StreamWatch

Volunteer Water Quality Monitoring Handbook

Chemical Action Team

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Welcome to The Watershed Institute

The Watershed Institute is New Jersey's premier center for learning and leadership on watershed health, water resources protection, and community resiliency in the face of climate change. Keeping water clean, safe, and healthy is the heart of our mission. We work to protect and restore our water and natural environment in central New Jersey through conservation, advocacy, science, and education.

Our staff includes policy advocates, scientists, land and water stewards, naturalists, and educators. By integrating the practices of land conservation, environmental advocacy, watershed science and education in the pursuit of our mission, we design practical solutions to real-world problems. We speak out for water and the environment, protect, and restore sensitive habitats, test our waterways for pollution, and inspire others to care for the natural world. We focus much of our work in the Stony Brook-Millstone and the adjacent part of the Central Delaware River Watersheds, while also leading several statewide initiatives.

As a non-profit organization we depend on the support of members and volunteers like you! Please consider donating and becoming a member at www.thewatershed.org.

What is a Watershed?

A watershed is an area of land that drains into a particular body of water, such as a stream, river, pond, or lake. A watershed is not determined by political boundaries, but instead is shaped by nature's hills and valleys. The watershed includes not just the water, but also the land over which the water must travel. A ridge or other area of elevated land, called the divide, separates one watershed from another. Streams on one side of the divide flow away from streams on the other side.

Streams originate from snowmelt, rainwater, springs, and/or groundwater. As water flows overland or percolates through soil, it recharges surface and groundwater supplies, which can be used for drinking water. This process also filters out impurities such as sediments, oil, grease, and bacteria. The concentration of these impurities, the speed and amount of water, the materials the water flows over or through, and the grade of the land all contribute to the ability of a natural system to regenerate itself and maintain good water quality. Human activity has significantly taxed these natural processes by altering land cover and thus increasing concentrations of pollutants.

Our Watershed

Our central New Jersey waterways include the Millstone, Delaware, and Raritan Rivers and D&R Canal. These waterbodies collectively provide drinking water for more than 16 million people across four states.

The Millstone River itself is 38 miles long and flows northwest and then north from Millstone Township in Monmouth County to the Raritan River at Manville Borough in Somerset County. Since the damming of the Millstone River in 1906 to create Carnegie Lake, the river was divided into two main sections: the Upper Millstone, which feeds into Lake Carnegie, and the Lower Millstone which drains Lake Carnegie and flows north to the Raritan River.

The Stony Brook is 21 miles long with headwaters in East Amwell and flowing generally east to feed Lake Carnegie and merge with the Millstone River.

In 2018, The Watershed Institute expanded its coverage area to the adjacent stretch of the Delaware River watershed from the Alexauken Creek watershed in Lambertville to the Crosswicks Creek watershed south of Trenton.

Sources of Water Pollution

Point-Source Pollution

Point sources of pollution are those direct discharges into waterways emitted from pipes. They include municipal and industrial sewage treatment plants, power plants, and stormwater discharges. These are the simplest sources of pollution to locate and to act against, since the pollution is entering the waterways from one "point". In 1972, the Federal Water Pollution Control Act, commonly known as the Clean Water Act, was enacted. The overall objective was to restore and maintain the chemical, physical, and biological integrity of our nation's waterways. The Act mandated that a comprehensive program be established by the United States Environmental Protection Agency (USEPA) to monitor and control water pollution. The goal was that by 1985 all navigable waters would be free of pollutant discharge. After the Act, the New Jersey Pollutant Discharge Elimination System (NJPDES) was established. This required anyone discharging pollutants in the state to obtain a permit specifying the amounts and types of pollution discharged.

Most of these point sources are discharged legally through permits issued under the Clean Water Act and NJPDES. Permits limit the quantities and types of pollutants permitted in wastewater. Permit holders are charged with the responsibility of making sure their actual discharge is in compliance with their permits. Some wastewater dischargers comply with permits at all times, while others frequently are in violation, making routine monitoring of wastewater discharges important.

In 1989, the New Jersey legislature passed the Clean Water Enforcement Act (CWEA) that ensures that permit violators are significantly fined when they are not in compliance with their permits. In addition, a citizen action suit provision allows citizens the opportunity to file suit against dischargers who are in violation of their permits. With organization and evidence, citizen groups can directly improve water quality.

Non-Point Source Pollution (NPS)

NPS or "people pollution" is that pollution we generate in our everyday lives, which is not discharged via a pipe directly into a waterway. Unlike point sources of pollution, NPS comes from miscellaneous sources and no comprehensive legislation currently exists to regulate it.

In most developed areas of our watershed, stormwater flows from downspouts, sidewalks, and roads into a storm sewer system that pipes directly to the nearest waterbody. Every chemical or waste product that can be carried by rainfall into storm sewers and streams becomes a part of NPS, unless picked up by soil and absorbed or neutralized. Common examples of NPS include fertilizers, herbicides, insecticides, spilled motor oil and animal waste from pets, wildlife, and farm animals. Other significant sources of NPS include improperly operating septic systems, erosion from construction sites and plowed fields, acid rain and runoff from roadways, and road salting activities. As development occurs, and impervious surfaces (parking lots, streets, sidewalks, rooftops) increase, runoff volumes and velocities increase substantially, significantly impacting levels of NPS and erosion.

The key is the individual citizen and his or her commitment to a healthy environment. Ultimately, control of NPS will require the voluntary cooperation of individual citizens in lessening their contribution to NPS. Efforts such as good management of septic systems, good farming practices, controlling chemical use on lawns and gardens, and disposing of household chemicals properly are all a part of reducing NPS and protecting our waterways.

