BACTERIA

What are bacteria?

Bacteria are naturally found in our waterways. Though most are harmless, the presence of certain bacteria serve as indicators for other more harmful pathogens. *Escherichia coli* (*E. coli*) or enterococci are common bacteria that live in the intestines of humans and animals and are present in feces. High levels of *E. coli* or enterococci mean harmful bacteria could be present in the water. Bacteria in water can come from many sources, like wastewater, agricultural runoff, or pet waste. Bacteria levels are usually higher after rainfall, when bacteria on land are washed into waterways.

How do we measure it?

Bacteria levels are typically monitored weekly from May through September or monthly year-round, depending on the monitoring goals. Enterococcus is sampled in tidal waters and *E. coli* is sampled in non-tidal waters. Samples can be measured at home using R-Card or Coliscan, or through lab analysis. Bacteria samples are collected in the field then grown in an incubator. Colonies are then counted to determine the number of colony forming units (CFU) or most probable number (MPN) per 100 mL of water, depending on the method used.

Equipment	Cost	Monitoring Time
R-Card (*E. coli* or enterococcus)	$	10 mins per site 24 hour incubation
Coliscan Easygel (*E. coli*)	$	20 mins per site 24–48 hour incubation
Lab analysis (*E. coli* or enterococcus)	$$$	5 mins per site 18–24 hour incubation

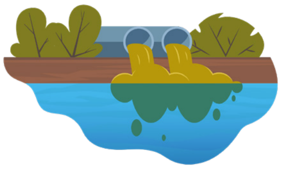
Why do we care?

Human Health

High bacteria levels in areas where people recreate could increase the risk of people getting sick from contact with the water.

Pollution

Sudden spikes in bacteria values, especially in dry weather, can indicate sources of pollution such as leaking septic systems, broken sewer lines, or livestock manure entering waterways.



How is my water?

Per the Mid-Atlantic Tributary Assessment Coalition (MTAC) protocol, 235 CFU/100mL is often used as a cutoff for *E. coli* using a single value, but standards vary by state. The use of averages is encouraged when looking at recreational health, please refer to your state's bacteria guidelines for more specific information.

Poor	Good
Enterococci: **>104 MPN/100mL**	**Enterococci:** **<104 MPN/100mL**
***E. Coli*:** **>235 CFU/100mL**	***E. Coli*:** **<235 CFU/100mL**

PLEASE NOTE:

This fact sheet provides general information about bacteria, but water monitoring in specific locations may require more detailed methods and considerations.

BENTHIC MACROINVERTEBRATES

What are benthic macroinvertebrates?

Benthic macroinvertebrates are small organisms that live in and on the bottom of waterbodies. These organisms do not have backbones and include insects, worms, molluscs, and crustaceans.

How do we measure them?

Sampling for benthic macroinvertebrates occurs in wadeable streams and smaller rivers typically once or twice a year in the spring and/or fall. Organisms are collected by stirring up the stream bed, picking up and rubbing rocks, or disturbing habitats and catching benthic organisms in a net. After collecting the samples, the benthic species are identified and counted, either in the field or the sample is preserved and sent to a lab for analysis. Benthic sampling is typically done by a team with a minimum of two participants.

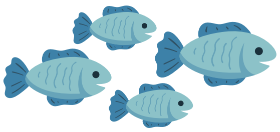
Equipment	Cost	Monitoring Time
Kick-net (Rocky streams), Field identification to order level	$	3–4 hours
D-net (Muddy streams), Field identification to order level	$	3–4 hours
D-net, Lab identification to family/genus level	$$$	1–1.5 hours


Photo by the Izaak Walton League of America.

Why do we care?

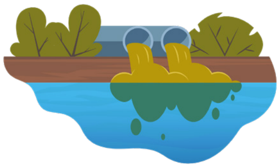
Aquatic Life

Benthic species provide the foundation for a healthy aquatic food web. Fishes, birds, and amphibians all rely on benthic organisms as a food source.



