifying and eliminating sources of contamination (exclude pets that can jump on countertops, reduce dust draft, don't eat breakfast nearby, etc.)
  - Consider wearing lab gloves - these are provided in your kit.
- On the Bacteria Datasheet, **record** the Team and incubation Start Date.

WWA Volunteer Water Quality Monitoring Program

Circle One: BA | MI | SB | WR

<b>Bacteria Datasheet</b>		<b>3 mL</b>
Coliscan Easygel PLUS		
<b>Team:</b>	<b>Start Date:</b>	

- **Prepare the plates** (petri dishes).
  - **Inspect** each petri dish to make sure the film on the bottom of the plate is intact and covers the entirety of the plate.
  - If the plate has an unusual appearance, and especially if the film does not cover the bottom of the plate, **do not use the plate**. Put the plate back in the kit and notify the VOLT.
  - Label the petri dishes with the site name and sampling date on the outer top lid of the petri dish using a permanent marker.
    - **DO NOT** remove the lid while labeling.
- **Remove** the sample from the cooler and take the sample bottle out of the plastic bag.
  - Keep the square plastic bag to use for plate disposal the following day.
- **Process** one sample at a time.
  - **Gently invert** the sample bottle three times to mix the sample. **Do not shake**.
- **Remove** the cap from the sampling bottle.
  - **Do not touch** the bottle's rim.
- **Select** a bottle of thawed Coliscan EasyGel media.
  - **Gently invert** the Coliscan EasyGel media bottle three times to mix.
  - If part of the media remains frozen, let it melt before using the media.
- **Remove** the cap from the Coliscan EasyGel media bottle.
  - **Place** cap on the table with the opening pointing up.
- **Remove** a sterile pipette from its packaging. Hold the pipette only from the bulb end.

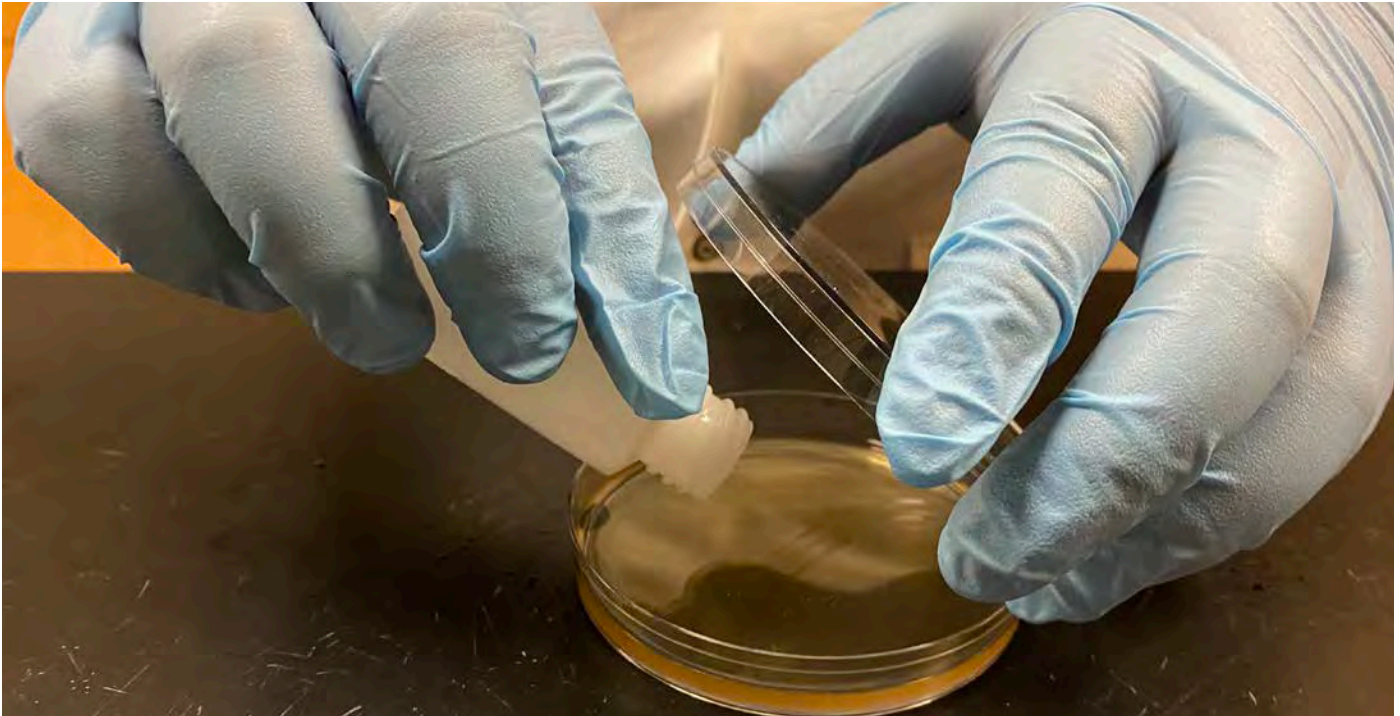


Figure 22: Proper pour method of Coliscan media and sample mixture onto petri dish.