The predominant non-point pollution sources in Central New Jersey are those associated with suburban development, which is on the increase throughout the watershed. Runoff from construction sites, suburban surfaces, storm sewers, and roads is contributing to excessive sediment loading. Septic systems are also believed to be a potential pollution problem throughout the watershed.

Types of Pollutants

The pollution of waterways is primarily due to human activity and is reflected by a decline in the diversity of aquatic plants and animals. Water pollution can be divided into four interrelated general categories: toxic substances, nutrient pollution, organic wastes, and sediment pollution.

These types of pollutants are not static or separate. They interact with each other and negatively impact biodiversity within our waterways and increase the risk of water degradation in many areas.

Toxic Substances

Toxic substances may enter water bodies through point and non-point sources - industrial and municipal wastewater dischargers, agricultural and urban land runoff, the leaching of waste materials dumped in the area or through the airborne deposition of pollutants. Toxins make the consumption of water and fish unsafe. In addition, these substances impair or kill aquatic life, reducing the numbers and diversity of species, thereby disrupting the natural aquatic community.

The ways in which toxic substances affect living organisms can be divided into four categories:

- Acute toxicity causes immediate danger or death.
- Chronic toxicity has long-term non-lethal effects, which may alter appetite, growth, metabolism, or reproduction.

- Bioaccumulation becomes toxic as substances become concentrated in animal tissues from direct consumption of toxic substances or through consumption of other contaminated animal tissue.
- Behavioral modification causes an organism to leave the area or otherwise alter its normal behavior.

Excessive levels of toxins in our watershed have led NJDEP to classify the vast majority of NJ waters as unsafe for fish consumption.

Nutrient Pollution

Nutrients like nitrogen and phosphorus are necessary for the growth of aquatic vegetation and algae, but nutrient overloading can result in too much of a good thing. When they grow in excess, algal blooms can blanket the water's surface, increase water temperature and turbidity, and cause problems with drinking water odor and taste. Dissolved oxygen may be depleted from the water as bacteria break down the excess vegetation. In turn, a lack of oxygen decreases the ability of the waterway to support other forms of aquatic life. Harmful algal blooms (HABs) result when cyanobacteria produce toxic substances, like microcystin and anatoxin-a, at a concentration that can harm humans, pets, livestock, and wildlife.

Excessive phosphorus and nitrogen in a water body may be the result of wastewater discharges, improperly functioning septic systems, or stormwater runoff from agricultural and residential lands which carries with it pesticides and fertilizers.

Organic Wastes

Most aquatic life needs oxygen to survive, however, water is capable of dissolving only a small amount of oxygen from the surrounding air. Wastes containing organic material require oxygen for bacterial decomposition. Large accumulations of organic waste use a substantial amount of oxygen during decomposition, leaving little oxygen for fish, aquatic insects, and other stream inhabitants. Pollution sensitive organisms can disappear from waters polluted by organic wastes, leaving only pollution tolerant organisms like fly larvae, aquatic worms, and leeches. In addition, bacteria levels from human or animal wastes can make water unsafe for swimming and drinking.

Excessive levels of fecal coliform throughout our watershed have led to the classification of most waters in our region as "unswimmable" by the NJDEP.

Sediment Pollution

Sediment pollution exists wherever the sediment load of sand, silt, mud, and soil in a water body exceeds that of its natural conditions. This occurs where development has stripped away the natural vegetation, removing the soil-binding root systems, creating highly erodible areas. These areas include construction sites, land cleared for housing developments, sand and gravel pits, agricultural lands, urban areas, unpaved roads, and eroding streambanks. Sediment pollution can have a detrimental impact on our waterways and their inhabitants. Excessive sedimentation is a devastating pollutant for aquatic organisms, as it interferes with foraging, predation, and breathing. Suspended sediments also block sunlight, which is the basic energy source for photosynthesis - the primary source of food in an ecosystem. Sediment can impact nutrient pollution, particularly if agricultural chemicals and fertilizers bind with soil particles and are transported to downstream waterways. Gravel bars and islands are formed from sediment deposits, which tend to cause channel changes and accelerate streambank erosion, in addition to increasing the risk of flooding.

Plastic Pollution

Since the early 1900s, plastics have played an increasing role in our everyday lives. Because plastics can take hundreds of years to degrade, all the plastic that has ever been produced is still present in our environment, breaking down into smaller and smaller particles. Microplastics are less than 5 millimeters across and act as magnets for pollutants, helping them to spread in the environment and bioaccumulate in the food chain. On average, the presence of microplastics in a marine ecosystem increases the toxicity by 10 times (Rubin & Zucker, 2022). Studies have suggested that microplastics have been found in rain and show potential uptake by plants (Wetherbee, Baldwin, & Ranville, 2019; Azeem, et al., 2021).

Made from fossil fuels, plastic contributes to global CO_2 emissions and climate change. Climate change related increases in precipitation lead to more frequent and larger floods, introducing even more microplastics and trash into our streams. We are not currently monitoring for microplastics, but it is important to understand the impacts of plastic on the health of our waterways. The first step is to reduce your personal consumption of plastic. In 2022, NJ passed a statewide ban on single-use plastic bags to help us get started.

