ADOPT a STREAM

SOUTH CAROLINA ADOPT-A-STREAM

VOLUNTEER *FRESHWATER STREAM* MONITORING

SC DEPARTMENT *of* ENVIRONMENTAL SERVICES

Map of South Carolina Major Watersheds

Source: SCDNR

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Need Help?

Access resources and answer questions by visiting our website, www.scadoptastream.org.

For questions about adopting a site, where to get monitoring supplies, or help getting started, contact your South Carolina Adopt-a-Stream (SC AAS) program coordinators by emailing scaas@des.sc.gov.

How to become a certified SC AAS freshwater stream monitor:

Step 1. **Get** certified at a workshop
Step 2. **Adopt** a freshwater stream site
Step 3. **Monitor** monthly
Step 4. **Enter** data in the SC AAS Database
Step 5. **Share** data and educate others
Step 6. **Renew** certification annually

FRESHWATER STREAM CERTIFICATION

1. I was trained by ____________________ on ___________.
(trainer name and date of training)
2. I need to renew my annual certification before: ______________________.
(recertify online or at another in-person workshop.)

WATER QUALITY EMERGENCY?

For evidence of ongoing and dangerous pollution discharges, fish kills, or public health hazards, call the 24-hour SCDES Emergency Hotline:

1-888-481-0125

REPORT A CONCERN!

For nonurgent concerns, visit the SCDES Report It! page (www.des.sc.gov/report-it) to file a report.

Scan to report a concern.

South Carolina Freshwater Stream Ecosystems

Saluda River in Greenville County.

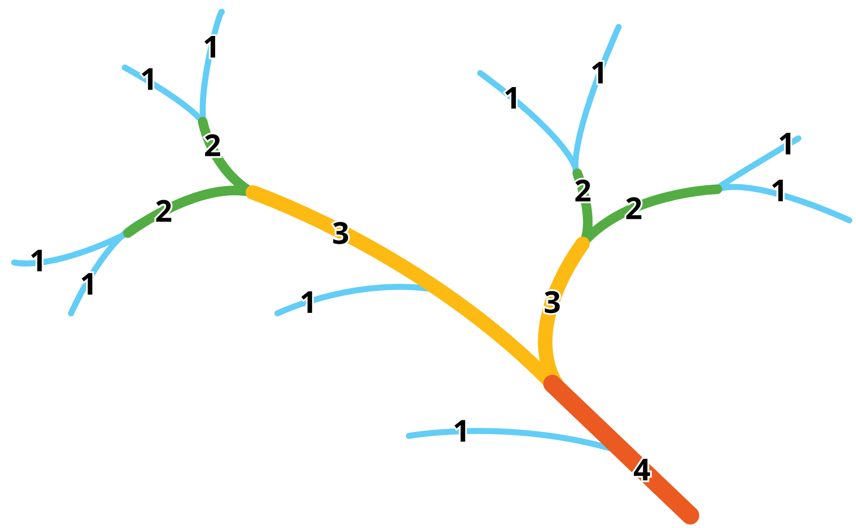
A stream is a body of water flowing on the Earth's surface in a distinct channel. Streams form over time when water running across the surface of the land wears away the soil to create a channel. This can happen when rainfall or snowmelt moves across the surface of the landscape as runoff, or when groundwater comes to the surface and flows continuously across the land.

Streams can vary in size and are known by a variety of names. Whether called a brook, creek, stream, tributary, or river, the defining feature of these aquatic ecosystems is their constantly moving water, or current. Water generally flows downhill in small streams, joining and forming larger streams and rivers to become a connected network of moving water. Streams are essential in connecting mountain and coastal ecosystems through transport of nutrients and relocation of sediments.

Scientists classify streams by assigning them a stream order which indicates their size and position within the watershed. A first-order stream is the smallest continuously flowing stream with no tributaries in a system. When two first-order streams come together, they form a second-order stream. When a first-order stream joins a second-order stream, it remains a second-order stream. It continues as a second-order stream until it joins with another second-order stream, when it becomes a third-order stream, and so on. First-order streams are small and often found in greater numbers in the mountains. Higher order streams are generally larger, slower, and transport larger volumes of water.

Groundwater:

The water that exists underground in the cracks and crevices between rocks and soils. The body of permeable rock that holds and transmits groundwater is known as an aquifer.



Stream order diagram.

South Carolina contains a wide variety of unique waters. Streams in the sandhills and coastal plain are very different from those in the mountains. Mountain streams and rivers like the Chauga River and Chattooga River systems in Oconee County are trout streams and are sometimes recreationally designated as whitewater. These classifications refer to how the waterbodies are utilized by people and animals, but they also indicate these rivers are cool, rocky-bottomed, and fast running with high amounts of dissolved oxygen.

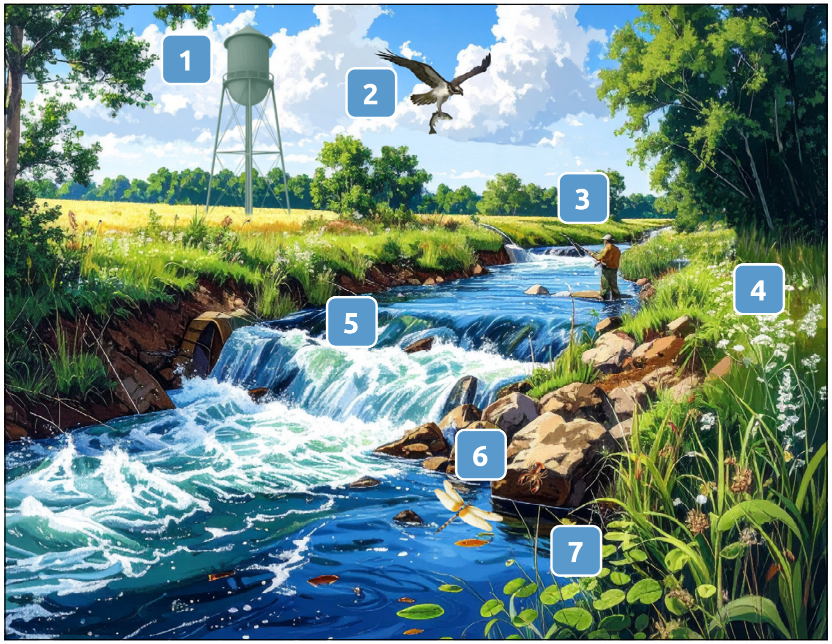
Closer to the coast, the Edisto River is one of the longest free-flowing blackwater systems in the United States. It is considered a blackwater river due to its dark, tannic coloration which is caused by decaying leaves and organic matter. Blackwater systems are generally slower-flowing and have naturally lower dissolved oxygen and lower pH than other types of streams.

Stream ecosystems and the organisms that live in and rely on them are adapted to levels of natural variability. Streams exist in a state of dynamic equilibrium where change is constant. However, they are also fragile, highly adapted systems that can struggle if those natural ranges are exceeded. Because streams can exhibit so much natural variation in volume, velocity, temperature, and chemical composition, long-term and site-specific data collection is essential to establish a stream's baseline conditions. After all, the best way to determine if the water quality in any given stream is changing over time is to compare it to itself.

Streams provide valuable ecosystem services. They have long been corridors to transport goods and people. Today, streams provide people with water for drinking, irrigation, industrial uses, recreation, waste discharge and dilution, and power generation. Streams, wetlands, and floodplains absorb and reduce the severity of flood events. Streams are habitats for many animals, including amphibians, reptiles, mammals, and commercially and recreationally important fishes. Streams are also home to aquatic insects and plants that are an important component of both terrestrial and aquatic food webs.

FRESHWATER STREAM ECOSYSTEM SERVICES

Within the ecosystem are diverse habitats and organisms that provide a multitude of benefits.

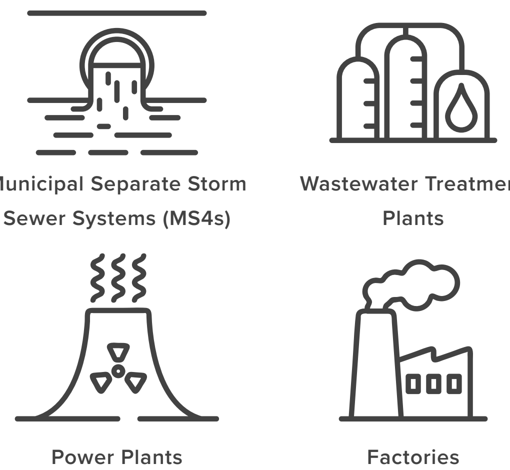


1. Freshwater streams are a source of drinking water.
2. Nutrients flow through terrestrial and aquatic ecosystems through complex feeding relationships known as food webs.
3. Streams provide opportunities for recreation.
4. Vegetation surrounding the stream (known as the riparian buffer) can filter out pollutants, slow down stormwater runoff, reduce flood severity, and protect banks and shorelines from erosion.
5. In-stream features like riffles, runs, and pools provide diverse habitat for aquatic organisms.
6. Macroinvertebrates can act as indicators of water quality.
7. Aquatic plants increase oxygen in the water through photosynthesis and provide habitat and food to animals.

WATER QUALITY THREATS

As water travels through the watershed, it collects substances including pollutants and transports them over and through the land and into streams. Pollution originates from two broad categories of sources: point sources and nonpoint sources.

What Makes Point Source Pollution?

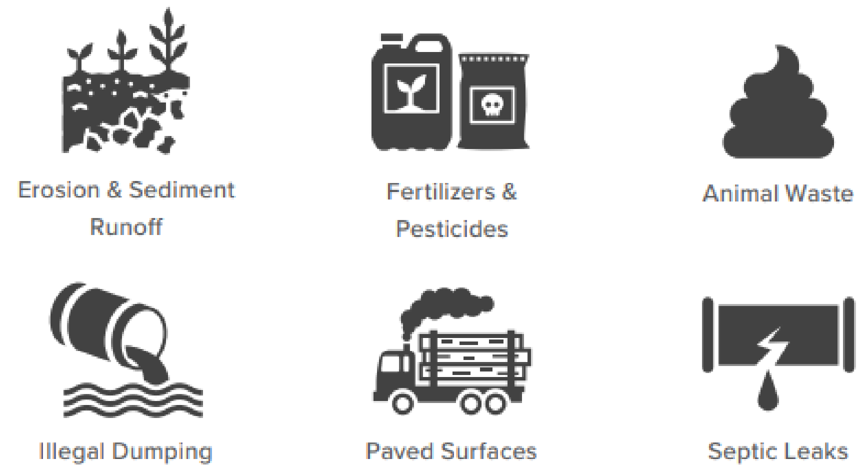


Point source pollution comes from a single, identifiable source, such as a discharge pipe. Examples include discharges from industries and municipal sewage treatment plants. These pollution sources are regulated by the South Carolina Department of Environmental Services (SCDES). Permits contain limits on what permit-holders can legally discharge, monitoring and reporting requirements, and other provisions to protect water quality, water uses, and human health. Nationally, the amount and severity of point source pollution have been drastically reduced since the Clean Water Act was implemented in 1972.