- **Transfer** 3 mL of the sample from the 30 mL sampling bottle into the bottles of Coliscan EasyGel media using the pipette.
  - For samples with high *E. coli* levels, a 1 mL pipette is used and results are recorded on a different datasheet. The VOLT will notify you if this is necessary at your sampling site.
- **Cap** the Coliscan EasyGel media bottle that now contains sample water.
- **Gently invert** the media bottle three times to mix the sample and the media together.
- **Remove** the cap from the Coliscan EasyGel media bottle containing the mixture of sample and media.
- **Remove** the lid from the correctly labeled petri dish.
- While holding the petri dish cover in one hand, slowly **pour** the mixture into the petri dish (see Figure 22).
  - Pour smoothly and slowly to avoid introducing air bubbles as you pour the mixture.
- **Place** the lid back on to the petri dish.
- **Gently swirl** the dish until the dish's bottom surface is entirely covered with liquid.
  - Swirl smoothly and slowly to prevent splashing the mixture on the side or lid of the plate.
- **Repeat** for each sample.

#### MIXING TRICKS

- Always gently invert the sample, never shake! Shaking introduces air bubbles which can cause issues with reading the plates after incubation.
- Always invert three times.

# Incubation

- Check incubator temperature. It should be stabilized within the range of 33 to 37 °C according to the NIST thermometer kept inside the incubator.
  - o If it is not reading within this range, make a minor adjustment to the temperature using the temperature knob. Check incubator temperature according to the NIST after one hour. If not acceptable, make minor adjustment again until incubator is in the correct temperature.
- On the Coliscan Plus Datasheet Incubation section, **record** the following information:
  - o Incubation Start Time.
  - o Incubation Start Incubator Temp (as displayed on the front panel of the incubator).
  - o NIST Temp (temperature on the thermometer located inside the incubator).

Incubation		Time (HH:MM)	Incubator Temp	NIST Temp	Quality Control (QC)
	Incubation Start		°C	°C	Sample(s) arrived on ice? <input type="checkbox"/> Yes <input type="checkbox"/> No
	Incubation End		°C	°C	Incubation Temps 33 to 37? <input type="checkbox"/> Yes <input type="checkbox"/> No
	Total Time Incubated		Analyst Initials:		Time Incubated 18 to 20 hrs? <input type="checkbox"/> Yes <input type="checkbox"/> No

Site:	QC
Sampling Time:	Total Hold Time ≤ 8 hours? <input type="checkbox"/> Yes <input type="checkbox"/> No
Hold Time:	

- **Calculate and record** the Hold Time as the time elapsed between sampling and the start of the incubation.
  - o This should be no more than 8 hours.
- Open the door to the incubator and place all the petri dishes onto the wire shelf. Close the incubator door.
  - o Put all plates in at the same time to minimize the amount of time that the door is open and to prevent temperature deviations.

Table 7: Incubation Timing Table.

Plate Time	Next Day Minimum Read Time to Maximum Read Time
10:00 a.m.	4:00 a.m. to 6:00 a.m.
11:00 a.m.	5:00 a.m. to 7:00 a.m.
12:00 p.m.	6:00 a.m. to 8:00 a.m.
1:00 p.m.	7:00 a.m. to 9:00 a.m.
2:00 p.m.	8:00 a.m. to 10:00 a.m.
3:00 p.m.	9:00 a.m. to 11:00 a.m.
4:00 p.m.	10:00 a.m. to 12:00 p.m.
5:00 p.m.	11:00 a.m. to 1:00 p.m.