About the Chemical Action Team

StreamWatch is a citizen science program that employs the watchful eyes and willing hands of volunteers to help protect water quality and habitat in Central New Jersey. It was developed after research showed that no public agency was monitoring our waterways on a consistent basis. Since government agencies cannot control all the collective and individual actions that harm our environment, it is important for everyone to play a role in the stewardship of the natural world. The Chemical Action Team (CAT) of StreamWatch, the first of our water quality monitoring programs, was developed in the spring of 1992 by Watershed staff as our response. Volunteers Lesley Barnhorn and Tim McDermott implemented it that summer.

StreamWatch has four overall project goals:

- To characterize the water quality in Central New Jersey,
- To involve citizens in observing, monitoring, recording, and reporting stream conditions,
- To motivate the public to initiate change in their use of the land and drainage systems that will enhance water quality, and
- To provide quality data to decision-makers which may bring about improvement in water quality.

The goals will be achieved by establishing short and long-term objectives, including the compilation of information gathered by other sources on watershed water quality, the publication of progress reports, and sharing of collected data with local government.

The Role of Volunteers

Volunteers visit their assigned monitoring sites monthly, tracking water quality by:

- Using a handheld meter to measure temperature, pH, conductivity, and dissolved oxygen,
- Conducting visual assessments of stream habitat and condition, and
- Collecting water samples for analysis in The Watershed Institute lab for nutrients, chloride, and turbidity.

Volunteers who undertake monitoring of their local waterbodies will become scientists carrying out an ecological study of that site. When analyzed and interpreted, detailed data collected by several individuals at contiguous sites can describe the ecology of an entire watershed. We can answer the question, "What is the quality of water in our watershed? Is water quality improving, becoming more degraded, or staying the same?" And we can then begin to answer the next question, "What actions need to be taken to further protect and improve the quality of our streams and lakes?"

The StreamWatch project is part of an outgrowth of a network of 4,500 volunteer monitoring programs across the country. These volunteer programs are responding to growing concerns about water quality; the effects of pollution; and the lack of local, state, and federal funds to monitor sites on a consistent basis.

The Use of Collected Data

The importance of StreamWatch lies in its long-term commitment and regional focus. With more than 70 active monitoring locations and a plan to continue monitoring indefinitely, StreamWatch is unique in Central New Jersey.

By using standardized sampling procedures, reporting formats, and a carefully designed data management system, the data collected by volunteer citizen monitors is of high enough quality to use as a basis for a water quality assessment. Supplemented and enhanced by data collected in other water quality monitoring efforts in the watershed, the data gathered through StreamWatch can be a very effective tool in protecting and improving the environment within our watershed. Data is shared with volunteers, the public, and municipal officials through report cards and maps on our website at www.thewatershed.org/streamwatch.

With funding from NJDEP, The Watershed Institute launched the New Jersey Watershed Watch Network in 2018 to support community water monitoring programs throughout the state. In addition to providing training, technical assistance, and a central hub for communication between stakeholders, the Network produces standardized guidance for water quality monitoring study design and quality assurance. A three-tiered system was developed to set clear expectations for data quality standards and to facilitate NJDEP use of community data. The StreamWatch Chemical Action Team primarily operates at the Tier 2 level though it is a goal to seek certification from NJDEP's Office of Quality Assurance for Tier 3 data use.

Table 1: Community Water Monitoring Tiered Data Quality Framework for Chemical Monitoring

	Tier 1 *Educational*	**Tier 2** *Targeting*	**Tier 3** *Regulatory*
Minimum Data Requirements	N/A	Use of standard operating procedures with defined levels of accuracy and precision	Lab certification by NJDEP Office of Quality Assurance
Documentation	Study design available on request	QAPP approved by data users	QAPP approved by NJDEP
Appropriate Data Uses	• Public education • Community engagement	All Tier 1 uses, plus: • Water quality assessment • Targeting BMP installation, areas for advanced monitoring • BMP effectiveness monitoring • NJDEP Comprehensive Regional Assessments	All Tier 2 uses, plus: • Regulatory assessments

2023 Program Upgrades

StreamWatch made strides to improve the quality and quantity of data collected by our volunteers by upgrading our methods and equipment. Instead of using test kits in the field, volunteers use digital handheld meters to collect their measurements. Whereas the methods used previously were vulnerable to variation and interpretation, meters will provide clearer, more accurate results in a fraction of the time. The time saved in the field will instead be used at The Watershed Institute lab where trained staff, interns, and volunteers analyze water samples collected by our field volunteers. A new data sheet was created to accommodate data collection at multiple locations by a single person or volunteer team, and to provide a chain of custody form for water samples to be delivered to the lab.

Meters and lab analysis will improve the quality of the data collected and may also allow for an increase in the quantity of data as new analytical protocols allow testing for additional parameters. StreamWatchers will monitor two or three locations each, thereby increasing our program's geographic reach as well.

Sampling Parameters

On each sampling occasion, six basic water quality parameters are tested. In this section, the meaning and significance of each parameter is explained. In the next section, testing procedures for each parameter, as well as general testing patterns, are presented.

Air and Water Temperature

Although temperature may be one of the easiest measurements to perform, it is probably one of the most important parameters to be considered. It dramatically affects the rates of chemical and biological reactions within water. Elevated water temperatures, or thermal pollution, can decrease the capability of water to hold dissolved oxygen, crucial to aquatic organisms. Thermal pollution can also impair feeding, growth, and reproduction and can cause death to aquatic organisms. Fish species vary in the level of thermal pollution they can withstand. Even a small change in temperature can drastically affect a fish's life cycle. Spawning activities, metamorphosis, and migration can be triggered at the wrong time of the year by a slight change in temperature. This, in turn, can decrease or destroy a species' chance of survival.