Nonpoint source pollution is the leading cause of water quality concerns across the nation. Nonpoint source pollution is any source of water pollution that does not meet the legal definition of a “point source.” It often comes from multiple, diffuse sources, and it can be difficult to identify and control. Water that runs into streams, lakes, and rivers

following rain events, called stormwater runoff, often carries nonpoint source pollution with it. Examples of nonpoint source pollution include runoff from agricultural fields, residences, golf courses, and parking lots. This runoff can carry pollutants such as sediment, nutrients, bacteria, and litter. Many impaired waterways have multiple sources of this type of pollution, making it difficult to address.

What Makes Nonpoint Source Pollution?



In addition to nonpoint source pollution, our waterbodies are also threatened by invasive species, harmful algal blooms, and increasing urban development. Invasive plants and animals can outcompete native species and damage the ecosystem. Harmful algal blooms (HABs) produce toxins that can be deadly to people and pets. Urban development can increase nonpoint source pollution through stormwater runoff from impervious surfaces. Impervious surfaces, such as roads and parking lots, prevent water from infiltrating the ground, which increases the volume and velocity of stormwater runoff. This can lead to flash flooding, increased erosion, and other problems. Impervious surfaces also increase the temperature of runoff, and this heat stress impacts aquatic organisms.

Volunteers can play an important role in monitoring water quality and sharing information about local water resources with their communities.

POLLUTANTS

Many "pollutants" in a stream are naturally occurring and are only considered pollutants when their presence impairs a waterway's ability to maintain life or threatens water uses. Monitoring helps identify possible pollution or changes in water quality. Some common pollutants affecting freshwater stream ecosystems are nutrients, sediments, and bacteria.

Nutrients such as nitrogen and phosphorus are natural and necessary for plant and algal growth and reproduction. Animal waste and decomposing plant matter are natural sources of nutrients in streams. Excess nutrients may enter the aquatic environment from human and animal wastes; fertilizer runoff from agriculture, golf courses, and commercial and residential properties; and atmospheric deposition. Nutrients become pollutants when they are too concentrated in the waterway.

Excess nutrient input can lead to harmful algal blooms.

Sediments in the water are also an important component of a freshwater stream ecosystem. Some sediment is necessary, but too much can negatively impact natural functions. Excess sediment can clog fish gills, limit sunlight penetration, and decrease photosynthesis rates. When the sediment settles to the streambed, it can bury benthic habitats and alter stream flow and morphology. Additionally, pollutants such as nutrients, metals, and bacteria may adhere to sediments. During rain events, sediments can enter streams in stormwater runoff.

Excess sediment can make water opaque.

Bacteria are microscopic organisms that are naturally present in streams. Many bacteria are beneficial and necessary for important processes such as nutrient cycling and decomposition. However, some bacteria are pathogenic (disease-causing) and may result in human health issues. Excess bacteria in streams is often a result of fecal contamination. Fecal coliform bacteria that live in the intestinal tracts of humans and other warm-blooded animals can be introduced to waterways through failing septic systems, sanitary sewer overflows, illegal dumping, and stormwater runoff carrying bacteria from livestock, pet, and wildlife waste.

Water quality standards for South Carolina are implemented by SCDES. The standards are designed to protect water quality for the waterbody's designated uses, such as maintaining aquatic life, contact recreation (swimming, boating, and wading), shellfish harvesting, fish consumption, and drinking water supply.

If you want to learn more about waters in South Carolina that do not meet state standards, explore SCDES's 303(d) List of Impaired Waters and TMDLs.

When a water quality monitoring location does not meet the water quality standard set to protect these uses, that site is listed on the 303(d) List of Impaired Waters ("303(d) List") for the pollutant that is exceeding the standard. The name of the list comes from Section 303(d) of the Clean Water Act, which mandates that all states create a list of impaired waters. If water quality improves, the monitoring site could be removed from the 303(d) List. If water quality does not improve, a Total Maximum Daily Load (TMDL) for the pollutant of concern may be developed, at which point the monitoring site would also be removed from the 303(d) List. If a monitoring site is not included on the 303(d) List, it does not necessarily mean the site has achieved water quality standards.

WATERSHEDS

To better understand how pollution impacts freshwater streams, it is important to understand where the water entering the system originates.

A watershed is an area of land and water from which water drains to a common point such as the inflow of a reservoir, mouth of a bay, or any point along a stream channel. Ridges and hills that separate two watersheds are called drainage divides.

Watersheds vary in size, and larger watersheds contain many smaller watersheds with different outflow points. We all live in a watershed, and our actions affect the health of local ecosystems as well as those downstream. The activities and land management practices within the watershed of your monitoring site can impact your data and observations.

Map of South Carolina Major Watersheds

South Carolina's water systems are commonly divided into eight major river basins: the Savannah, Saluda, Broad, Catawba, Pee Dee, Edisto, Santee, and Salkehatchie. Source: SCDNR

Program Overview and Goals

SC AAS volunteers holding dissolved oxygen sample bottles.

South Carolina Adopt-a-Stream (SC AAS) is a statewide volunteer water quality monitoring program where participants learn to assess the health and water quality of their local waterways. The program offers certification in four different protocols: **freshwater stream, tidal saltwater, macroinvertebrate, and lake monitoring.** Anyone interested in protecting South Carolina's waterways can be directly involved by monitoring with SC AAS.

Volunteer water quality monitors help our state by collecting data on waterways that may not be regularly monitored otherwise. These data establish baseline conditions, indicate possible water quality concerns, and are used for education. The data collected through SC AAS are not regulatory in nature and are not to be used for targeting neighbors or businesses.

MISSION, VISION AND GOALS

Mission: South Carolina Adopt-a-Stream empowers community members to protect and improve water quality through education and certified volunteer monitoring.

Vision: South Carolina is known for healthy watersheds because of a collaborative statewide network of volunteers.

GOALS

EDUCATION: Foster environmental stewards by educating communities about their watersheds.

CERTIFICATION: Certify volunteers to collect long-term water quality data accessible for public use.

COLLABORATION: Enable communities to address watershed needs through local partnership and collaboration.

CULTIVATION: Secure support and resources to ensure sustainable program growth.

SC AAS volunteers at a workshop.

Volunteers ADOPT sites to Actively collect Data Outdoors in order to Protect our waterways Together.

Data collected through the SC AAS program are publicly accessible for viewing and exporting from the SC AAS Database. When data fall outside of normal ranges, an email alert is generated for the SC AAS program coordinators and others who have signed up to receive alerts. Program coordinators can help connect volunteers with water quality professionals or local partner groups for follow-up when unusual data are submitted to the Database.

By joining SC AAS, you are agreeing to represent the program with integrity by:

- Following the SC AAS monitoring methods
- Fully and accurately documenting observations
- Reporting data to the Database in a timely manner
- Accurately and respectfully discussing the program with others

SC AAS monitoring protocols have been approved by an Environmental Protection Agency (EPA) Quality Assurance Project Plan. Volunteers must pass a certification test and be recertified annually. Only certified volunteers can upload data to the Database. These guidelines ensure the consistency and quality of data collected and reported by SC AAS volunteers.

ADOPT a STREAM

A

ACTIVE
Volunteers are actively monitoring across the state.

D

DATA
Baseline data are collected and stored for public use.

O

OUTDOORS
Monitoring is a good excuse to get outdoors.

P

PROTECT
Data helps the protection of streams.

T

TOGETHER
Monitoring helps improve waters together.

Selecting a Site

A freshwater stream site.

SC AAS volunteers are asked to sample monthly at the same location, at roughly the same time of day, during daylight hours. Sampling at the same time helps collect consistent baseline data, as certain parameters will vary in response to changes throughout the day.

Adopted sites must meet the following criteria:

- ☑ Safe stream access
- ☑ Clear location for you to set supplies down
- ☑ Wrist to hip-deep water
- ☑ Year-round flow
- ☑ Permission to access the site

If sampling near a bridge or road crossing, try to sample slightly upstream of the feature to avoid potential impacts from the crossing itself. By doing so, you are collecting water quality data representative of the watershed upstream of your site. Do not sample directly downstream of a lake, dam, or pipe.

You can choose where to sample! Adopt a new site or select a historic site that has not been monitored within the last year. You can choose to adopt more than one site. If you would like assistance, ask your trainer, a program coordinator, or a local water organization for advice on where to monitor.

IF SAMPLING ON PRIVATE PROPERTY:

- Seek written permission to access the property.
- Communicate sampling dates and times or set an agreed-upon monitoring schedule.
- Never misuse or harm private property.
- Share results of monitoring with landowners.
- Share the goals of SC AAS and data uses.

SAFETY

The safety of volunteers is of the highest priority. We care more about you than your data!

Do not sample during a storm. Wait until it has stopped and strong water flow has subsided.

Wear proper attire including gloves and closed-toed shoes.

Use the "buddy system." Sample with someone, even if they are not a certified volunteer, or tell someone else that you are going out into the field and how long sampling should take.

Be aware of surroundings and potential hazards including traffic, wildlife, harmful plants, stinging insects, slippery surfaces, steep banks, fast current, and other people.

Wash your hands after sampling. Your site may be contaminated with bacteria or other pollutants.

After sampling, rinse equipment with tap water and dry before storing. This helps prevent the transfer of invasive species and helps your equipment last longer.

Remember, if you believe that your monitoring location is experiencing an ongoing significant or harmful pollution event, do not sample and call the SCDES Emergency Hotline at 1-888-481-0125.

Monitoring Protocol: Observations

SC AAS volunteer observing water color from a clear container.

Observations should be made before any other tests are conducted. Visual monitoring allows you to identify problems or changes that may be impacting the stream ecosystem. Observing both physical and biological factors gives a snapshot in time of your site conditions.

Weather

At the time of your sampling event, record the present weather condition: **sunny, partly cloudy, intermittent rain, or steady rain.** In the Database, record rainfall accumulation as inches in the past 24 hours.

Sunny weather can increase plant photosynthesis while cloudy weather can reduce it. The amount of photosynthesis that occurs alters dissolved oxygen (DO) in the water. Precipitation can also greatly affect water characteristics. Rainfall may dilute point source pollution and lower pH levels, as rainwater is often slightly acidic. Rain may increase surface water runoff which carries nonpoint source pollution, causing skewed baseline data. Floods, droughts, or other climatic extremes can dramatically change the waterway's physical and chemical characteristics by creating sandbars, pools, widening a channel, and more.