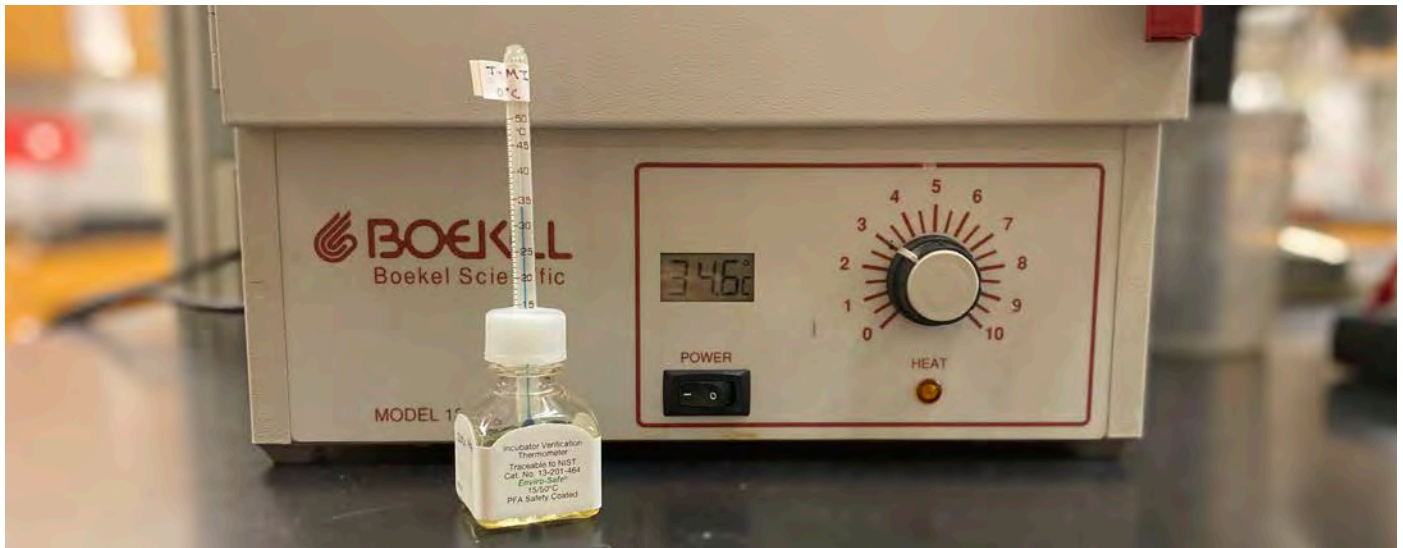


Figure 23: The digital incubator temperature may differ from the NIST thermometer. Always defer to the NIST temperature.

- After 18 to 20 hours of incubation, **remove** the petri dishes from the incubator.
- **Record** the following information on the datasheet:
  - Incubation End Time.
  - Incubation End Incubator Temp (as displayed on the front panel of the incubator).
  - Incubation End NIST Temp (temperature on the thermometer located inside the incubator).
  - Calculate and record the Total Time Incubated as the time elapsed between incubation start and end. This should be between 18 and 20 hours.
- **Answer** all QC questions.
  - Notify the VOLT if you are unable to answer “Yes” to any question.
  - “Incubation Temps 33 to 37?” refers to the NIST Temperature (Figure 23).
- **Initial** incubation section with initials of Analyst who prepared the samples for incubation.

### WHY 18 TO 20 HOURS IS IMPORTANT

Read the plate as close to the minimum 18-hour incubation time as possible. *E. coli* grows faster than other microbes, so they will be prominent by 18 hours.

- The longer you wait to read the plate, the more the fluorescent halo will diffuse and will become more difficult to see.
- To keep the incubation temperature stable, minimize the amount of time the incubator door is open.

### IF INCUBATION EXCEEDS 20 HOURS

Contact the VOLT for assistance in documentation. They may ask for a photo of the plate or if you noticed colonies of unusual color or size.

- For Coliscan Plus Media: in the case where the incubation time exceeds 20 hours AND the percent fluorescence is under 85 percent, the *E. coli* concentration reported will be determined solely on the number of blue colonies present, NOT by the numbers that fluoresce.

# Colony Counts and Calculations

The last step is to count “colonies” that have grown on your plates. Most have the appearance of a circle or a shape very close to circular. Irregular shapes can result when colonies merge or overlap. To minimize this, read your plates at 18 hours. *E. coli* colonies are blue-tinged, whereas the pink colonies are other types of coliform bacteria, that when added to the *E. coli* numbers, constitute the total coliform count. When using the Coliscan Plus media, *E. coli* colonies will also have a fluorescent halo under a UV black light. Use the Colony Color Guide (Figure 24) as a reference when counting colonies. *E. coli* and Total Coliforms are reported in Colony Forming Units (CFU) per 100 mL. Therefore, the colony counts that you determined must be multiplied by a factor relative to the volume of sample used to prepare the plate.