The temperature in all of our streams should be less than 29.4 °C. If the stream temperature consistently exceeds these standards, there may be a problem with a lack of stream shading or a discharge of heated water.

During a StreamWatch sampling session, volunteers measure both air and water temperature. Air temperature can influence the water temperature greatly, especially where water is shallow. Temperature is reported in degrees Celsius (°C), where 0.0 °C is the freezing point of pure fresh water.

Nitrate & Phosphate

Nitrogen makes up about 80% of the air we breathe. It's an essential component of proteins and is found in the cells of all living things. Inorganic nitrogen may exist in the "free" state as a gas, or as nitrites, nitrates, or ammonia. Organic nitrogen is found in proteins and other compounds. Acceptable nitrate levels for drinking water have been established as less than 10.0 milligrams of nitrate in one liter of water (mg/l). Unpolluted water generally has a nitrate reading of less than 2.0 mg/l. The nitrate test measures nitrate-nitrogen levels in parts per million (ppm). Ppm is equivalent to mg/l.

Nitrates represent the most completely oxidized states of nitrogen commonly found in water. Nitrates in water come from soil, fertilizer runoff, leaky cesspools, sewage treatment plants, manure from livestock animal wastes, and from car exhausts. These nitrates, along with phosphates, and chlorides become detrimental when they over-fertilize aquatic plants and cause accelerated eutrophication.

Eutrophication is the natural aging process of a body of water. However, an excess of nutrients such as nitrates and phosphates can greatly accelerate this natural process by stimulating excessive plant growth. These plants die more quickly than they can be decomposed, and the dead plant matter builds up. Together with the sediment entering the water, the plant matter results in a filling of the bed of the water body making it progressively shallower. Although the process of eutrophication may take hundreds or even thousands of years naturally, human impacts may reduce this time period to tens of years.

Chloride

Increased chloride levels in freshwater systems can be attributed to human impacts. Since the widespread adoption of the use of road salts in the 1970s, chloride concentrations have risen dramatically. Excessive chloride concentrations can lead to a multitude of biological effects from smaller animal body sizes and changing sex ratios to cellular desiccation and death. In lakes stratified by salt, denser salty water sinks to the bottom and avoids vertical mixing with the layers above, preventing dissolved oxygen from replenishing the deeper parts of the lake. Chloride concentrations have increased over time since there are few methods to filter it from surface and groundwater, compromising drinking water supplies. Salty drinking water may taste bad for some, but it can be harmful to those on low-salt diets, sometimes without them even knowing. Saltier water also corrodes infrastructure, increasing the likelihood of lead and copper leaching into drinking water.

The NJ surface water quality standard for “chronic” chloride toxicity is 230 ppm, meaning concentrations should generally remain below this value. Chloride levels should never rise above 860 ppm, NJ’s “acute” standard. Healthy NJ freshwaters typically contain less than 50-100 ppm chloride.

pH

A measure of acidity or alkalinity of the water, pH is based on a scale of 0.0 to 14.0 standard pH units. A pH of 0.0 is the most acidic, a pH of 14.0 is the most alkaline, and a pH of 7.0 is neutral. Normal rainwater is slightly acidic with a pH ranging from 5.5 to 6.0.

Each organism requires a certain pH range to survive, and most organisms are very susceptible to changes in pH. The pH of unpolluted water depends on the local geology and physical conditions. For example, streams draining wooded swamps usually have a pH between 5.5 and 6.5, while streams in limestone areas may have a pH of 9.0.

Low pH values (high acidity) may be caused by acid precipitation, which results when water vapor in the air becomes acidified and falls to the earth as rain. Acids can also be suddenly released during spring thaw when snow melt occurs, freeing acids concentrated in the ice over the winter months. In addition, acidic conditions may result from effluent discharges from various industries, sewage lagoons, or livestock yards.

High pH values (high alkalinity) may be caused by water treatment plant discharge or raw sewage. Natural growth processes of aquatic and marsh plants can also increase pH significantly. The photosynthetic process undertaken by aquatic plants removes carbon dioxide from the water causing an increase in pH. Therefore, in waters with plant life, especially low-velocity or still waters, an increase in pH can be expected in the growing season.

The pH for all the watershed's streams should be between 6.5 and 8.5. The buffering capacity of water, or its ability to resist pH change, is critical to aquatic life. Generally, the ability of aquatic organisms to complete a life cycle greatly diminishes as the pH goes above 9.0 or below 5.0.

Sedimentation

Sedimentation is the process by which streams, storm runoff, and other forms of moving water carry sand, silt, clays, organic matter, and other substances into streams and lakes from the surrounding watershed. In general, the amount of material deposited into a lake or stream is directly related to the use of watershed land. Activities that clear the land and expose soil to winds and rain (i.e., agriculture, site development) may greatly increase sedimentation.

Sediment material from the watershed tends to fertilize algae and aquatic plants because essential nutrients are attached to incoming sediment particles. Further, sedimentation can ruin the lake bottom for aquatic insects and bottom dwelling creatures and negatively affect fish spawning beds.

Turbidity measures how much the sediment particles suspended in the water affect the passage of light through the water. The presence of suspended sediment may cause the water to be cloudy and brownish in appearance. Suspended particles block light from penetrating into the water and may interfere with the gills of fish and the breathing mechanisms of other creatures.