Rainfall Data

You can find recent rainfall data on most weather websites; however, the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) is the recommended resource because it gives local amounts instead of regional ones. Learn more about this volunteer science program at cocorahs.org.

Do NOT sample during or just after rain events. How long you wait to sample after rainfall will depend on the size of your stream, its position in the watershed, and the amount of rainfall. We recommend waiting at least 24 hours, or until high flow has subsided, before sampling. Instead of skipping a month of data collection, simply move your sampling date to avoid rain events.

Water Surface

Conditions at the water surface can alter chemical and physical measurements. Note if any of the following are present:

Oily sheens can be caused by petroleum or chemical pollution, or they may be natural by-products of decomposition. To tell the difference between petroleum spills and natural oil sheens, poke the sheen with a stick. If the sheen swirls back together immediately, it may be petroleum. If the sheen breaks apart and does not flow back together, it is likely caused by bacteria or the decomposition of plants and animals.

Oily sheen on water.

Surface foam is common and can be naturally occurring. Vegetation can produce surfactants which can cause surface foam. Human-induced surface foam may be an unnatural color (red, pink, blue, yellow, or orange) and have a fragrant smell. This foam is most likely generated by household detergents and may be a sign of a failing septic drain field or an illegal discharge. You can also use the stick method previously described to determine if surface foam is natural or manmade.

Naturally occurring foam on water surface.

Algae are important to aquatic ecosystems, but excessive growth can occur when human activities introduce excess nutrients to the waterway. They can grow on the surface or form thick mats, impacting other organisms in the environment.

Algal Bloom

If algae are present at your monitoring site, note how widespread they are. In a balanced ecosystem, algae provide beneficial food and oxygen for the aquatic ecosystem but can cause issues when overgrowth occurs. When algae die and decompose, oxygen is decreased, which affects other aquatic life and water chemistry. Rapid growth of algae is called an algal bloom and can be associated with foam, scum, or thick layers of algae on or below the water surface.

When blooms produce toxins that may negatively impact the health of people, animals, and the environment, they are known as Harmful Algal Blooms (HABs). For HABs to grow and form they need sunlight, slow-moving water, nutrients (specifically nitrogen and phosphorus), and a warm water temperature. HABs are more likely to occur from late spring to early fall and are less likely to occur in winter months.

Algal bloom on water.

Water Color

The color of the water can provide immediate clues that indicate a waterway's condition. Looking directly into the stream will not result in an accurate observation because depth, vegetation, and the stream bottom can influence how you see water color. Instead, fill a clean, clear container (such as glassware from the monitoring kit) with sample water to determine color. Collect your sample below the water surface to avoid any algae, pollen, or debris that may be present.

- **Clear** water does not necessarily mean clean water but can indicate low levels of suspended or dissolved substances.
- **Brown/muddy** water is usually due to heavy sediment loads.
- **Green** water is often the result of excessive algae growth or the presence of phytoplankton.
- **Milky/white** water may be caused by salts in the water or can be a sign of an illicit discharge.
- **Tannic** water is natural in certain South Carolina waters and gets its "sweet tea" appearance due to the decomposition of leaves in the water that produce tannins.
- **Other** water colors can have a number of causes. If you believe an unusual water color to be the result of an ongoing pollution event, do not sample and call the SCDES Emergency Hotline at 1-888-481-0125. Make sure to take photos of the water.

Tannic water in blackwater streams has a reddish-brown color but is transparent.

Water Odor

Water odor can also provide immediate clues about water quality. Make sure you are smelling the water from your sample cup and not the air. This should be one of the first things you observe upon visiting your site so that you do not acclimate to the smell and become "nose-blind."

- **Gasoline** or any petroleum/chemical smells may indicate serious pollution problems from a direct source, such as a factory, parking lot, boat, marina, or storm sewer runoff.
- **Sewage/manure** smells can be common in the air but should not be what our water smells like. Both can be an indication of an ongoing pollution event.
- **Fishy** odors may be a sign of dead and decomposing fish in the water.
- **Chlorine** smells may be a sign of pollution and will smell like a swimming pool.
- **Other** odors can be from a wide variety of causes. Look around your sample site to identify any potential odor causes.

Water Clarity

Clarity is a measure of how far light can penetrate into the water. Suspended sediment or algae in the water column can impact water clarity. Note if the water appears **clear, cloudy**, or **opaque** when looking through your clear sample cup.

Clear water vs. opaque water.

Trash Cleanup

It is a good idea to bring a garbage bag when sampling. If litter that you can discard is present, please clean the site. If there are tires or other large, potentially hazardous materials present, take photos and record **concern of illegal dumping**. This will generate an alert to PalmettoPride, our litterbug busting partners.

Get litter clean up supplies from palmettopride.org.

Illegal dumping is defined as more than fifteen pounds of solid waste, litter, deceased animals, or other materials which create a hazard to public health and welfare. Careless, scattered littering of smaller items is not considered illegal dumping.

Illegal dumping at an SC AAS monitoring site.

Outfall Flow

Pay special attention if pipes are flowing during dry spells. This could be an illegal discharge or pollution event.

Security and Hazards

Note any security issues or hazards at your site. These could include evidence of **drug abuse**, **vagrancy**, **dangerous animals**, **a steep bank**, **fast current**, **harmful waste**, or **other issues**. If you ever feel unsafe while sampling due to factors such as these, please consider adopting a new site.

Barriers to Fish Movement

Record any barriers that could prevent fish from freely moving from one part of the stream to the other, such as **low flow, dams,** and **perched culverts**. A perched culvert is an outlet elevated above the downstream water surface. This could prevent the movement of migrating fish.

A culvert.

Bacteria Sources

Make note of any potential sources of fecal bacteria visible at the time of your sampling, such as waste from a **dog, goose, livestock, human,** or **other** source.

Reach Dimensions

To determine the reach of your stream, measure from one side of the water to the other to find your channel width, then multiply this result by 12. Measuring the reach dimensions of your stream each month is optional. A measuring tool can be purchased at most hardware stores.

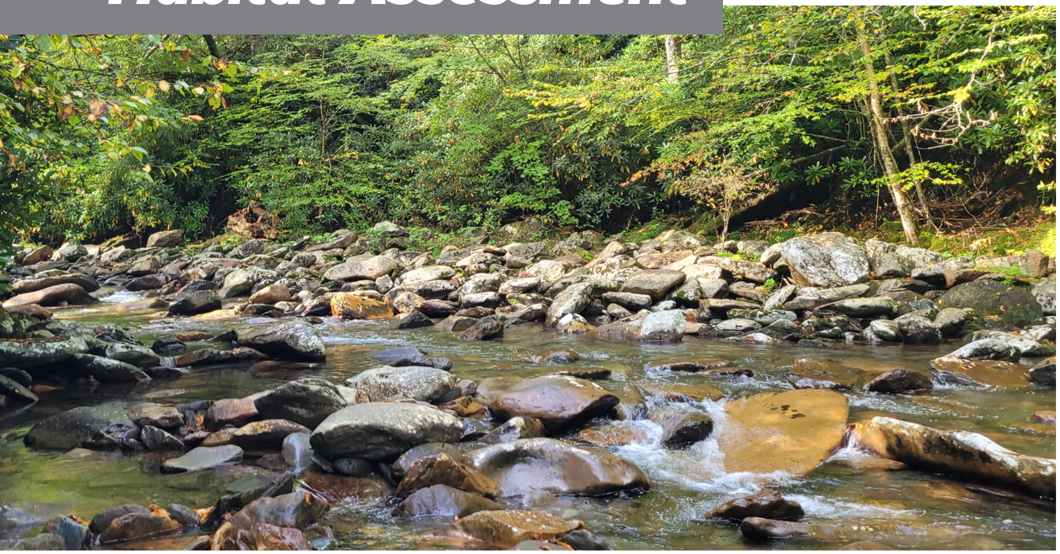
Photos

Photos are VERY important to collect and upload. Take photos in the upstream and downstream direction. Be consistent with photos to see changes over time and include a landmark in the photo for reference.

In the additional photo field in the SC AAS Database, please include images of anything of concern (like litter, hazards, or pollution) or fun group pictures. Extra photos can be sent to scaas@des.sc.gov.

Seasonal changes at SC AAS site CRC-1234 in Greenville County.

Monitoring Protocol: Habitat Assessment



A rocky stream site.

Each time you sample, it is important to assess the area surrounding your stream, record conditions, and note changes. If you have calculated the reach of your stream, use this distance to complete your habitat assessment. Otherwise, evaluate the area visible from your sampling site.

RIPARIAN BUFFER VEGETATION

Riparian zones, the areas adjacent to a stream, are important because they buffer waterways from the impacts of land use. Vegetated riparian zones slow down stormwater runoff, which increases water infiltration, reduces excess nutrients entering waterways, and traps sediment. In urban watersheds with impervious surfaces that heat runoff, riparian zones allow water to cool before it enters waterways. Vegetated riparian zones also provide shade for waterways and habitat for wildlife. They also help to stabilize banks, protecting them from erosion.

Note the presence of **trees, shrubs, herbaceous plants, mowed grass, bare soil,** and **unseasonable loss of vegetation** at your site. Record any major changes that have occurred in the riparian buffer since the last sampling event, such as mowing, land clearing, or riparian buffer planting.

LOCATED WITHIN 100 FEET OF WATERWAY

Make note of anything that may be disrupting the riparian zone and non-natural land uses that exist within 100 feet of the stream such as:

- **Industrial** *(manufacturing, mining, waste management, etc.)*
- **Commercial** *(retail, office, restaurant, hotel, etc.)*
- **Agricultural** *(cropland, pastureland, animal operations, etc.)*
- **Residential development**
- **Recreational** *(trail, golf course, park, sports field, etc.)*
- **Paved surfaces** *(parking lots, roads, bridges, sidewalks)*
- **Other**

STREAMBANK CONDITION

Both human activities and natural disasters can have adverse impacts on streambanks. Land use changes and heavy rainfall may result in increased volume and velocity of flow that can lead to bank destabilization and erosion.

Note whether the streambank is **steeply sloping, gently sloping,** or **undercut**. Record significant changes to the streambank since the last sampling event.

An eroded streambank.

IN-STREAM HABITAT

A variety of in-stream habitats is necessary to support healthy and diverse aquatic ecosystems. Record any of the following habitats you observe:

- A **riffle** is a shallow area of the stream that has a swift current and water that is normally "bubbling" due to a rocky streambed.
- A **run** has a moderate current, medium depth, and smooth water surface.
- A **pool** is deep and slow-moving and often found at a channel bend or downstream of a riffle, boulder, or tree.
- A **leaf pack** is a cluster of leaves and organic debris on the edge of a stream or on the upstream side of large rocks, fallen trees, or logs.
- **Aquatic vegetation** grows in water and can be floating, submerged, or emergent (rooted in the stream bottom with leaves and stems extending out of the water).