Sample 1	<b>Site:</b>				<b>QC</b>	
	<b>Sampling Time:</b>		<b>Hold Time:</b>		Total Hold Time ≤ 8 hours? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Colony Counts			Calculations		
	<b>A. Blue Colonies</b> (purple & teal)	<b>B. Fluorescing Colonies</b>	<b>C. Pink Colonies</b>	<b>% Fluorescing?</b> = $(B \div A) \times 100$	<b>E. Coli</b> = $B \times 33.33$	<b>Total Coliform</b> = $(B + C) \times 33.33$
				%	$\frac{CFU}{100mL}$	$\frac{CFU}{100mL}$
<b>Notes:</b>				<b>Analyst Initials:</b>		

*Bacteria Datasheet for use with 3 mL sample and Coliscan Easygel Plus*

## COUNT BLUE COLONIES

- **Inspect** the plates.
  - To make the plate easier to read under visible light, place it on a piece of white paper or another white surface.
  - Just before beginning counts, take the lid off the plate. Flip the plate over and “read” through the clear plastic bottom of the plate.
- **Count** all the blue-tinged colonies including both purple and blue-teal. Do not include pink, white, yellow, green or colorless colonies.
  - Colonies must be sufficiently large to be counted. The diameter including the halo should be at least 0.5 mm, which is about the size of a pencil point or dot like this → •
- **Record** the count on the datasheet as Blue Colonies (purple and teal).

## COUNT PINK COLONIES

- **Count** the pink colonies with pink halos.
  - Colonies must be sufficiently large to be counted. The diameter should be greater than 0.5 mm, which is about the size of a pencil point or dot like this → •
- **Record** the count on the datasheet as Pink Colonies.

# Colony Color Guide

**Count As  
Pink Colonies  
(Total Coliform)**

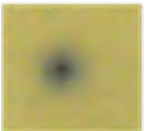


pink with pink halo

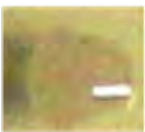
**Do NOT Count  
(other bacteria)**



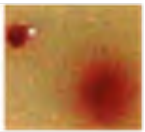
pink, no halo



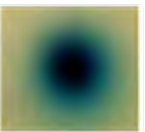
pinpoints



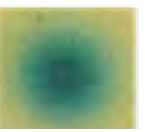
white



red



teal green with teal halo



teal green, no halo

**Count As  
Blue Colonies  
(E. coli)**



dark blue with teal halo



blue with purple or pink halo



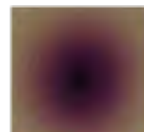
dark blue with dark blue halo



blue or dark blue, no halo



purple with purple halo



purple with pink halo



purple, no halo

Photographs and definitions compiled by James Beckley, QA Coordinator of the Dept. of Environmental Quality, Richmond, VA

Figure 24: Colony color guide from the Virginia Department of Environmental Quality.



### COUNT FLUORESCING COLONIES (PLUS MEDIA ONLY)

- **Place** the plate upside-down on a black surface.
- **Remove** as much visible light as possible (turn lights off, close blinds, etc.).
- **Shine** the UV black light at a 45° angle from a few inches away onto the bottom of the plate.
- **Mark** on the bottom of the plate the colonies that have a diffuse blue fluorescent halo using your black permanent marker.
- **Turn on** lights and **turn off** the UV black light.
- **Confirm** that the marked fluorescent colonies are blue under visible light.
- **Count** blue fluorescing colonies.
- **Record** these colonies as the count of Fluorescing Colonies on your datasheet.

### DUAL CONFIRMATION METHOD

For colonies to count as fluorescing, they must both fluoresce under the UV black light and be blue in color under visible light!

- Some blue colonies will occasionally grow close to one another, so their fluorescent halos can overlap giving the appearance of a single fluorescing colony when in fact BOTH colonies are fluorescing. In this case, count each colonies as contributing towards the total fluorescing colonies.
- As per the manufacturer's instructions, at least 85 percent of all blue colonies should fluoresce under the UV black light. If you are having trouble meeting these criteria, contact the VOLT and they will help troubleshoot the issue.

### TIPS FOR COUNTING OVER POPULATED PLATES

Ideally, plates should have no more than 300 colonies on them. To avoid high colony counts at sites that typically have high *E. coli* concentrations, a smaller (1 mL) pipette is used. Sometimes you will still have to count a plate with very large numbers of colonies. The following are two strategies for these kinds of plates.

#### Method 1: Counting Colonies by Quarters

- Divide the plate into four quarters and count colonies one quarter at a time (Figure 25).
- Add all the quarters to obtain the total colony counts.
- If counting all the colonies in each quarter is not possible, count just two quarters.
  - Select the quarters with the highest and lowest counts.
  - Multiply the sum by 2 to obtain the value for colony counts.

#### Method 2: Too Number to Count (TNTC)

Occasionally, you may have a plate with too many colonies to count, even with the quarter system. In this instance, take several clear photographs to share with the VOLT.