Dissolved Oxygen

Dissolved oxygen (DO) is one of the most important indicators of the quality of water for aquatic life. It is essential for all plants and animals inhabiting the stream. When oxygen levels in the water fall below about 3.0 – 5.0 ppm, fish species become stressed. At a level below 2.0 – 3.0 ppm, they cannot survive. Oxygen is a sensitive constituent because other chemicals present in the water, biological processes, and temperature exert a major influence on its availability during the year.

Oxygen is transferred directly from the atmosphere into the surface waters by the aerating action of the wind and wave action. It is also added at or near the surface as a by-product of plant photosynthesis. As a result, floating and rooted aquatic plants increase DO levels. Since the existence of plants also depends on the availability of light, the oxygen producing processes occur only near the surface or in shallow waters.

Levels of DO tend to fluctuate daily in streams, falling at night, reaching the lowest level just before dawn, and then peaking in the late afternoon. Such fluctuation occurs mainly because of the photosynthetic processes of aquatic organisms, which are most active in the afternoon. DO levels also vary at different temperatures. As temperatures rise, DO levels fall. Table 2 below illustrates this relationship at various temperatures and gives the maximum concentration (or 100% saturation) of DO that can be found at each temperature.

Table 2: Maximum Solubility of Dissolved Oxygen in Water

Temperature (°C)	Solubility (ppm)	Temperature (°C)	Solubility (ppm)	Temperature (°C)	Solubility (ppm)
0	14.6	10	11.3	21	9.0
1	14.2	11	11.1	22	8.9
2	13.8	12	10.9	23	8.7
3	13.5	13	10.6	24	8.6
4	13.1	14	10.4	25	8.4
5	12.8	16	10.0	26	8.2
6	12.5	17	9.8	27	8.1
7	12.2	18	9.6	28	7.9
8	11.9	19	9.4	29	7.8
9	11.6	20	9.2	30	7.7

The numbers in the above table represent the concentration of oxygen in ppm that is equivalent to the 100% saturation for the indicated temperature.

DO depletion may occur for a variety of reasons. In some cases, a warm water discharge originating from a power plant will reduce the stream water's ability to dissolve oxygen. Perhaps more often, oxygen depletion may occur because of an excess of bacteria, possibly originating from a sewage plant discharge or farmland runoff, or the overgrowth of aquatic organisms such as algae. Most natural streams require at least 5.0 – 6.0 ppm of DO to support a diverse ecosystem.

DO concentrations need to remain above 4.0 ppm at all times to maintain a healthy ecosystem, as indicated by the NJDEP Surface Water Quality Standards.

Algal Bloom and Aquatic Vegetation

The proliferation of algae and aquatic plants is a significant water quality problem in our watershed. Such conditions are signs of man-induced eutrophication. Slow stream velocities present particularly in the Upper Millstone further accelerate the rate of eutrophication.

Algae are photosynthetic plants that contain chlorophyll and have a simple reproductive structure but do not have tissues that differentiate into true roots, stems, or leaves. Some species are microscopic single cells, and others grow as mass aggregates of cells (colonies) or in strands (filaments). Some even resemble plants growing on the lake bottom. Excessive growth of one or more species of algae is termed a "bloom". Algal blooms, usually occurring in response to an increased supply of nutrients, may give the water an unpleasant taste or odor, reduce clarity, and color a stream or lake a vivid green, brown, yellow, or even red depending on the species. Filamentous and colonial algae are especially troublesome because they can mass together to form scums or mats on the water surface. During a Harmful Algal Bloom (HAB), some species of cyanobacteria produce toxins at a level that poses a risk to humans, pets, livestock, and wildlife.

Aquatic plants have true roots, stems, and leaves. Like algae they can overpopulate and become a water quality problem in streams and lakes. Aquatic plants may be either "emergent" with stems or leaves that will rise above the surface or "submergent" with all or most of the leaves and stems below the water surface. Many submergents flower above the surface.

Conductivity

With the use of Hanna meters, we have added conductivity to the list of parameters StreamWatch monitors. Conductivity is the measure of the ability of water to conduct an electrical current. Higher conductivity indicates the presence of chemicals, minerals, and dissolved substances in the water. Salts and other inorganic chemicals dissolve in water and break down into negative ions, anions, (including chloride, nitrate, sulfate, and phosphate) and positive ions, cations (including sodium, magnesium, calcium, iron, and aluminum). Factors impacting the conductivity of a waterbody include flow conditions, temperature, pH, and the geological formations through which it flows.

Specific conductance is reported in microsiemens per centimeter (µS/cm), at a standardized temperature of 25 °C. In the United States, freshwater streams and rivers range from 50 – 1500 µS/cm but are typically below 500 µS/cm (U.S. Environmental Protection Agency, 2012). Conductivity readings above natural ranges can indicate changes in point source discharges or increased nonpoint source pollution. Excessive dissolved solids in the water can decrease the solubility of oxygen making the water less suitable for aquatic organisms.

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General CAT Monitoring Practices

Monitoring Schedule

Volunteers must start sampling between 10:00 am and 12:00 pm on the Saturday or Sunday of the third weekend of the month. A list of sampling dates is sent to volunteers every winter or given out on an as needed basis. See attachment for current schedule.

Field Safety

If you feel that conditions at the stream are unsafe, DO NOT SAMPLE.

If a personal health emergency occurs while in the field, contact the appropriate police/ambulance number for your township or borough, and/or call 911. Also, contact The Watershed Institute at (609) 737-3735, as soon as possible. The Watershed Institute carries liability insurance under a "green umbrella" policy that extends to all volunteers at all sampling locations.

Chemical Safety

Some of the chemical reagents have hazardous components and may be harmful if inhaled, contacted through the skin, or ingested. MSDS forms are included in the training binder for your reference.