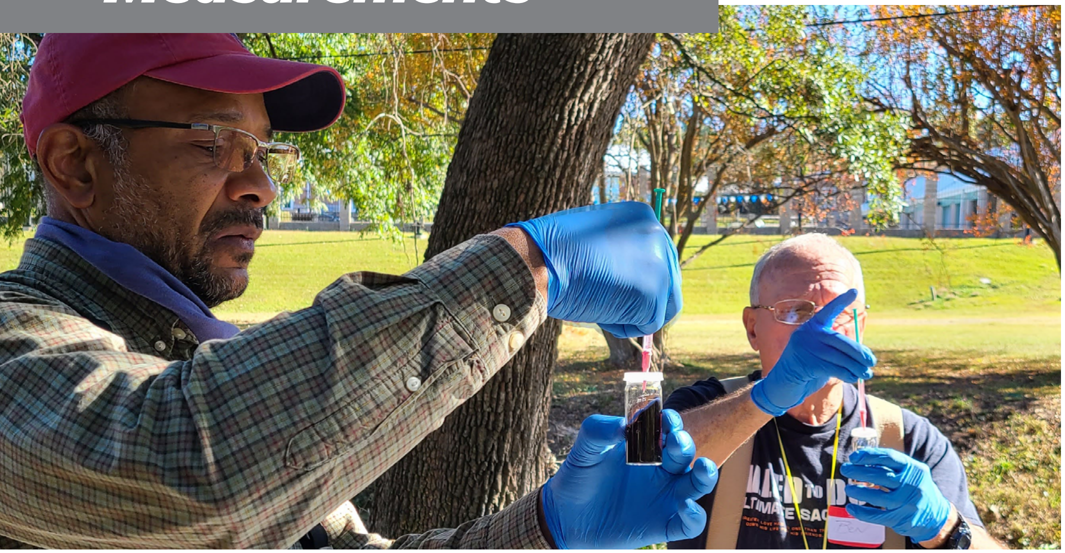
WILDLIFE SURVEY

The wildlife survey can be useful in determining the long-term baseline conditions of your site. Many species require a specific set of conditions to thrive, and their presence or absence can provide insight into habitat quality. While you are sampling, make note of any wildlife you observe.

Wildlife you may encounter at a freshwater stream site.

A stream in Paris Mountain State Park.

Monitoring Protocol: Measurements



SC AAS volunteers performing a dissolved oxygen titration.

Physical and chemical monitoring allows you to gather information about specific water quality characteristics that are indicative of stream health. Volunteers monitor these five parameters monthly:

- Air temperature
- Water temperature
- Transparency
- pH
- Dissolved oxygen (DO)

Regular monitoring enables data to be compared over time. It is important to understand that water chemistry is very complex and that natural variation in some parameters is not unusual, but actually the norm. The following are some examples of how environmental conditions can influence water chemistry:

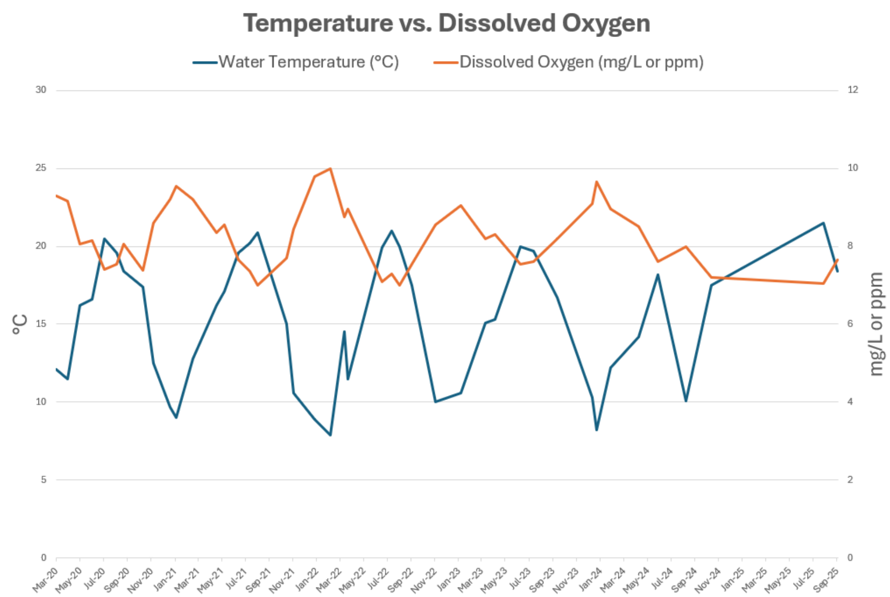
- **Time of Day** – Dissolved oxygen (DO) levels rise during sunlight hours due to increased photosynthesis in aquatic plants and algae. DO levels decrease overnight when photosynthesis is not occurring.
- **Weather** – Runoff from heavy rains can transport pollutants and sediment to streams. Wind, storms, and other weather events affect temperature, transparency, and more.
- **Physical Influences** – Alterations in vegetative communities, fires, landslides, drought, and other changes in the physical landscape can impact temperature, transparency, pH, and DO.

TEMPERATURE

A volunteer reading an armored case thermometer.

Water temperature is an important factor in determining which species may or may not be present in the stream ecosystem. Temperature greatly affects feeding, reproduction, and the metabolism of aquatic animals. A week or two of high temperatures may make the habitat unsuitable for sensitive aquatic organisms, even if temperatures are within tolerable levels the rest of the year. Not only do different species have different requirements, but optimum habitat temperatures may also change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adult fish.

Temperature is also very closely linked with dissolved oxygen concentrations in waterbodies. The higher the water temperature, the less oxygen water can hold. Cooler winter waters will have higher dissolved oxygen levels, and hotter summer waters will have lower levels. This is why you may see stories about fish kills in the heat of summer and why temperature and oxygen-sensitive fish species, like trout, only thrive in cold streams.



Long-term temperature and dissolved oxygen data from SC AAS site CRC-1234 in Greenville, SC.

To measure temperature, use an armored case thermometer. Take air temperature first as a reference point for the water temperature. Record measurements in degrees Celsius (°C).

Measuring Air Temperature:

- ALWAYS take air temperature before water temperature.
- Suspend the thermometer in the shade. You can use your body to create shade if none is available.
- Let the thermometer stabilize for at least 60 seconds before reading the result.
  - » It may take longer for the thermometer to stabilize if you are moving it from an air-conditioned location to the hot summer air or if the thermometer has been sitting in direct sunlight.
- Hold the thermometer from the top and away from you. Do not wrap your hand around the bottom of the thermometer when taking the reading as this will increase the temperature.
- Record air temperature in °C.

If you have an unexpected measurement, check to make sure your thermometer does not have any breaks or air bubbles in the color line.

Measuring Water Temperature:

- Submerge the thermometer in the stream and let it stabilize for at least 60 seconds before reading the result.
- If possible, read the thermometer in the water. If not, read immediately after removing from the water. Remember to hold the thermometer from the top and away from you.
- Record water temperature in °C.

Temperature Conversion Chart

°C	°F	°C	°F	°C	°F	°C	°F
0	32	10	50	20	68	30	86
1	33.8	11	51.8	21	69.8	31	87.8
2	35.6	12	53.6	22	71.6	32	89.6
3	37.4	13	55.4	23	73.4	33	91.4
4	39.2	14	57.2	24	75.2	34	93.2
5	41	15	59	25	77	35	95
6	42.8	16	60.8	26	78.8	36	96.8
7	44.6	17	62.6	27	80.6	37	98.6
8	46.4	18	64.4	28	82.4	38	100.4
9	48.2	19	66.2	29	84.2	39	102.2

TRANSPARENCY

Volunteer using transparency tube.

Transparency, or the clearness of water, is a measure of light penetration into a waterbody. It is affected by both the color of the water and materials suspended in the water. Transparency is measured using the metric system (meters or centimeters). The terms clarity and transparency can be used interchangeably.

Turbidity, or the cloudiness of water, is a measure of how light is scattered and blocked by suspended materials in the water. Suspended materials may include soil, algae, and phytoplankton. Turbidity is measured in Nephelometric Turbidity Units (NTUs).

Transparency and turbidity are inversely related: the higher the turbidity, the less transparent the water. There are no state standards in South Carolina for transparency, only turbidity. The SC AAS Database automatically converts transparency tube values to turbidity values for data to be compared to state standards. Transparency and turbidity can indicate erosion or land use changes in your watershed and may influence the suitability of a waterway as habitat for aquatic organisms.

To measure transparency, SC AAS uses a transparency tube. The transparency tube is filled with stream water, which is then slowly released from the bottom until it is possible to distinguish the black from white quadrants of the Secchi disk inside the tube.

STATE STANDARDS:

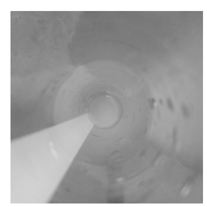
To meet state standards for turbidity, most freshwater streams must not exceed 50 NTUs, provided existing uses are maintained.

In special trout waters in the Upstate and Lower Saluda, turbidity must not exceed 10 NTUs or 10% above natural conditions, provided uses are maintained.

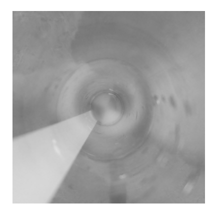
For reference, 50 NTUs is equivalent to 16.6 cm on a transparency tube, and 10 NTUs is equivalent to 52.2 cm.

Measuring Transparency:

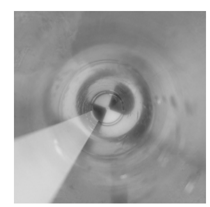
- Remove hats and sunglasses. Perform this test in the shade or indirect sunlight to eliminate glare.
- Fill the transparency tube to the top. Be careful not to stir up the bottom sediment when collecting water.
- If you are unable to fill the tube completely, use an extra container to fill to 120 cm.
- Sample water should be well-mixed. Place your hand over the end of the tube and gently invert to resuspend sediments.
- Press down on the tube to slowly release water, stopping at the point where the black and white quadrants can just begin to be discerned.
- Using the ruler on the tube, record your measurement in centimeters (cm).
- After sampling, rinse any mud or debris from the transparency tube and allow to dry completely before storing.