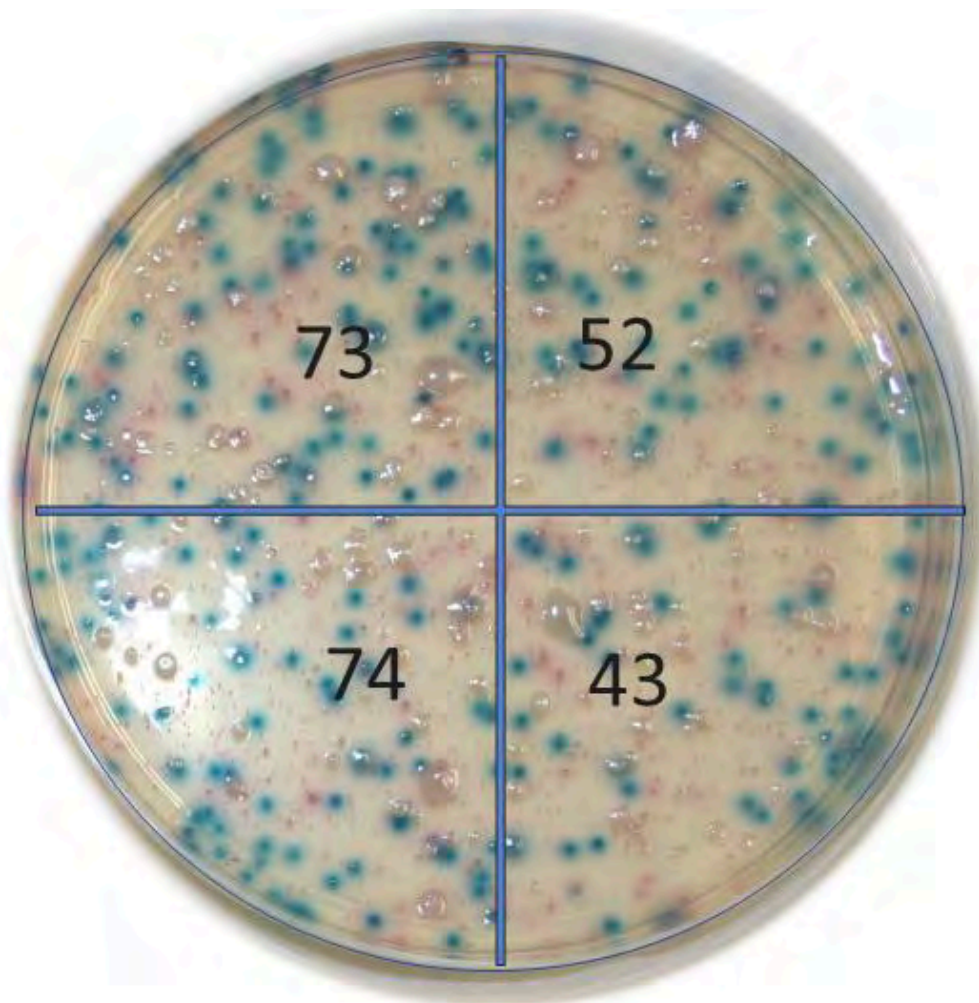


Figure 25: Example plates with quarter counts.

### CALCULATE E. COLI AND TOTAL COLIFORM (PLUS MEDIA)

Sample 1	Site:				QC	
	Sampling Time:		Hold Time:		Total Hold Time ≤ 8 hours? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Colony Counts			Calculations		
	A. Blue Colonies (purple & teal)	B. Fluorescing Colonies	C. Pink Colonies	% Fluorescing? = (B ÷ A) × 100	E. Coli = B × 33.33	Total Coliform = (B + C) × 33.33
				%	$\frac{CFU}{100mL}$	$\frac{CFU}{100mL}$
Notes:				Analyst Initials:		

*Bacteria Datasheet for use with 3 mL sample and Coliscan Easygel Plus*

- **Calculate** the percent of the blue colonies that fluoresced under the UV black light by dividing the count of fluorescing colonies by the count of blue colonies and multiplying that result by 100 (% Fluorescing = (B ÷ A) × 100).
- **E. coli** in units of CFU/100 mL is equal to the count of fluorescing colonies multiplied by the result of 100 mL divided by 3 mL ( $E. coli = B \times (100 \div 3)$ ). To get the appropriately rounded value, use the formula printed on your datasheet ( $E. coli = B \times 33.33$ ).
- **Total Coliform** in units of CFU/100 mL is equal to the sum of the counts of fluorescing AND pink colonies multiplied by the result of 100 mL divided by 3 mL ( $Total Coliform = (B + C) \times (100 \div 3)$ ). To get the appropriately rounded value, use the formula printed on your datasheet ( $Total Coliform = (B + C) \times 33.33$ ).