Read all instructions to familiarize yourself with the test procedure before you begin.

- Keep all equipment and chemicals out of the reach of young children.
- Avoid contact between reagent chemicals and skin, eye, nose, and mouth.
- In the event of an accident or suspected poisoning, immediately call the New Jersey Poison Control Center at: 1-800-222-1222 or (973) 972-9280. Be prepared to give the name of the reagent in question.
- Wipe up any reagent chemical spills as soon as they occur. If inside your home, rinse the area with a wet sponge, then dry.
- Be careful not to spill any chemical reagents in the environment.
- Keep waste water in your waste water container and empty regularly empty that container into the chemical waste bins at The Watershed Center. Make sure to label your container as "Poison – Do Not Drink".

Incident Reporting

Your monitoring work adds to the number of eyes and ears on the waterways ready to detect unusual incidents that should be reported. Reporting suspected pollution, fish kills, and dramatic changes is vital.

If you notice or suspect that an oil or chemical spill, or another significant water pollution incident (i.e., a fish kill) has occurred, contact the **NJDEP Action Hotline at 1-877-WARNDEP (or 1-877-927-6337**). You may also report environmental incidents through the **WARN NJDEP app**, which will allow you to submit photos.

- Fish kills: Observations of numerous dead fish or unusual behavior of fish or macroinvertebrates should be noted under miscellaneous observations. Strange behavior would include numerous fish rising to the surface of the water for air. In the event of a fish kill, note the number and kinds of dead fish, the exact location of the kill and time it was first observed. Even if you are unable to identify the fish, it is helpful to know how many kinds of fish are involved (a single species could indicate that "natural" conditions caused a fish kill). If the kill is ongoing or very recent, collect 3 or 4 of the freshest fish, wrap them in aluminum foil, or place them into a Ziploc bag and put them on ice. DO NOT FREEZE! Call the NJDEP's Emergency Hotline immediately and notify The Watershed Institute as soon as possible.

- Spills and other suspected pollution: Any sign of serious pollution or other hazard requiring immediate attention should be reported as soon as possible to the NJDEP Hotline (1-877-WARNDEP) and to The Watershed Institute.

- Soil erosion and sediment pollution: Serious erosion problems should be reported to your local county conservation district. The USDA Natural Resources Conservation Service and/or the state agency are important resources. You should also alert the local municipality about the problem and as always, notify The Watershed Institute.

- Dredging and filling: If you witness these activities, they may or may not be illegal. The local municipality or county conservation district usually track wetlands or stream encroachment permits. If not, your regional office of the NJDEP should be contacted (see page 53 for contact numbers). Note when and where the activity occurred. If you can, get the name of the company performing the activity. Be alert for proposed projects or "For Sale" signs, which may involve wetlands, floodplains, ponds, and streams.

- Dumping: If you witness illegal dumping into a stream, floodplain or wetland, immediately call the local police department. Local and state police can be most helpful for incidents that require an immediate response such as spills and illegal dumping. They are frequently able to contact a spill response team directly from their patrol cars. You will also want to contact The Watershed Institute and the NJDEP Hotline in the event of the dumping of any toxic chemicals.

Caring for your Kit

The Watershed Institute will provide each StreamWatch Chemical Action Team volunteer with all the materials and tools necessary to complete their monitoring activities. In addition to this training binder, your kit will contain the following:

- Hanna digital meter, multiparameter probe, and cable
- Calibration cup & silicone beaker
- pH 7.01 calibration solution
- Conductivity calibration solution
- pH 4.01 buffer for probe storage
- Electrolyte solution for DO membrane
- Distilled water for rinsing probes
- Wire brush for cleaning probes
- Soft-sided cooler for storage and transport of water samples on ice
- Bottleware for collecting water samples
- Clipboard & markers
- Multi-Site data sheets & Chain of custody forms
- Laminated quick-start meter instruction & field procedure cards

Best Practices

- Keep all the provided materials and equipment together in the provided carrying case and store in a safe place out of reach of children.
- Avoid prolonged exposure of equipment and reagents to direct sunlight or extreme cold. We advise that you keep the kit inside your home (in a place unreachable by small children), rather than in your car or garage.
- Tightly close all reagent containers immediately after use. Do not interchange caps from different containers.
- Do not handle the sensing surfaces of the sensors.
- Avoid rough handling and abrasive environments that can scratch the reactive surfaces of the sensors.
- Avoid long-term exposure of sensors to bright sunlight. If possible, calibrate indoors or in a shaded area.
- Discard standards after use. Do not return the used standards to the bottles of "fresh" solution.

Kit Cleaning & Maintenance

It is **very important** to perform regular kit cleaning and maintenance to ensure that the data you collect is the most accurate and reliable possible.