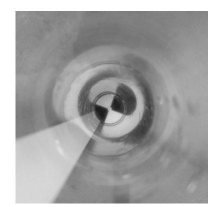
Full tube



Record measurement



Too far



Empty tube

Volunteers using the color comparator.

pH

pH is a measure of how acidic or basic a substance is and uses a scale of 0.0 to 14.0. A pH of 7.0 is neutral, a pH greater than 7.0 is basic, and a pH less than 7.0 is acidic. The pH scale is logarithmic, so every unit of change in pH represents a tenfold change in acidity. A pH of 6.0 is 10 times more acidic than a pH of 7.0, and a pH of 5.0 is 100 times more acidic than a pH of 7.0.

pH Scale

	pH	Example
Increasingly Acidic	0	Battery acid
	1	Gastric acid
	2	Lemon juice
	3	Apple juice
	4	Tomato juice
	5	Black Coffee
	6	Milk
Neutral	7	Water
	8	Egg
	9	Baking Soda
	10	Milk of Magnesia
	11	Ammonia solution
	12	Soap
	13	Bleach
Increasingly Alkaline	14	Drain cleaner

The pH of water is influenced by the types of soils in the watershed and the concentration of acids in rain. Acid rain is formed when carbon dioxide from the atmosphere enters falling rain, forming a weak carbonic acid. Typical rainfall in the US is slightly acidic with a pH ranging from 5.0 to 5.6. Very acidic water can react with soils and allow toxic substances, such as ammonia and heavy metals, to leach out. This can have a harmful impact on aquatic communities.

Certain waters in South Carolina's coastal plain naturally have a lower pH. These rivers and swamps are known as blackwater systems. In these slow-moving streams, vegetation decays and adds tannins to the water. These tannins cause the water to become acidic and colored reddish brown to black. An example of this is the Edisto River.

STATE STANDARDS:

In freshwater habitats in South Carolina, pH levels should fall between 6.0 and 8.5 to meet state standards.

In special trout waters in the Upstate and Lower Saluda, pH levels should fall between 6.0 and 8.0. Specially designated areas of the coastal plain, such as swamps and blackwater systems, may have lower pH levels due to natural conditions.

pH is measured by adding an indicator solution to a sample of water to produce a color change. The color of the sample is then matched to a color comparator to determine the pH level.

Make sure to compare the tube to both color comparator slides.

Measuring pH:

- Rinse the plastic tube twice in the stream.
- Facing upstream, collect water samples from a well-mixed, flowing section of water.
- Fill the tube to the 10 mL line with sample water.
  - » Water in your tube will form a curve known as the meniscus. The bottom of the meniscus should align with the 10 mL mark.
  - » To get exactly to the 10 mL mark, it is helpful to flick water out of the tube rather than attempt to pour out excess water.
- Add 10 drops of the pH Wide Range Indicator, holding the bottle vertically.
- Cap and gently invert the tube several times to ensure even mixing.
- Compare the tube to **both** color comparator slides.
  - » Use a white piece of paper behind the comparator for best accuracy.
- Record pH by matching your sample to the closest color on the color comparator.
  - » The pH color comparator scales are in increments of 0.5. **Do NOT estimate between marked increments.**
- Repeat this process with the second tube.
- Both pH results must be recorded in the SC AAS Database.
- **The duplicate precision for pH is ± 0.25.** If your two sample results differ by more than 0.25, resample until your results are within this acceptable range.
  - » Because the pH color comparator scale is in increments of 0.5, your two sample results must be identical.
- Empty both tubes into your waste container. Rinse each tube twice with rinse water and discard into the waste container.

SC AAS volunteer performing a dissolved oxygen titration.

DISSOLVED OXYGEN

Like organisms that live on land, aquatic organisms need oxygen to survive. Dissolved oxygen (DO) is the oxygen available in water for aquatic species and is measured in milligrams per liter (mg/L) or parts per million (ppm). DO levels in streams naturally fluctuate throughout the day, seasonally, and in response to environmental changes. You may see a wide range of values during your monitoring trips.

The amount of DO an aquatic organism requires varies by species and life stage. Fish and invertebrates usually require DO levels of 5.0 to 6.0 mg/L for growth and activity. When DO levels drop below 2.0 mg/L, species who are able to move will relocate to areas with higher DO.

Critically low oxygen levels often occur during the warmer summer months when solubility decreases and oxygen demand increases. Living organisms increase their activity in warm water, which requires more oxygen to support their metabolism.

Factors That Influence Dissolved Oxygen	
Increases DO	**Decreases DO**
• **Cooler temperatures**, which increase solubility of oxygen • **Atmospheric diffusion**, which adds oxygen to the water from the atmosphere • **Turbulent mixing**, which adds oxygen to the water when wind or currents agitate the water's surface • **Photosynthesis**, which produces oxygen as a byproduct when plants, algae, and phytoplankton use energy from the sun to make sugars	• **Warmer temperatures**, which decrease solubility of oxygen • **Slow-moving, deep water**, which lacks turbulent mixing • **Decaying organic matter**, which consumes oxygen when bacteria decompose dead plants and animals • **Low transparency**, which prevents plants from photosynthesizing

STATE STANDARDS:

For the majority of South Carolina's fresh waters, DO levels must have a daily average of 5.0 mg/L and not less than 4.0 mg/L.

Dissolved oxygen is measured using the Winkler Titration Method, which involves adding a series of chemicals to the sample.

Measuring DO:

- Wear gloves and closed-toed shoes. Protective eyewear is encouraged.
- Rinse both bottles twice with sample water.
- Completely fill both bottles with sample water and cap underwater to prevent air bubbles.
  - » Air bubbles will skew your measurements.
  - » Flip sample bottles upside down to make sure no air bubbles are hiding in the caps.
- Add 8 drops of Manganous Sulfate Solution (chemical #1) and 8 drops of Alkaline Potassium Iodide-Azide (chemical #2) to each sample bottle.

  - » Hold the chemical bottles upside down and completely vertical to dispense drops evenly.
  - » Do not leave the cap off of your sample bottles for longer than necessary, as DO can still fluctuate.
- Cap and gently shake the bottles until a cloudy, white to brownish-orange floc forms. Allow this floc to settle past the shoulder of the bottle before moving on.

Wait for the floc to settle past the curved shoulder of the sample bottle.

- Add 8 drops of Sulfuric Acid 1:1 (chemical #3) to each bottle.
  - » Hold the chemical bottles upside down and completely vertical to dispense drops evenly.
  - » Do not leave the cap off of your sample bottles for longer than necessary, as DO can still fluctuate.
- Shake the bottles until the samples are a clear, amber color throughout. DO in your sample is now fixed and will no longer fluctuate if exposed to air.
  - » If you still see dark solids in the solution, you can add another drop of chemical #3 to both glass bottles and shake again. If they still do not disappear, they could be organic matter from the water. Proceed to the next step.
- At this point, keep both sample bottles and their corresponding glass cylinders and titrator syringes separate. The two samples will be compared to ensure duplicate precision.
- Rinse each glass cylinder twice with your corresponding sample. Pour the sample rinse water into your waste container.
- Fill each glass cylinder with 20 mL of your sample.
  - » Water in your cylinder will form a curve known as the meniscus. The bottom of the meniscus should align with the 20 mL mark.

   » If you overfill your cylinder, pour off excess into your waste container.

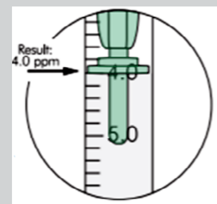
- Firmly insert the tip of the titrator syringe into the Sodium Thiosulfate 0.025N (chemical #4). Turn the bottle upside down and slowly pull back the plunger of the syringe to fill it to the 0 mL mark.
   » Make sure there are no air bubbles in the syringe. Bubbles can be dislodged by tapping the side of the syringe or by pushing in the plunger until the bubble disappears. Always refill to the 0 mL mark.
- Insert the syringe into the small hole on the glass cylinder's lid.
- Slowly add 1 drop of chemical #4 to your sample and swirl the cylinder. Repeat until the solution is a pale yellow color.

Before adding chemical #5, the solution will be a noticeably paler yellow than the original sample.

- Remove the syringe and glass cylinder lid. Set the syringe safely to the side as you will need it again.
- Add 8 drops of Starch Indicator Solution (chemical #5) to the cylinder. Cap and swirl the cylinder until the solution is an even, purple-blue color.

Once you add chemical #5, your solution will change from pale yellow to dark purple or blue.

- Reinsert the syringe into the cylinder lid and again dispense 1 drop of chemical #4 to your sample. Swirl thoroughly after every drop. Repeat until the solution is clear.
   » Once the solution is a pale purple color, check it against a white piece of paper after each drop so it is obvious when it turns fully clear.
   » If you have dispensed your entire syringe and the solution is still not clear, refill the syringe to the 0 mL mark and continue to add drops until the solution turns clear. Add 10.0 mg/L to your final DO measurement to account for the first syringe.



Read the syringe from the bottom of the green ring. In this example, the result is 4.0 mg/L or ppm.

- Remove the syringe from the cylinder and hold it with the tip pointing down. Read the syringe from the bottom of the solid green ring. Each division on the syringe is 0.2 mg/L.
- Record your DO values for each sample to one decimal place in mg/L or ppm.
- Both final results must be recorded in the SC AAS Database.
- **The duplicate precision for DO is ± 0.6 mg/L.** If your two sample results differ by more than 0.6 mg/L, resample until your results are within this acceptable range.
   » Begin titrating from the fixed sample. If your results are still not within duplicate precision, start from the beginning.
- Empty all bottles, cylinders, and syringes into the waste container. Rinse bottles and cylinders twice. Do not rinse the syringe or take off the tip.

For a visual walkthrough of the DO titration process, see the appendix.

CHEMICALS AND KITS

Store your kit in a cool, dry place (NOT in a hot car or garage). Check that the chemicals used for pH and DO testing are not expired before sampling. Expiration dates can be found on the labels of each chemical bottle. After your sampling event, rinse your sampling equipment and let it dry. If you are on a public sewer system, sampling waste can be poured down your sink at home with extra water or flushed down the toilet. If you are on a septic system, do not dispose of your waste at home. Return your sampling waste to your kit loan location or dispose of it in a location connected to the public sewer system.

To replenish the chemicals in your SC AAS monitoring kit, consider purchasing kit refills online. Visit our website to view a list of suppliers. Please contact your trainer(s), kit loan location, or the program coordinators at scaas@des.sc.gov for guidance and to return any expired chemicals.

SC AAS chemical kits.

Monitoring Protocol: Bacteria


SC AAS volunteers practicing plating water samples at a workshop.

Bacteria are microscopic, single-celled organisms. Under favorable conditions, bacteria can reproduce rapidly and form colonies that are visible without magnification. They are the most numerous life form on the planet and can survive and adapt to almost all conditions. Most bacteria are beneficial and responsible for important environmental processes such as decomposition, nutrient cycling, and the breakdown of toxins. However, some bacteria are pathogenic, or disease causing, and may result in human health issues.