### CALCULATE E. COLI AND TOTAL COLIFORM (REGULAR MEDIA)

Sample 1	Site:				QC	
	Sampling Time:		Hold Time:		Total Hold Time ≤ 8 hours? <input type="checkbox"/> Yes <input type="checkbox"/> No	
	Colony Counts			Calculations		
	A. Blue Colonies (purple & teal)	B. Pink Colonies	C. Total Col. = A + B	E. Coli = A × 33.33	Total Coliform = C × 33.33	
				$\frac{CFU}{100mL}$	$\frac{CFU}{100mL}$	
Notes:				Analyst Initials:		

*Bacteria Datasheet for use with 3 mL sample and Coliscan Easygel Regular*

- **E. coli** in units of CFU/100 mL is equal to the count of blue colonies multiplied by the result of 100 mL divided by 3 mL ( $E. coli = A \times (100 \div 3)$ ). To get the appropriately rounded value use the formula printed on your datasheet ( $E. coli = A \times 33.33$ ).
- **Total Coliform** in units of CFU/100 mL is equal to the sum of the counts of blue AND pink colonies (C. Total Col.) multiplied by the result of 100 mL divided by 3 mL ( $Total Coliform = C \times (100 \div 3)$ ). To get the appropriately rounded value, use the formula printed on your datasheet ( $Total Coliform = C \times 33.33$ ).

### A NOTE ON ROUNDING

The final calculated bacteria values should be rounded to the nearest whole number. Look at the first digit after the decimal point, if this digit is greater than five (5, 6, 7, 8, or 9) round up.

- For example, 133.3 would become 133 CFU/100 mL and 166.6 would become 167 CFU/100 mL.

- When finished, the reading analyst should **initial** each set of sample results they have generated. Include notes of anything unusual about the appearance of the colonies and plate.
- **Review** the datasheet and make sure all QC questions were answered.
- When complete, the reading analyst should **sign and date** the datasheet.

<input type="checkbox"/> Check when complete to verify that all QC questions were answered Yes, otherwise note below.	
<b>Signature:</b>	<b>End Date:</b>
<b>Notes:</b>	

Form VM9215B Rev 3 (06/22/2020)

EQL QA Reviewer: \_\_\_\_\_ Date: \_\_\_\_\_

## Plate Disposal

- **Remove** the lid from the petri dishes.
- **Add** approximately a teaspoon (5 mL) of household bleach to cover the surface of the medium in each dish. Replace the lid.
- **Allow** the dish to stand for 5 to 10 minutes to ensure sterilization.
- **Place** the covered petri dishes in a water-tight bag and **discard** in household trash.
  - o Be sure that fresh bleach from the kit is used for each batch as an active ingredient, chlorine, will dissipate after the bleach has been exposed to the room's air. Active bleach will smell of chlorine.
  - o Use your square bag that was attached to the bacteria bottle!



# VI.

## Appendix

Troubleshooting

Riverkeeper's Quick Reference Table

Frequently Asked Questions

Acceptance Ranges

Glossary

Thanks to Our Volunteers!



# Troubleshooting

Table A: Orion Star A329 Meter Troubleshooting.

PROBLEM	THINGS TO TRY
<p><b>Meter shuts off unexpectedly</b></p>	<p>The ambient operating temperature for this meter is 5 to 45 °C (or 41 to 113 °F). If outside of this range, move meter to a warmer (inside of the car) or cooler (shaded) location.</p>
	<p>Batteries are low. Check for the battery icon in the top left corner. If flashing or low, change the batteries with the tools provided in your kit. Notify the VOLT if you had to change the batteries.</p>
<p><b>Calibration solutions or calibration check not within acceptance range</b></p>	<p>Sometimes calibration solutions can get contaminated during the numerous rinsings necessary for calibration. Dump out calibration solutions and refill. Redo the calibration. Contact the VOLT if the problem persists as it may indicate a faulty probe.</p>
<p><b>pH probe mV not within acceptance range</b></p>	<p>Attempt to recalibrate. If mV are still out of range, contact the VOLT as the pH probe may be failing.</p>
<p><b>Temperature reads MAN &amp; 25.0 °C instead of ATC</b></p>	<p>As the meters begin to age, the ports at the top of the meter may become increasingly sensitive. Make sure the probes are properly seated in their ports by giving them a gentle wiggle and verifying the probes are secure in their ports. If the problem persists, contact the VOLT immediately.</p>
<p><b>Probe slow to stabilize</b></p>	<p>The Dissolved Oxygen probe stabilizes slower when temperatures are high (summer) and the pH probe stabilizes slower when temperatures are low (winter). Allow more time for these probes during their slow seasons.</p>
	<p>When the sample water's conductivity is less than 100 <math>\mu\text{S}/\text{cm}</math>, the pH meter will take 10 to 15 minutes to fully stabilize in your sample. As the drift rate slows, the meter will lock onto a reading, so keep pushing the MEASURE button to reactivate the meter. Once 10 minutes has passed, you can try taking your first measurement. The meter should lock onto a stable pH reading quickly. Check for drift using the criteria on your field datasheet. If you are not meeting the criteria, let the sensor equilibrate for another 5 minutes by pushing the MEASURE button to reactivate the meter. If the pH measurements are still drifting after a total of 15 minutes, call the VOLT to discuss.</p>