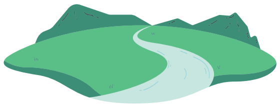
Pollution

Benthic macroinvertebrates are easily harmed by pollution. When high levels of pollution are present, benthic organisms cannot survive.



Stream Health

Changes in stream hydrology, temperature, salinity, or pH affect benthic species. Relatively small changes in environmental conditions over the course of a season are reflected in the composition of a benthic sample.



How is my water?

Healthy streams are home to an abundant and diverse community of benthic macroinvertebrates. Streams with fewer species and lower numbers show poorer stream conditions. The presence and number of species can be used to calculate a stream health score.

PLEASE NOTE:
This fact sheet provides general information about benthic macroinvertebrates, but monitoring in specific locations may require more detailed methods and considerations.

CHLOROPHYLL

What is chlorophyll?

Chlorophyll is the pigment that makes plants green and helps them photosynthesize. Measuring chlorophyll allows us to keep track of how much algae is in the water. Algae is an important part of aquatic ecosystems, but too much can be harmful, reducing water clarity and dissolved oxygen.

How do we measure it?

Chlorophyll is collected by taking a water sample and passing the sample through a filter to collect the algae, which contains chlorophyll. That filter is then sent to the lab for analysis to measure the concentration of chlorophyll in micrograms per liter (µg/L).

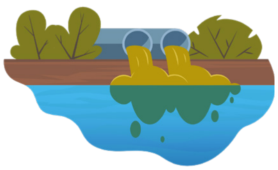
Equipment	Cost	Monitoring Time
Lab analysis	$$$	5–10 mins

Photo by Arundel Rivers Federation.

Why do we care?

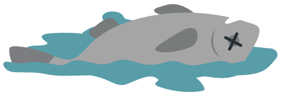
Pollution

Nutrient pollution from sewage treatment plants, agricultural and urban runoff, or air pollution can cause algal overgrowth and elevated chlorophyll levels.



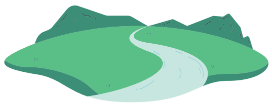
Aquatic Life

Some types of algae can produce toxins that are harmful to people, pets, and wildlife. These harmful algal blooms (HABs) can kill fish, degrade water quality, and create smelly, scummy conditions in the water.



Bay Health

A healthy concentration of chlorophyll means there is enough algae to fuel the food web, with clear water and enough dissolved oxygen for all the organisms that live there.



How is my water?

Chlorophyll levels are typically lower in the spring and higher in the summer. What's considered a healthy level can vary depending on how salty the water is. In general, chlorophyll measurements below 5 µg/L indicate good conditions, while levels above 25 µg/L may signal excessive algal growth.

PLEASE NOTE:

This fact sheet provides general information about chlorophyll, but water monitoring in specific locations may require more detailed methods and considerations.

CONDUCTIVITY

What is conductivity?

Conductivity is a measure of how well water conducts electricity, and saltier water typically has a higher conductivity than freshwater. This depends on the presence of dissolved ions, or tiny, charged particles that come from salts and minerals. The more ions in the water, the better it conducts electricity. These ions can come from natural sources, like rocks breaking down over time, or from human activities.

How do we measure it?

Conductivity is measured in microsiemens per centimeter (µS/cm) using either an individual conductivity probe or a conductivity sensor on a multiparameter probe. In tidal areas, conductivity can be measured throughout the water column along with temperature, dissolved oxygen, and salinity.

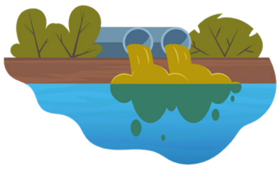
Equipment	Cost	Monitoring Time
Individual probe	$$	10 mins per site
Multiparameter probe	$$$	10–20 mins per site

Photo by Kertu Liis Krigul, CC BY-SA 4.0.

Why do we care?