> Some human health concerns related to high bacteria levels include swimmer's ear, dermatitis, and gastrointestinal illnesses such as giardia.

Bacteria that live in the intestinal tracts of warm-blooded animals and are present in human and animal waste are called fecal coliform bacteria. *Escherichia coli (E. coli)* is one species of fecal coliform bacteria that is known as an indicator species. Its presence in surface water can indicate that other disease-causing organisms, such as viruses, protozoa, and pathogenic bacteria, may be found. *E. coli* is naturally found in South Carolina's waters, and by itself is generally not a cause for alarm. However, excessive levels may indicate water quality concerns.

Bacteria can enter water through many avenues. Broken sewer pipes, illicit discharges, and stormwater outfalls are a few of the potential point sources for fecal material. Large rain events, power failures, and technical problems can cause excessive volumes of water to enter wastewater treatment plants, potentially resulting in partially treated sewage being discharged directly into rivers and streams. Fecal matter can also be transported to waterways through runoff from rain events. Stormwater runoff can collect bacteria from agricultural operations, pet and wildlife waste, failing septic systems, and garbage. Bacteria can even attach to soil particles and wash into the stream.

SC AAS volunteers counting bacteria colonies on photos of Petrifilm® plates.

SAMPLING CONSIDERATIONS

Bacteria monitoring should be completed during monthly sampling events under normal flow conditions. Do not sample during or just after a rainstorm, as rain runoff can increase the amount of bacteria in a stream. Bacteria replicate faster in warmer environments, so there may be an increase in the number of bacteria colonies that you record during the summer.

The sampling process can be broken into six steps:

1. Preparing the blank/control
2. Collecting a sample
3. Plating
4. Incubating
5. Counting
6. Disposal

BEFORE FIELD SAMPLING

Before visiting your stream site, you will collect a tap water sample to act as your blank. Using a blank ensures you are practicing sterile techniques that prevent contamination. The blank should travel with you throughout your sampling event. The blank is plated and analyzed alongside stream samples.

- Using a permanent marker, label one Whirl-Pak® bag as "blank" and record the date and time.
- Put on gloves and remove the perforated seal from the top of the Whirl-Pak® bag.
    - » Do not touch the inside of the bag as this could contaminate your sample and alter the results.
- Use the two small white tabs to open the bag.
- Fill the bag two-thirds of the way full with tap water.
- Grab the twist ties and whirl the bag, spinning away from your face. Cross the twist ties to close the bag.

- Flip the bag upside down and squeeze gently to ensure no water leaks out.
- Place the bag into a disinfected cooler with ice or an ice pack and take it with you throughout your sampling event.
- Before you leave, turn on your incubator and set it to 35 °C so it has reached the proper temperature when you return.
  - » For accuracy, use a digital max-min thermometer to measure the internal temperature instead of the incubator display.

Store stream sample water in a cooler alongside your blank tap water.

DURING FIELD SAMPLING

Collecting water samples for bacteria monitoring should be the last thing you do at your site. Keep the water samples out of the sun, as UV light and heat can alter the bacteria results.

- Label an unopened Whirl-Pak® bag using a permanent marker with the site name, date, and time.
- Wearing gloves, remove the perforated seal from the top of the Whirl-Pak® bag.
  - » Do not touch the inside of the bag as this could contaminate your sample and alter the results.
- Use the two small white tabs to open the bag.
- While holding the twist ties, place the bag in the water and allow the water to fill the bag two-thirds of the way full.
  - » Collect the sample in an area of flowing water at least wrist deep and upstream of where you are standing.
  - » Avoid areas where you have disturbed the stream bottom. Empty and refill if sediment enters the bag.

- Grab the twist ties and whirl the bag tight, spinning away from your face. Cross the twist ties to close the bag.
- Flip the bag upside down and squeeze gently to ensure no water leaks out.
- Immediately place the Whirl-Pak® bag into the cooler with ice and the blank.
- Samples can be held on ice or refrigerated for up to 24 hours, but optimal holding time is less than 6 hours.
- Make sure to collect paper towels, gloves, the Whirl-Pak® seal, and any litter at your site to properly dispose of after sampling.

AFTER FIELD SAMPLING

Analyzing the water for bacteria involves plating and incubating the blank and stream samples. After 24 hours, you will complete the process by counting the bacteria colonies that have grown on each plate.

Petrifilm® plates should be stored in the freezer. Before use always check expiration dates. To store an opened Petrifilm® pouch, fold the end over, tape shut, and place in a sealable plastic bag or container to prevent moisture from reaching the plates.

Plating

- Put on gloves and remove four Petrifilm® plates from the freezer. Allow them to thaw to room temperature. This will only take a few minutes.
  - » Use plates before the expiration date on the package.
  - » When handling the Petrifilm® plates, do not touch the pink center even when it is covered by the top film.
- Label each plate with the site number, plate identification, and the incubation start time and date.
  - » You will use one blank plate as well as three stream sample plates for each site you monitor.
- Gently shake the blank Whirl-Pak® bag to ensure an even mix of the sample.

- Place the blank bag in the plastic cup to keep it upright. Open the bag using the white tabs.
  - » Do not touch the inside of the bag as this could contaminate your sample and alter the results.
- Carefully insert your pipette into a pipette tip from the sterile container.
- Load 1 mL of the blank water into the fixed-volume pipette.
  - » Push the pipette plunger down to the first "stop," submerge the tip into the sample, and release the plunger.
  - » Always hold the pipette vertically while the tip is full of water.
- Using the corner, lift the clear top film of the Petrifilm® plate.

Do not touch the pipette tip with your hands or allow it to touch anything other than the water sample.

Dispense the blank water on the center of the plate by pushing the plunger all the way down to the second "stop".

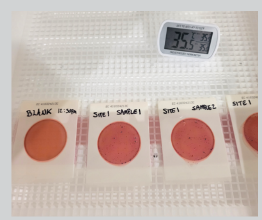
  - » Do not let the pipette tip touch the plate.
- Slowly lower the top film until the plate is completely covered.
  - » If air bubbles are present on your plate, discard that plate and try again.

Carefully plate samples to avoid air bubbles.

- Dispose of the pipette tip and the blank tap water.
- Gently shake the stream sample Whirl-Pak® bag to ensure an even mix.
- Repeat the plating process with water from your stream sample using a single pipette tip for all three of the stream sample Petrifilm® plates.

Incubating

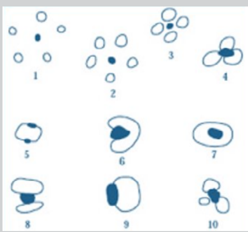
- After plating, leave plates undisturbed for one minute to allow the gel to solidify, then place them flat in the incubator pre-warmed to 35 °C.
  - » The top film side should be facing up.
- Place the incubator lid on top. The lid handles and base indents are labelled left and right, so be sure to orient them correctly.
- Incubate samples for 24 hours ± 1 hour.
  - » For example, if you started incubation at 2:00 PM on Tuesday, you would have between 1:00 PM and 3:00 PM on Wednesday to read your results.
- The internal temperature of the incubator must remain at 35°C ± 1°C for the duration of incubation.
  - » If the digital max/min thermometer indicates a temperature fluctuation outside of this range, the samples must be discarded.
- After 23-25 hours, put on gloves and remove the plates from the incubator. Record the minimum and maximum temperatures displayed on the thermometer as well as the time plates were placed in and taken out of the incubator.



Place the incubator away from areas where temperature fluctuations are more likely, such as near a vent or window.

Counting

- Count the *E. coli* colonies on each plate. These appear blue and are closely associated with gas bubbles.
  - » Do not count blue colonies without gas bubbles, any red colonies, or *E. coli* colonies on the border or outside of the pink circle.
- On your data form, record your bacteria count for each of the four plates.
  - » The SC AAS Database will calculate your final result by taking the average of the three sample plates and multiplying this by 100. This yields a result of colony forming units per 100 milliliters of water (CFU/100 mL).
  - » The blank plate should not grow bacteria. If your blank has any bacteria colonies, discard all plates and resample. Contact your water supplier or disinfect your well if bacterial colonies continue to appear.



E. coli colonies can have a variety of gas bubble association patterns. Here are some examples of patterns you might observe.

Getting High Bacteria Counts

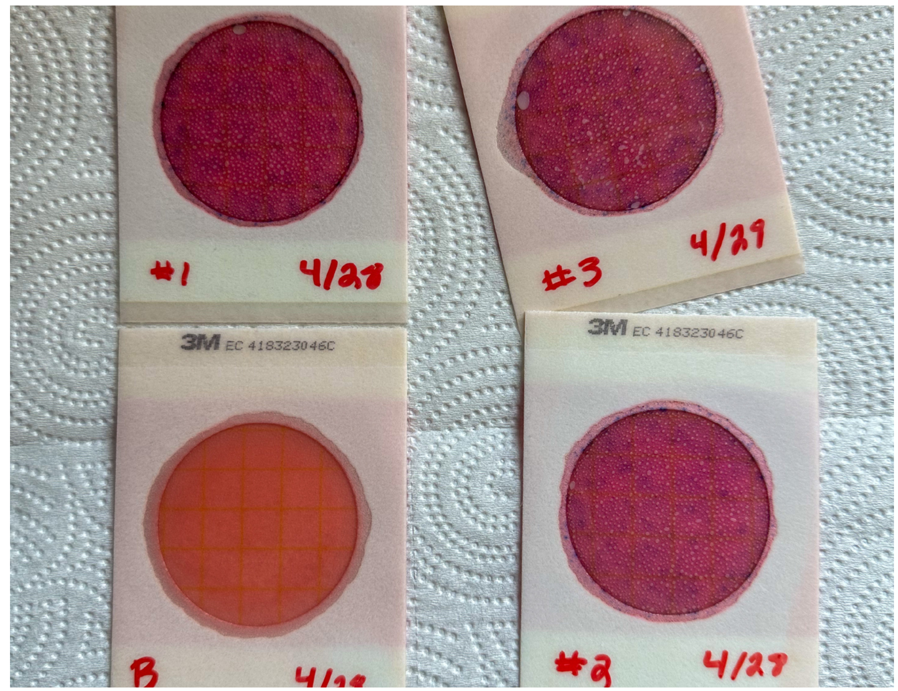
When *E. coli* colony counts exceed 1000 CFU/100 mL, an email alert is generated for the SC AAS program coordinators and others who have signed up to receive alerts. If your bacteria count is over this threshold, it may be a one-time event or occurrence. Upload your initial observation to the Database and return to the site as soon as possible to collect another bacteria sample.