Table B: Field Sampling Troubleshooting

PROBLEM	THINGS TO TRY
Site is inaccessible	If the site is inaccessible due to flooding, attempt to sample as close to the normal sampling site as possible. Only sample if safe to do so. Note any relocation and potentially contaminating activities on the Field Datasheet. If the site is completely inaccessible, contact the VOLT.
	If the site is inaccessible due to unsafe circumstances, contact the VOLT and notify them of conditions. Contact the local police if necessary.
Meter is not working at site	Collect turbidity samples and transfer samples as soon as possible to the VOLT for processing at CCU.

Table C: Orion Meter Channel and Mode Options

CHANNEL (F3)	MODE OPTIONS
pH	pH → mV → RmV → ORP → ISE
Conductivity	Cond → TDS → Salt → Res
DO	RDO (% sat) → RDO mg/L → °C



# Riverkeeper's Quick Reference Table

Table D: Riverkeeper's quick guide to sampling parameters and what they mean.

Parameter	Definition	Why it's important	Why it might be outside acceptance range	Important observations to make
<b>Temperature</b>	How hot or cold the water is	Warmer temperatures are great for swimming, but they are also good for bacteria and algal blooms.	We see seasonal and tidal variations in our region.  Either of these could affect the water temperature.	Discharge entering waterway, season, abnormal weather, etc.
<b>Conductivity</b>	Measurement of water's ability to conduct current; approximates amount of dissolved solids (minerals, salts, etc.) in the water.	Good indicator of where water is coming from; groundwater has a high conductivity whereas rain waters has a low conductivity.	Rain or drought events as well as tidal influence are the most likely causes. However, abnormal conductivity could indicate pollution.	Discharge or runoff, increased turbidity, recent heavy rainfall, etc.
<b>Dissolved Oxygen</b>	The amount of oxygen in the water	Fish require dissolved oxygen to breathe; if it's too low, they will die.	Low dissolved oxygen means there are organisms using up all the oxygen. This could mean there is bacteria present.	Algal blooms, polluted runoff, recent rain, dead fish, etc.
<b>pH</b>	Measurement of relative acidity or alkalinity (low pH is acidic, 7 is neutral, above 7 is alkaline or basic).	pH is a good indicator of impacts to a waterbody. A pH that is too acidic or too alkaline can kill off plant and animal life.	Extreme pH measurements could be due to pollution entering the waterbody.	Runoff, discharge.
<b>Ammonia</b>	Measurement of the ammonia form of nitrogen.	Excess nitrogen can lead to toxicity and can kill off plant and animal life.	Fertilizer or other industrial applications can contain ammonia. It could also result from natural sources like organic decomposition, animal waste, or human waste.	Runoff, effluent discharge, foul smells, presence of animals, algal blooms.

Table D: Riverkeeper’s quick guide to sampling parameters and what they mean, continued.

Parameter	Definition	Why it’s important	Why it might be outside acceptance range	Important observations to make
<b>Nitrate/ Nitrite</b>	Nitrates are the oxidized form of nitrogen, combining nitrogen and oxygen.	Excess nitrogen can lead to unchecked growth of algae leading to eutrophication or anoxia. Excessive algal growth leads to low dissolved oxygen as the algae decomposes causing fish kills.	Though occurring naturally, excess nitrates are often from human activity such as agriculture, human waste, or industrial pollution.	Runoff, effluent discharge, foul smells, presence of animals, algal blooms.
<b>Turbidity</b>	The amount of solid particles suspended in the water - how cloudy or opaque the water is.	High turbidity could indicate pollution from stormwater; fecal bacteria also like to stick to sediment particles.	Recent heavy rains or pollution can increase turbidity. Disturbing bottom sediments while sampling can artificially increase turbidity.	Runoff, disturbed bottom, disturbed banks, erosion, algal blooms.
<b>Fecal Bacteria</b>	Concentration of fecal bacteria per a volume of water; fecal bacteria is a fecal indicator bacteria (that means poop).	High concentrations of fecal bacteria indicate fecal pollution which can cause serious health risks for humans such as skin irritants, GI distress, and the potential for viral infections.	Fecal bacteria can be transported in stormwater runoff. Extremely high concentrations could indicate a malfunctioning sewage system.	Foul smell, polluted runoff, wildlife.