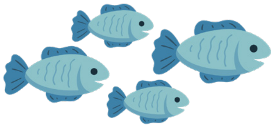
Pollution

High conductivity in non-tidal streams can be caused by pollution from road salts, mining activities, and wastewater treatment plants.



Aquatic Life

High conductivity can stress organisms, impacting reproduction and growth. Increases in conductivity also make water more acidic, which hurts aquatic plants and fishes.



Stream Health

Measuring conductivity, along with other parameters, helps us know if a water body is able to support a vibrant ecosystem.

How is my water?

Conductivity changes depending on the water's salinity and has different thresholds based on geologic features. Consistently high values that are not related to local geology can indicate poor conditions—such as an influx of road salt—and stressful aquatic environments. In a stream with little bedrock erosion, a very good conductivity reading is typically less than 50 µS/cm. A concerningly high conductivity reading would be greater than 500 µS/cm. In tidal water, conductivity does not have discrete thresholds.

PLEASE NOTE:

This fact sheet provides general information about conductivity, but water monitoring in specific locations may require more detailed methods and considerations.

DISSOLVED OXYGEN

DO

What is dissolved oxygen?

Think of dissolved oxygen (DO) as the "breath of life" for our water bodies. Just like humans need oxygen to breathe, fish and other aquatic animals need oxygen in the water to survive. Moving water mixes in dissolved oxygen from the air and from plants in the water that produce it through photosynthesis.

How do we measure it?

A Winkler titration kit, DO probe, or multiparameter probe are tools that can measure dissolved oxygen. Oxygen levels can be measured at the surface of the water, where oxygen is usually higher, or in deeper water, where levels can decrease due to biological activity and less mixing from wind, storms, and rain. Monitoring at the surface and in deeper water, typically using a probe, provides a fuller picture of oxygen conditions.

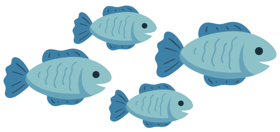
Equipment	Cost	Monitoring Time
Winkler titration kit	$	30 mins per site
Individual probe	$$	10–20 mins per site
Multiparameter probe	$$$	10–20 mins per site

Photo by the Chesapeake Bay Program.

Why do we care?

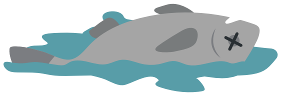
Aquatic Life

Healthy oxygen levels are crucial for fish, plants, and other aquatic animals to live and thrive.



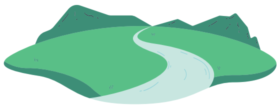
Fish Kills

Low oxygen levels, especially in the summer, can kill fish and create unhealthy water conditions for fish nurseries.



Stream Health

Measuring dissolved oxygen helps us know if a water body is able to support a vibrant ecosystem.



How is my water?

Per the EPA, good oxygen levels are generally 5 mg/L or higher. DO can be indicative of habitat conditions at the site where you're monitoring, and you may observe higher or lower values based on conditions such as temperature, time of day, depth, and season. Consistently poor values can indicate stressful aquatic environments.

Poor	Good
<5 mg/L	≥5 mg/L

PLEASE NOTE:

This fact sheet provides general information about dissolved oxygen, but water monitoring in specific locations may require more detailed methods and considerations.

NITROGEN

What is nitrogen?

Nitrogen naturally exists in both freshwater and saltwater in different chemical forms, including nitrate, nitrite, and ammonia. Total nitrogen includes all forms of nitrogen available in the water. Through the nitrogen cycle, it moves between the air, water, and living organisms. Different forms of nitrogen impact how plants and animals use it. Nitrogen is essential for plant growth.

How do we measure it?

Nitrate and nitrite are typically monitored in non-tidal areas and can be measured in the field using test kits or portable meters. Other forms of nitrogen, like ammonia and total nitrogen, are monitored in tidal areas and typically require lab analysis. Nitrogen levels are typically reported in milligrams per liter (mg/L) or micrograms per liter (µg/L).