When you return to your site, pay careful attention to anything out of the ordinary. Look for the presence of animals and be alert for any unusual odors. If you have access and permission, walk the banks to look for obvious sources of pollution. Make sure to note past and current weather

conditions. Always wear gloves while sampling and wash your hands carefully afterwards.

If you continue to find counts above the 1000 CFU/100 mL threshold, one of the program coordinators will contact you for more information. You can also alert your trainer, a local water organization, or other officials about your monitoring efforts and the results.

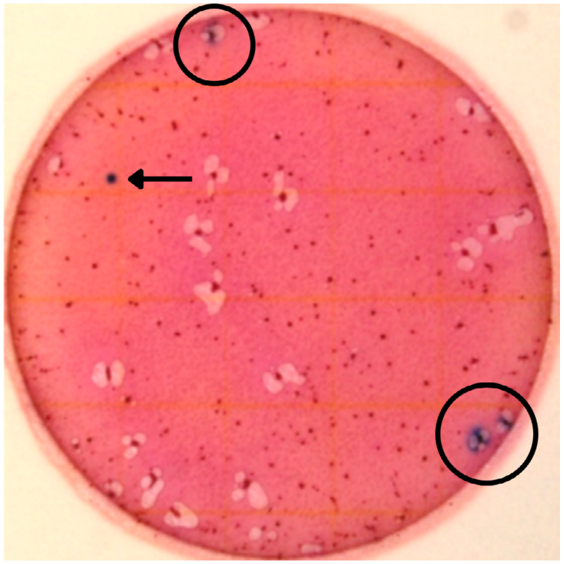
You may encounter a plate with colonies that are too numerous to count (TNTC). High concentrations of *E. coli* will cause the entire growth area to turn a deep purple color. The plate will be filled with colonies and barely have any empty space present. If this happens, take photos of the plates and record each colony count as “50” to generate an alert to the program coordinators. In the comment box of the bacteria section, record “TNTC” and resample your site as soon as possible.



TNTC plates and a blank sample plate.

Disposal

- To dispose of plates, lift the film to spray each one with an antibacterial disinfectant. Place them in a sealed zip lock bag and discard in the trash.
- Disinfect your workspace, incubator, and cooler.



Three *E. coli* colonies are present on this plate (circled). The arrow indicates a blue colony without an air bubble, which means it is not an *E. coli* colony.

The SC AAS bacteria monitoring process is used for screening purposes only. This process is not comparable to regulatory monitoring, but it is still useful in generating baseline data and identifying areas in need of further attention.

E. coli counts that exceed 349 CFU/100 mL are above South Carolina state recreational standards.

A stream in Greenville County.

Next Steps

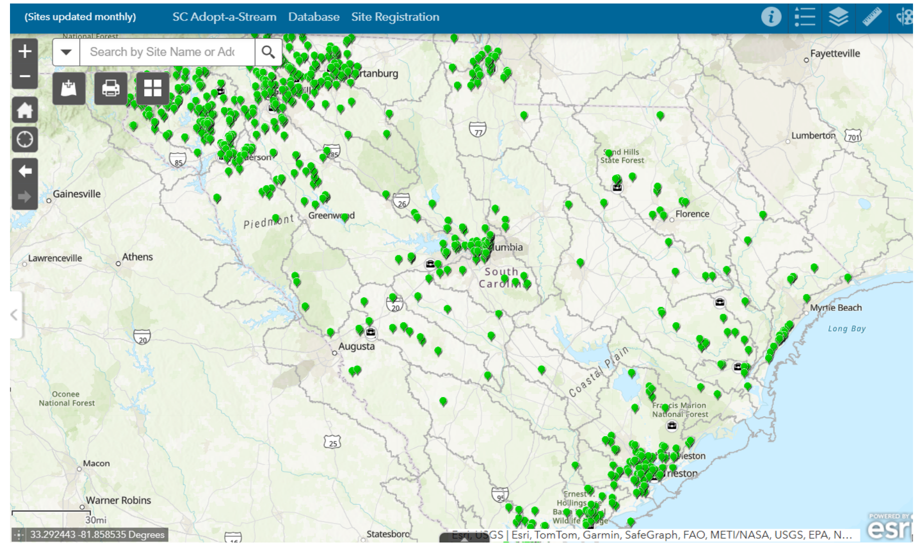
Newly certified SC AAS volunteers.

SC AAS ATLAS

The SC AAS Atlas is designed to assist certified volunteers in identifying watershed information needed for adopting new sites. The Atlas also allows fast look-up of existing monitoring sites and kit loan locations. Please be aware that there may be lag time in displaying new information.

Scan to visit the [SC AAS Atlas](). You can also access the Atlas from our website, www.scadoptastream.org.

Watersheds are identified by unique Hydrologic Unit Codes, or HUCs. HUCs are useful for identifying which watershed you want to monitor, as watersheds are not always exclusively contained by a single city, county, or state. The HUC system divides and subdivides areas into successively smaller watersheds. As the watershed area gets smaller, the unique HUC gets longer. The SC AAS Database and Atlas organize sites by 8-digit HUCs.



The SC AAS Atlas.

Atlas Tips

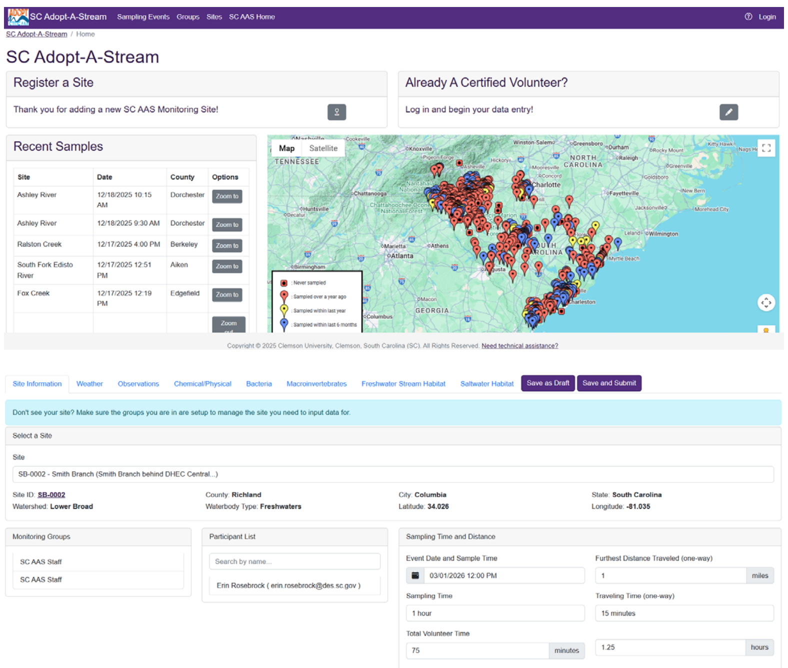
- Green pins represent adopted sites. Black and white icons are kit loan locations.
- To find information needed to adopt your site, zoom in to and click the location you wish to adopt. A popup will appear with the waterbody name (if named), watershed name, and 8-digit HUC.
- Popups may have more than one page of information displayed. Use the arrow to toggle through the pages.
- Latitude/longitude coordinates display in the lower left corner of the map window.
- Open the "Information" icon in the upper right-hand corner for additional instructions on tools.
- If the Atlas is missing information, open the "Layers List" to make sure that all layers are turned on (blue check box).

This [tutorial video]() gives a walkthrough on using the SC AAS Atlas.

SC AAS DATABASE

Once you become a certified volunteer, you will be added to the SC AAS Database as a certified user. The Database can be accessed from your phone or from a computer.

Data should be submitted to the Database as soon as possible so you can share it with your community. Anyone with internet access can view sampling events, groups, or sites. On those pages, you can use the export buttons to download data, or you can copy and paste the data into a new file. Personal information like your full name and email address are not publicly viewable.



The SC AAS Database.

Register in the SC AAS Database

Following your certification, a registration link will be emailed to you (be sure to check your spam folder). Follow the link to create your account in the Database. The email address you provided for the workshop will become your username.

Create or Join a Group

To create a new group:

- Click the "Groups" tab on the top purple bar on the SC AAS Database homepage.
- Click the purple "Add Group" button next to the search box. A pop-up window should appear with the title "Add Group" at the top.
- Enter the group name (this can be something fun and creative), county, date, description, and group members. Leave the "Monitored Sites" field blank.
- Click the purple "Add Group" button in the lower right corner of the window. The window will disappear, and you will see a green banner saying, "Successfully saved group" at the top of the page.

To join an existing group:

- Click the "Groups" tab on the top purple bar on the SC AAS Database homepage.
- Type the name of the group in the search box and hit enter.
- Click the gray "Join" button to the right of the group name (next to the "View" button) to add yourself.
- Click the "View" button to the right of the group name. Your name and email should now appear in the "Members" list.

Register Your Sampling Site(s)

- Click the "Sites" tab on the top purple bar on the SC AAS Database homepage.
- Click the purple "Add Site" button next to the search box.
- Enter the site information.
    - » Waterbody Name: If you are not sure of your waterway's name, refer to the SC AAS Atlas. If it is unnamed, make sure it fits the criteria for site selection. If it does, you can choose a name. The waterbody name becomes the first part of your site ID (ex: Noisette Creek becomes NC-####).
    - » Watershed Name/Number: Use the SC AAS Atlas to record the 8-digit hydrological unit code (8-digit HUC) in which your site is located.

  - » Latitude and Longitude: You can use the map in the right half of the pop-up window to drop a pin on your site or use the coordinates that display in the lower left corner of the map window on the SC AAS Atlas.
  - » Monitoring Group: Start typing the name of your group. Select your group from the drop-down list.
- Click the purple "Add" button in the lower right corner. The window will disappear, and you will see a green banner saying, "Successfully created a site with ID ___" at the top of the page.

KEEP IN TOUCH

If you have any questions or concerns regarding the South Carolina Adopt-a-Stream program, contact the program coordinators by emailing scaas@des.sc.gov.

Follow us on Facebook (SC Adopt-a-Stream) and Instagram (@scadoptastream) to keep up to date with the latest events. Once you have been registered in the Database, you will also be added to our monthly e-newsletter distribution list. SC AAS is an ever growing and evolving program, and we hope you join us in monitoring South Carolina's waterways.

SC AAS volunteers performing a DO titration at a workshop.

INTERESTED IN MORE?

If you would like to explore different volunteer monitoring opportunities, check out our other SC AAS programs! Workshops can be found on our website, www.scadoptastream.org.

Training Types

- **In-person:** 5-6 hours, classroom lesson, outdoor field practice, and open-book certification test.
- **Hybrid:** 3-hour live virtual lesson, 3-hour field day (separate date), and open-book certification test.
- **Online:** Lake monitoring only. Fully online certification.