Photo by Bob Steffens.

# Frequently Asked Questions

## Q. WHAT SHOULD I DO IF I MESS UP SAMPLING?

A. We are human. Sometimes things may go wrong in the field. Should you need more supplies or help with your meter, contact the VOLT. When in doubt, you should always save your extra turbidity or bacteria sample until the problem is resolved!

## Q. SOMETHING CAME UP LAST MINUTE AND I CAN'T SAMPLE IN THE MORNING!

A. Try to coordinate with your team members! If there aren't enough volunteers to sample, contact your field leader or the VOLT as soon as possible.

## Q. WHAT SHOULD WE DO IF IT'S GOING TO STORM DURING SAMPLING?

A. The number one priority of the Volunteer Water Quality Monitoring Program is participant safety. If inclement weather or other hazardous event results in the closure of Coastal Carolina University, the VOLT will contact volunteers about potential impacts to sampling.

Volunteers are encouraged to be cautious in the event of inclement weather or other hazardous conditions. Do not sample if it is unsafe to do so! However, we leave the final decision to sample up to the discretion of the volunteer team.



# Acceptance Ranges

Table E: Acceptance ranges for various parameters. The following acceptance ranges are as of Spring 2021 and are subject to change. Always refer to your datasheets for the most recent acceptance range criteria.

pH		
Standard	pH Acceptance Range	mV Acceptance Range
4.00	3.90 to 4.10	150 to 210 mV
6.00	5.90 to 6.10	NA
7.00	6.90 to 7.10	-30 to +30 mV

pH CALIBRATION SLOPE	
Acceptance Range	92 to 102%

CONDUCTIVITY PRIMARY STANDARD	
Standard	Acceptance Range
100 $\mu\text{S}/\text{cm}$	95 to 105 $\mu\text{S}/\text{cm}$
1413 $\mu\text{S}/\text{cm}$	1342 to 1484 $\mu\text{S}/\text{cm}$
12.9 mS/cm	12.4 to 13.4 mS/cm

CONDUCTIVITY FIELD CHECK	
Standard	Acceptance Range
147 $\mu\text{S}/\text{cm}$	139.7 to 154.4 $\mu\text{S}/\text{cm}$
1000 $\mu\text{S}/\text{cm}$	950 to 1050 $\mu\text{S}/\text{cm}$
35.47 psu	34.97 to 35.97 psu

DISSOLVED OXYGEN	
Acceptance Range	90 to 110%

TURBIDITY REPLICATES	
Sample Values	Replicate Acceptance Range (last two)
< 10 NTU	< 1 NTU
> 10 NTU	< 10%

# Glossary

- CWA - Clean Water Act
- IDDE - Illicit Discharge Detection and Elimination
- MS4 -Municipal Separate Storm Sewer System
- NPDES - National Pollutant Discharge Elimination System
- QAPP - Quality Assurance Project Plan
- QA/QC - Quality Assurance/Quality Control
- SC DHEC - South Carolina Department of Health and Environmental Control
- TMDL - Total Maximum Daily Load
- US EPA - United Stated Environmental Protection Agency
- VOLT - Volunteer Operations and Logistics Team
- WWA - Waccamaw Watershed Academy

# Thanks to Our Volunteers!

Some of our amazing volunteers throughout the years pictured in this handbook include: Amy Armstrong, James Aucremen, Mary Baker, Phil Baker, Mark Bertelsen, Archie Biggs, Faye Bridges, David Born, Julia Born, Liz Crosby, Dona Ducker, Judy Ellis, Valerie George, David Gifford, David Goettel, Ken Harth, Harriet Harvey, Dave Hastings, Kathy Herron, Eric Hurlin, Ken Kreikemeier, Mary Leonard, Parker Leonard, Pete Little, Steve Lowe, Melanie Mask, Ron Mask, Gary O'loughlin, John Orndorff, Keith Palmer, Jennifer Plunket, Charles Pinson, Mike Putts, Sharon Putts, Dale Scholfield, Jason Silverman, Patty Spier, Don Streiffert, June Veach, Alice Vivian, Hal Vivian, Susan Walker, Jeanne Weinrich, Jim Wilkie, and Amelia Wood. Their time and effort, plus that of the many more volunteers not pictured, makes this program possible!

Additional thanks to the Waccamaw Watershed Academy's past coordinators and partners who have contributed so much over the years to our volunteer monitoring programs including: Kelly Davis, Christine Ellis, Dave Fuss, Paul Gayes, Kenneth Hayes, Davinder Randhawa, Hamp Shuping, Sue Sledz, AJ Taylor, Jim Wilkie, and Heather Young.



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