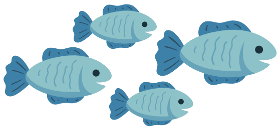
Equipment	Cost	Monitoring Time
Colorimetric kit	$	10–20 mins per site
Field colorimeter	$$	10–20 mins per site
Lab analysis	$$$	5 mins per site

Photo by the Alliance for Aquatic Resource Monitoring.

Why do we care?

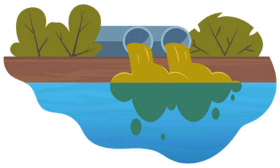
Aquatic Life

Increased nitrogen can result in algal overgrowth and harmful algae blooms that cause fish kills and decrease habitat quality.



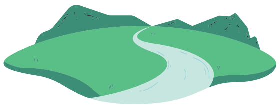
Pollution

High nitrogen levels in water indicate nutrient pollution. Excess levels of nitrogen often mean the ecosystem is unhealthy and the food web is unbalanced.



Stream Health

Nitrogen is found at unnaturally high levels in fertilizers and wastewater. During storms, nitrogen-rich stormwater runs from lawns, farms, and overflowing sewers and septic systems into waterways.



How is my water?

Nitrogen levels have different thresholds based on the type of nitrogen monitored and for different salinity regimes and geological features. Naturally occurring nitrogen amounts are higher in freshwater than saltwater. For example, in a Pennsylvania limestone stream, typical total nitrogen readings are around 3 mg/L for a healthy stream. In a tidal estuary, good total nitrogen levels would be less than 1 mg/L.

PLEASE NOTE:
This fact sheet provides general information about nitrogen, but water monitoring in specific locations may require more detailed methods and considerations.

pH

What is pH?

pH is the measure of acidity or alkalinity of water. The pH scale ranges from 0 (very acidic) to 14 (very alkaline, or basic) with 7 being neutral. Each whole pH value is ten times stronger than the previous value. Nutrients and other chemical substances can be toxic at pH levels outside of a healthy range (6.5–8.5).

How do we measure it?

pH is measured in Standard Units (SU) on a scale from 0–14. When using a colorimetric kit, test strips, or an individual pH probe, pH can only be measured at the surface of the water. When using a multiparameter probe, pH can be measured throughout the water column.

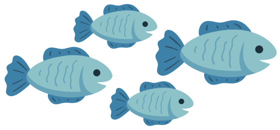
Equipment	Cost	Monitoring Time
Test strips	$	5 mins per site
Colorimetric kit	$	10 mins per site
Individual probe	$$$	10–20 mins per site
Multiparameter probe	$$$	10–20 mins per site

Photo by Loudoun Wildlife Conservancy.

Why do we care?

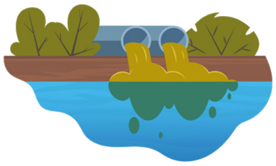
Aquatic Life

The pH of water determines the biological availability of nutrients, or how much of those nutrients can be used by aquatic life. Any changes in water pH will be harmful to the plants and animals living there.



Pollution

pH outside of the normal range can be a sign of pollution, which could be from mining or wastewater treatment plants.

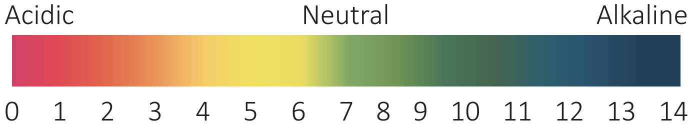


Stream Health

Even slight changes in pH can cause toxicity, poor aquatic health, and imbalanced ecosystems.

How is my water?

Normal pH ranges from 6.5 and 8.5, so any values outside this range are concerning. Many states have more specific water quality standards for pH. Drastic changes in non-tidal water within this range could still be of concern.



PLEASE NOTE:

This fact sheet provides general information about pH, but water monitoring in specific locations may require more detailed methods and considerations.

PHOSPHORUS

What is phosphorus?