Follow these steps to clean your kit:

1. Remove and inspect handheld meter for any damage or evidence of water leakage or battery corrosion.
2. Remove and visually inspect the probe and cable for any damage.
3. Unscrew the probe cover and visually inspect each internal probe for scratches, cracks, nicks, etc. Inspect all sensor connectors for corrosion and replace sensors if necessary.
4. Also inspect the O-rings at the base of each probe for any signs of damage.
5. Using the provided wire brush, gently brush off any debris and/or salt deposits on the probes.
6. Check the cap on the pH probe for storage solution. If it has evaporated, remove the cap, fill with the 4.01 pH buffer, and replace onto probe. (The probe should soak for 30 minutes before it can be used.)
7. Holding the probe vertically, examine the bottom of the dissolved oxygen probe. Make sure there is electrolyte solution in the cap, and that there are no air bubbles or debris between the membrane and the probe.
8. After prolonged storage or cleaning, calibration of the sensors is required.
9. After use rinse the probe with tap water and dry it. The pH electrode bulb must be kept moist. Dry the D.O. and EC sensors.

pH and pH/ORP Sensor Maintenance

- Remove the sensor protective cap. Do not be alarmed if any salt deposits are present. This is normal with pH/ORP electrodes, and they will disappear when rinsed with water.
- Shake down the sensor as you would do with a clinical thermometer to eliminate any air bubbles inside the glass bulb.
- If the bulb and/or junction are dry, soak the electrode in the pH 4.01 buffer solution for at least one hour.
- To ensure a quick response time, the glass bulb and the junction should be kept moist and not allowed to dry. Store the sensor with a few drops of pH 4.01 buffer in the protective cap.
- Inspect the sensor for scratches or cracks.

D.O. Sensor Maintenance

For a top performance probe, it is recommended to replace the electrolyte monthly. Proceed as follows:

- Unscrew the membrane by turning it counterclockwise.
- Rinse membrane with some electrolyte while shaking it gently. Refill with clean electrolyte.
- Gently tap the cap over a surface to ensure that no air bubbles remain trapped. Avoid touching the membrane.
- With the sensor facing down, completely screw the cap clockwise. Some electrolyte will overflow. If any deposit scales the sensor, gently brush the sensor surface with the supplied brush, while paying attention to not damage the plastic body. Do not use the brush on the membrane.

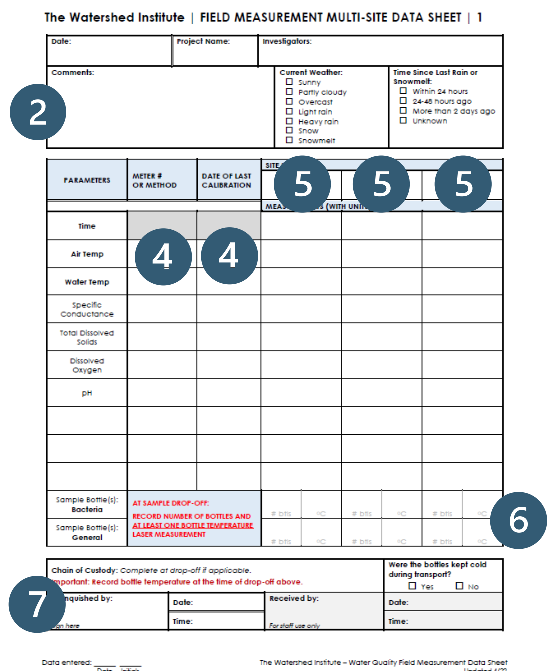
Quarterly Maintenance

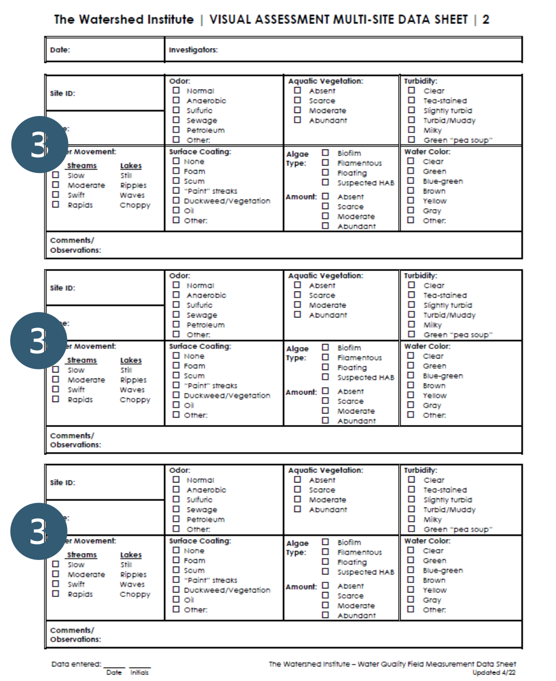
Every three months, when dropping off your data sheet and water samples, we will also collect your meter. Watershed staff will thoroughly inspect each meter, download the logged data, replace the DO membrane and any other parts that need to be changed, and calibrate temperature at the NJDEP Bureau of Freshwater & Biological Monitoring. The meters will be returned to volunteers prior to the next sampling event.

Data Sheet Instructions

During each sampling event, a StreamWatch Data Sheet should be fully completed. Apply the following guidelines when completing the data sheets:

1. All data should be recorded in print on original data sheet. Mistakes should be indicated by placing a line through the erroneous characters and entering new characters to the right of the lined-out entries and then initialed by the recorder.
2. Immediately upon arrival at the sampling station enter the observer's **full name**, date, time, and observations on weather conditions. Any variation from the official sampling date (Saturday or Sunday) or time (10:00 am – 12:00 pm) should be noted by placing a star in the left margin next to the date or time.
3. Use the back of the data sheet to record your observations of the habitat including water odor, color, movement, and turbidity. Also note any algae, aquatic vegetation, and any surface coatings. Use one box per site.
4. **Be sure to fill in the meter number and calibration dates for each parameter in the provided spaces.**
5. Use the Hanna multiparameter probe & meter to measure the following parameters: temperature, pH, conductivity, and dissolved oxygen. You should use one column per site in the table on the front of the data sheet. Make sure to include the units of your measurement. Always record the test results exactly as displayed on the meter on the data sheet. Do not rely on your memory or the meter.
6. Use the bottom two rows of that table to indicate how many water samples were collected at each site. For bacteria samples, also record the temperature of the bottle at drop off.
7. When your sampling is complete, bring the data sheet and any water samples to The Watershed Institute within 24 hours. Use the chain of custody box at the bottom of the first page of the data sheet to record the date and time of your sample hand-off.