Additional Monitoring Protocols

- **Tidal Saltwater Monitoring:** Learn to measure temperature, pH, dissolved oxygen, transparency, and salinity in salt marsh-tidal creek ecosystems. Choose a site that has a salinity greater than 0.5 ppt and is safely accessible from a bank, dock, landing, or boat. This program is designed for monthly monitoring.
- **Macroinvertebrate Monitoring:** Learn to collect and identify aquatic macroinvertebrates, which are visible organisms without a backbone. Macroinvertebrate monitoring can indicate the long-term health of freshwater stream habitat and water quality. Choose a site that flows year-round and is wrist to hip deep. This program is designed for biannual monitoring.
- **Lake Monitoring:** Learn to make observations and measure transparency, temperature, hue, and lake level. Keep an eye out for algal growth and report possible invasive aquatic plants. Sample from a dock, boat, or kayak/canoe/paddleboard. Select monitoring sites greater than 5 acres and do not sample engineered stormwater ponds. This program is designed for monthly monitoring.
- **Annual Habitat Assessment:** Document stream stability, habitat quality, riparian conditions, and other qualitative characteristics by assigning each bank a habitat score. Complete this protocol in the spring or summer when trees and shrubs are in "leaf out" condition with full foliage.

Other Ways to Get Involved

Another way to protect water quality is to get others in your community involved and educated. Share your data, reach out to local businesses to promote and support SC AAS, and lead community initiatives like litter pick-ups and riparian buffer repairs.

Additional Volunteer Monitoring Programs

CoCoRaHS: The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) is a non-profit, community-based network of volunteers working together to measure and map precipitation (rain, hail and snow). CoCoRaHS seeks to provide widespread high-quality precipitation data for many organizations and individuals, including the National Weather Service, meteorologists, hydrologists, scientists, engineers, and educators. Visit www.cocorahs.org for more information.

NOAA PMN: The National Phytoplankton Monitoring Network (PMN) is a community-based network of volunteers monitoring marine phytoplankton and harmful algal blooms (HABs). The PMN enhances the nation's ability to respond to and manage the growing threat posed by HABs. Volunteers collect important data about species composition and distribution in coastal waters. Volunteers collaborate with National Oceanic and Atmospheric Administration (NOAA) HAB researchers and state managers. Visit www.coastalscience.noaa.gov/monitoring-and-assessments/pmn/ to learn more.

Nurdle Patrol: Nurdle Patrol is a community science project tracking the presence of nurdles, which are small pellets used in plastic product manufacturing. Nurdles can wash up on beaches, riverbanks, and lake shorelines. Volunteers can help find and map nurdle sources by conducting surveys and submitting their data online. Visit www.nurdlepatrol.org/en/home for more information.

SC Aquarium's Litter Journal: The South Carolina Aquarium's Litter Journal tracks important data on litter across the state. Participants collect litter, document the number and type of all debris, and upload their data to an online database. The data collected is used to drive conversations, decisions, and change around plastic use throughout South Carolina. All data in the Litter Journal is publicly accessible. Learn more and upload your data at www.anecdata.org/projects/view/122.

A stream in Paris Mountain State Park.

Appendix

Helpful Resources

- **CoCoRaHS** (precipitation data)
  www.cocorahs.org
- **PalmettoPride** (anti-litter resources)
  www.palmettopride.org
- **SCDES Watershed Atlas**
  www.des.sc.gov/watersheds/

Helpful Apps

- **iNaturalist App** (species identification and tracking)
  www.inaturalist.org
- **Solocator App** (GPS field camera)
  www.solocator.com

FIELD CHECKLIST

- [ ] Data form found at www.scadoptastream.org
- [ ] Monitoring kit
  - Thermometer
  - Transparency tube
  - LaMotte pH Kit
    2 plastic tubes
    1 color comparator
    1 chemical
  - LaMotte Dissolved Oxygen Kit
    2 glass bottles
    2 syringes
    2 glass cylinders
    5 chemicals
  - Paper towels
  - Nitrile gloves
  - Pen/pencil
  - Rinse bottle
  - Waste bottle
  - Petrifilm® plates
  - Max/min thermometer
  - Incubator
  - Pipette and pipette tips
  - Whirl-Pak® bags
  - Cooler and ice packs
- [ ] Optional items
  - Clipboard
  - Bucket
  - Trash bag for litter
  - First aid kit
  - Sun protection

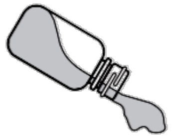
DISSOLVED OXYGEN INSTRUCTIONS

Dissolved Oxygen Test Procedure

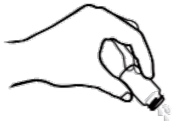
Use test tube caps or stoppers, not your fingers, to cover tubes during shaking or mixing.

Hold dropper bottles vertically upside-down, and not at an angle, when dispensing a reagent. Squeeze the bottle gently to dispense the reagent one drop at a time.

Wipe up any reagent chemical spills immediately.



Thoroughly rinse test tubes before and after each test.



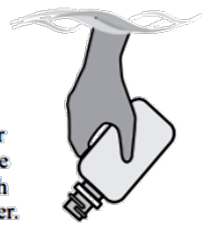
Tightly close all containers immediately after use.

Do not interchange caps from containers.

Avoid prolonged exposure of equipment and reagents to direct sunlight. Protect reagents from extremes of temperature.

Part 1 - Collecting the Water Sample (upstream from where you stand)

1. Rinse the Water Sampling Bottle (0688-DO) with the sample water.



2. Tightly cap the bottle, and submerge it to the desired depth.

3. Remove the cap and allow the bottle to fill.

4. Tap the sides of the bottle to dislodge any air bubbles.

5. Replace the cap while the bottle is still submerged.

6. Retrieve the bottle and make sure that no air bubbles are trapped inside.

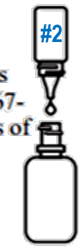
Part 2 - Adding the Reagents

REMINDER: Check expiration dates on chemicals.

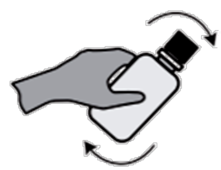
NOTE: Be careful not to introduce air into the sample while adding the reagents.

1 Remove the cap from the bottle.

2 Immediately add 8 drops of *Manganous Sulfate Solution (4167-CN) and Add 8 drops of *Alkaline Potassium Iodide Azide (7166-CN).



3 Cap the bottle and mix by inverting several times. A precipitate will form.



4 Allow the precipitate to settle below the shoulder of the bottle.

5 Add 8 drops of *Sulfuric Acid, 1:1 (6141WT-CN).

6 Cap and gently invert the bottle to mix the contents until the precipitate and the reagent have totally dissolved. The solution will be clear yellow to orange if the sample contains dissolved oxygen.

NOTE: At this point the sample has been "fixed" and contact between the sample and the atmosphere will not affect the test result. Samples may be held at this point and titrated later.

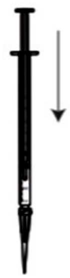
*WARNING: Reagents marked with an * are considered to be potential health hazards.

Part 3 - The Titration

1

Fill the titration tube (0608) to the 20 mL line with the fixed sample. Cap the tube.

2



Depress plunger of the Titrator (0377).

3

Insert the Titrator into the plug in the top of the Sodium Thiosulfate, 0.025N (4169-CN) titrating solution.

Leave the plastic tip ON the Titrator

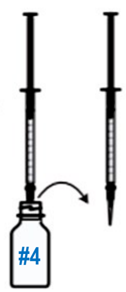
4

Invert the bottle and slowly withdraw the plunger until the large ring on the plunger is opposite the zero (0) line on the scale.

NOTE: If small air bubbles appear in the titrator barrel, expel them by partially filling the barrel and pumping the titration solution back into the reagent container. Repeat until bubble disappears.

5

Turn the bottle upright and remove the Titrator.



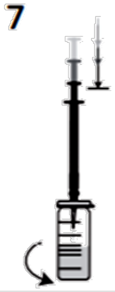
NOTE: If the sample is a very pale yellow, go to Step 9.

**Don't forget DUPLICATE PRECISION. Refer to chapter 5 in the SC Adopt-a-Stream Handbook for more information and FAQs.

6

Insert the tip of the Titraror into the opening of the titration tube cap.

7



Add 1 drop at a time by SLOWLY pressing the plunger to dispense the titrating solution until the yellow-brown color changes to a very pale yellow. Gently swirl the tube during the titration to mix the contents.

8

Carefully remove the Titrator and cap. Do not disturb the Titrator plunger.

9

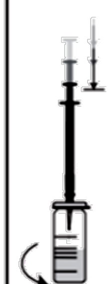
Add 8 drops of Starch Indicator Solution (4170WT-CN). The sample should turn blue.

**Or dark purple.

10

Cap the titration tube. Insert the tip of the Titrator into the opening of the titration tube cap.

11



Continue titrating until the blue color disappears and the solution becomes colorless.

NOTE: If the plunger ring reaches the bottom line on the scale (10 ppm) before the endpoint color change occurs, refill the Titrator and continue the titration. Include the value of the original amount of reagent dispensed (10 ppm) when recording the test result.

12

Read the test result directly from the scale where the large ring on the Titrator meets the Titrator barrel. Record as ppm Dissolved Oxygen. Each minor division on the Titrator scale equals 0.2 ppm.

NOTE: When testing is complete, discard the titrating solution in the Titrator. Rinse Titrator and titration tube thoroughly. DO NOT remove plunger or adapter tip.

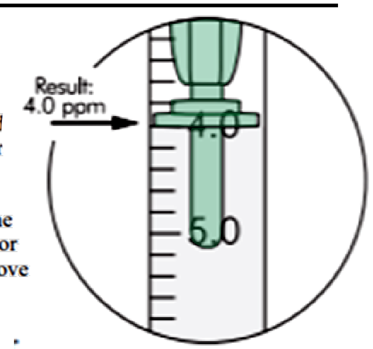


PHOTO ATTRIBUTION

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- **Page 2, 15:**
  8 Major Watersheds of SC
  https://www.dnr.sc.gov/water/waterplan/pdf/Major_Basins_of_South_Carolina.pdf
- **Page 40:**
  pH Scale
  https://www.science-sparks.com/what-is-the-ph-scale/
- **Page 47:**
  Reading Dissolved Oxygen Syringe
  Manual, available to download as a pdf here: https://Lamotte.com/dissolved-oxygen-test-kit-5860-01
- **Page 72-75:**
  LaMotte Dissolved Oxygen Test Kit Instructions
  Manual, available to download as a pdf here: https://Lamotte.com/dissolved-oxygen-test-kit-5860-01

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SC DEPARTMENT *of*
ENVIRONMENTAL SERVICES

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