Phosphorus naturally exists in both freshwater and saltwater in different chemical forms, including orthophosphate and total phosphorus. Phosphorus is an essential nutrient for all growth and reproduction.

How do we measure it?

All forms of phosphorus are measured by collecting water samples in a bottle. Orthophosphate, measured in milligrams per liter (mg/L) or micrograms per liter (µg/L), can be analyzed in the field using either a colorimetric kit or a field colorimeter, or in a lab. Total phosphorus (mg/L or µg/L) is analyzed in a lab.

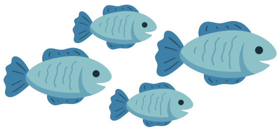
Equipment	Cost	Monitoring Time
Colorimetric kit	$	10–20 mins per site
Field colorimeter	$$	10–20 mins per site
Lab analysis	$$	10–20 mins per site

Photo by the Alliance for Aquatic Resource Monitoring.

Why do we care?

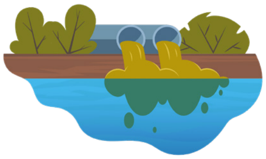
Aquatic Life

Increased phosphorus can result in algae overgrowth or harmful algal blooms that can cause fish kills and disrupt the food web.



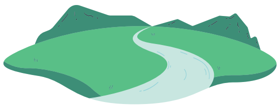
Pollution

Phosphorus is often present at unnaturally high levels in fertilizers and wastewater. Phosphorus-rich water from lawns, farms, and overflowing sewers or septic systems can flow into waterways.



Stream Health

Unusually high levels of phosphorus often mean that the ecosystem is unhealthy and habitat quality for organisms is low.



How is my water?

Phosphorus levels have different thresholds based on the type of phosphorus monitored, salinity regime, and surrounding geological features. In most streams, a typical total phosphorus reading of less than 0.05 mg/L indicates a healthy stream. Total phosphorus readings above 0.2 mg/L are notable and may cause concern.

PLEASE NOTE:

This fact sheet provides general information about phosphorus, but water monitoring in specific locations may require more detailed methods and considerations.

SALINITY

What is salinity?

Salinity measures how much salt is dissolved in water. In an estuary like the Chesapeake Bay, salinity forms a natural gradient: waters near the mouth of the Bay are as salty as the ocean (around 35 parts per thousand or ppt), and the water becomes less salty as you move upstream, eventually reaching freshwater (close to 0 ppt). At a site, salinity can change based on factors like flow, depth, and tides.

How do we measure it?

Salinity is measured in parts per thousand (ppt) using different tools. One method is a handheld device called a refractometer, which uses light to measure salt concentrations. Salinity can also be estimated using a water quality probe that measures conductivity, since salty water conducts electricity more easily. In tidal areas, salinity can change with depth, so taking readings at the surface and deeper in the water is helpful.

Equipment	Cost	Monitoring Time
Refractometer	$	3 mins per site
Individual probe	$$	10 mins per site
Multiparameter probe	$$$	10–20 mins per site

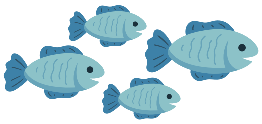
How is my water?

Salinity naturally varies dependent on location. For example, freshwater streams should be < 0.5 ppt, while brackish waters in tidal rivers range from 0.5–18 ppt. Near the mouth of the Bay, salinity is 18–35 ppt. Sudden changes from usual readings could reflect natural events or human-related impacts.

Why do we care?

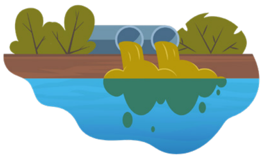
Aquatic Life

Many aquatic plants and animals are adapted for specific salinity measures, and changes in those conditions can harm the species that live there.

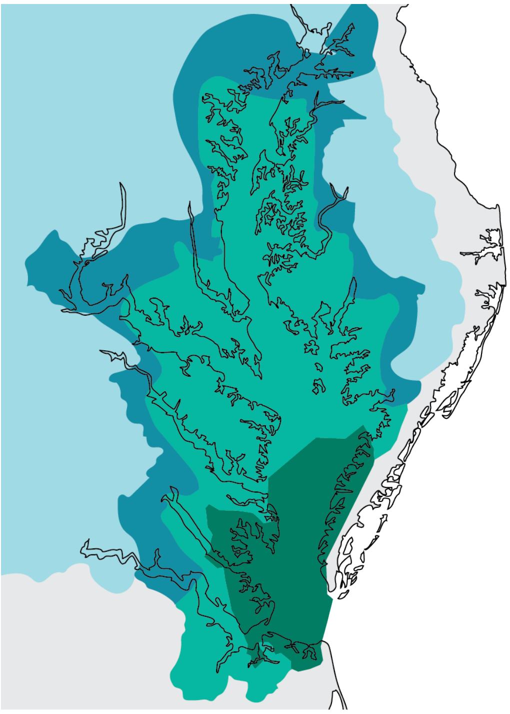


Pollution

An influx of salt into a freshwater stream can indicate pollution sources, such as road salt or mining activities.



Salinity Regimes



Freshwater (<0.5 ppt)
Slightly Salty (0.5–5 ppt)
Moderately Salty (5–18 ppt)
Very Salty (18–35 ppt)

PLEASE NOTE:
This fact sheet provides general information about salinity, but water monitoring in specific locations may require more detailed methods and considerations.

TEMPERATURE

What is temperature?

Temperature measures how much heat is present in water or air. It naturally changes throughout the day and across seasons. Water temperature affects other indicators, like dissolved oxygen, and plays a role in determining which plants and animals can survive in the water. States use temperature, and other indicators, to classify streams as coldwater or warmwater to protect species and ecosystems.

How do we measure it?

Air and water temperature (measured in degrees Celsius) can be collected using an armored glass thermometer, a digital thermometer, or a multiparameter probe. A single reading at the surface is often enough for streams and smaller waterways. In tidal areas, water temperature can vary with depth, so measuring at the surface and deeper in the water is helpful.

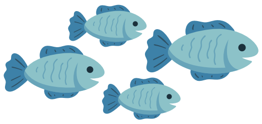
Equipment	Cost	Monitoring Time
Armored glass thermometer	$	3 mins per site
Digital thermometer	$	3 mins per site
Multiparameter probe	$$$	10–20 mins per site

Photo by the Alliance for the Chesapeake Bay.

Why do we care?

Aquatic Life

Different species have different temperature needs, and coldwater species are highly sensitive to small increases in water temperature. Coldwater streams are essential for supporting recreational fishing species.

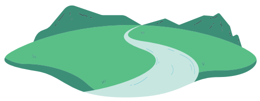


Changing Climate

Temperature is a key indicator of climate change. Tracking water temperature over time helps us understand how ecosystems are shifting.

Ecosystem Health

In the Bay, layers can form when warmer, fresher water sits on top of colder, denser, saltier water. These layers prevent mixing, which can lead to low dissolved oxygen and negatively affect ecosystem health.



How is my water?

In tidal waters and the Bay, temperature thresholds vary depending on the species and habitat; for example, high temperatures can be harmful for seagrass (Eelgrass, > 28°C) or low temperatures can be harmful for fish (Spotted Seatrout, < 3°C). In non-tidal areas, the Mid-Atlantic Tributary Assessment Protocol (MTAC) provides thresholds for stream temperatures. Warmwater streams should be < 32°C (90°F). Coldwater streams should be < 20°C (68°F). State and local thresholds vary.

PLEASE NOTE:
This fact sheet provides general information about temperature, but monitoring in specific locations may require more detailed methods and considerations.

WATER CLARITY & TURBIDITY

What are water clarity and turbidity?

Water clarity and turbidity show how easy it is to see through water. Water clarity is a measure of how far light travels from the surface of the water. Turbidity measures the amount of cloudiness of the water, caused by material like sediment, plankton, and algae.

How do we measure them?

Water clarity (m) is measured at shallow, slow-moving tidal sites by lowering a Secchi disk into the water until it is no longer visible. At some sites, a transparency tube can be filled with water to measure clarity (cm). Turbidity is measured with a turbidity test kit (JTU) or a field colorimeter (NTU).

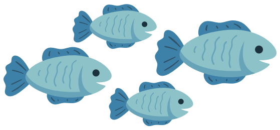
Equipment	Cost	Monitoring Time
Transparency tube	$	5 mins per site
Secchi disk	$	5 mins per site
Turbidity test kit	$	10 mins per site
Turbidimeter/ Field colorimeter	$$$	5 mins per site

Photo by the Chesapeake Bay Program.

Why do we care?

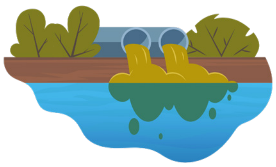
Aquatic Life

Clear water allows sunlight to reach aquatic plants, supporting photosynthesis. Crabs, fish, and other aquatic organisms rely on clear water to see the environment.



Pollution

Runoff of sediment and nutrients from land can result in poor water clarity and high turbidity.



How is my water?

Water clarity and turbidity measurements vary depending on the salinity, weather, and flow at a site. Poor water clarity values tend to be less than 45 centimeters (0.45 m); good water clarity values tend to be above 70 centimeters (0.7 m). Poor turbidity values tend to be higher than 10 NTUs, while good turbidity values tend to be below 3 NTUs.

Photo by the Chesapeake Bay Program.

PLEASE NOTE:

This fact sheet provides general information about water clarity and turbidity, but water monitoring in specific locations may require more detailed methods and considerations.

SITE CONDITIONS

What are site conditions?

Site conditions are observations that provide context to your water quality or benthic macroinvertebrate data. These include weather, rainfall, water depth, tide stage, and more. Visual indicators are valuable clues to understanding what might be influencing the data you collect.

How do we measure them?

This table describes some of the site conditions that are typically recorded. Each group may choose to add additional observations.

Indicator	Measurement/Observation
Water Depth	Use a secchi disk, depth finder, or weighted line to record a depth measurement in meters.
Water Stage (Height)	Use a marked gauge stick or tape measure to record a height measurement in feet.
Weather Conditions	Record the weather: sunny, partly cloudy, rain, snow, etc.
Water Color/Odor	Record a description of the water color or odor.
Tidal Stage	Reference a tide chart or observe conditions to determine the tidal stage: Incoming (Flood), Low, Outgoing (Ebb), High.
Rainfall	Record rainfall from a local weather station or personal rain gauge.
General Comments	Record anything noteworthy, such as debris or trash at the site, evidence of wildlife, fish or crab kills, algal blooms, and land use conditions and changes.

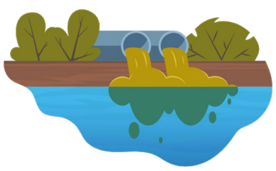
Why do we care?

Human Health

High bacteria values during wet weather indicate typical combined sewer overflows; high values during dry weather suggest infrastructure issues.

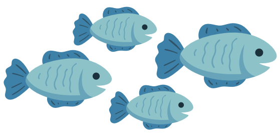
Pollution

Site conditions like unusual water color and odor can help identify urban pollution issues, like oil spills or discharges. Water color can also be a good first indication of algal blooms.



Aquatic Life

If your stream appears unusually cloudy or has a layer of fine sediment along the bottom, it could suggest upstream erosion or runoff. This can reduce habitat quality, resulting in fewer sensitive species.



Streamwater turned white, likely from carwashing. Photo by the Alliance for Aquatic Resource Monitoring.

PLEASE NOTE:

This fact sheet provides general information about site conditions, but monitoring in specific locations may require more detailed methods and considerations.