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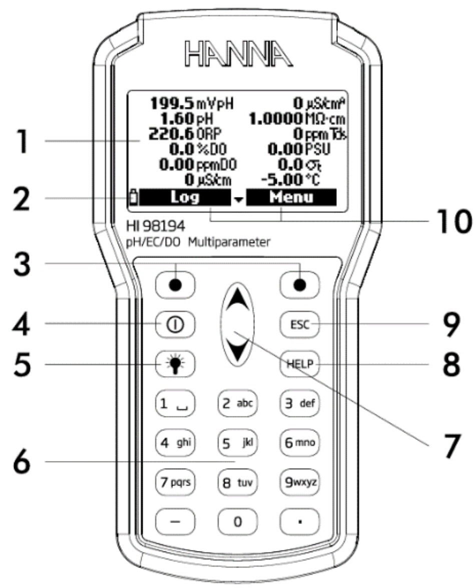
Preparing to Test

Volunteers will use a Hanna multiparameter probe & meter provided by The Watershed Institute to measure water temperature, pH, dissolved oxygen, and conductivity. Plastic bottles are also provided for testing bacteria, nitrate, phosphate, chloride, and turbidity in the lab. The methods for each sampling parameter are described below. It is extremely important that volunteers adhere to each step of the following instructions for accurate, precise, and reliable data that is collected consistently across our monitoring network.

1. Graphic LCD display
2. Battery level indicator
3. Softkeys
4. ON/Off key: turn the meter on and off
5. Lamp key: turn the backlight on and off
6. Alphanumeric keyboard: insert alphanumeric codes
7. Arrow key: scroll the displayed options/message
8. HELP key: obtain information about the displayed screen
9. ESC key: return to the previous screen
10. Softkey functions defined on display



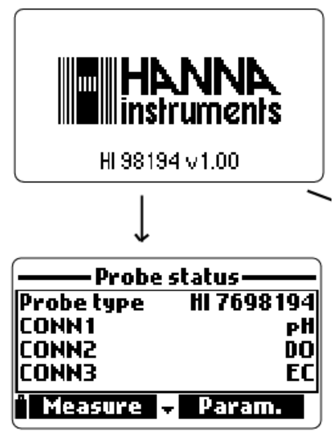
Prep for Field Work

- Fill cooler with a sufficient amount of ice to cover your sample bottles for the day.
- Confirm that you have all the materials you need to sample.
- Suggested: Label bottles with your last name, site name, and sample date before you leave the house.
- Suggested: Check www.wunderground.com/history for rainfall totals in your area in the last 24-48 hours.

Prep Meter

1. Remove the probe from the carrying case and unscrew the black protective covering.
2. Inspect internal probes and O-rings for scratches, cracks, corrosion, nicks, or other damage. Contact The Watershed Institute if you discover any damage.
3. Remove the plastic cap from the pH sensor.
    a. If the storage solution in the cap has evaporated, gently brush any debris off the pH probe. Pour a little of the provided 4.01 pH buffer into the plastic cap and replace the cap on the probe. Allow the probe to soak in the pH buffer for 30 minutes prior to sampling.

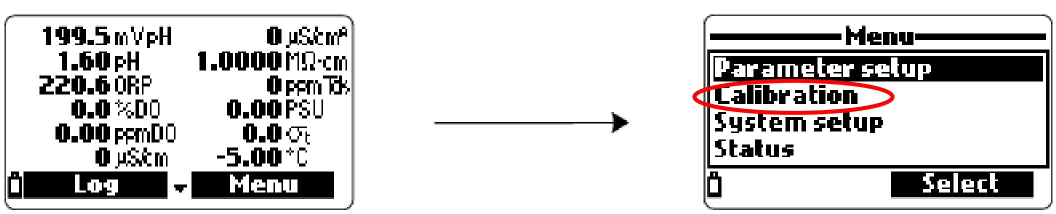
4. Remove the membrane cap from the dissolved oxygen probe and replace electrolyte solution.
    a. Being very careful not to lose the O-ring inside the cap, shake out any remaining electrolyte solution. Add 3-5 drops of electrolyte solution and shake to rinse the membrane. Repeat if necessary.
    b. Dump out electrolyte and add another 3-5 drops of clean electrolyte. Gently tap the membrane cap to dislodge air bubbles. To avoid damaging the membrane, do not touch it with your fingers or directly tap the membrane.
    c. With the sensor facing down, screw the membrane cap counterclockwise to the end of the threads. Some electrolyte solution may overflow. Invert sensor and inspect. There should be no bubbles or debris between the membrane and sensor body.
5. Use the provided brush to remove any debris or salt deposits then rinse all probes with deionized water.
6. With the meter off, connect the probe to the instrument input on the top of the meter. Align the pins and then push the plug into the socket. Clip the lanyard on the probe to the metal loop on the top of the meter.
7. Turn the meter on by pressing the On/Off key. The meter will automatically recognize the probe and the installed sensors and identify them on the probe status screen.



Calibrate Your Meter

Your Hanna Multiparameter Meter needs to be calibrated for pH, conductivity, and dissolved oxygen at the beginning of each sampling day. Follow the instructions below to complete the required calibrations:

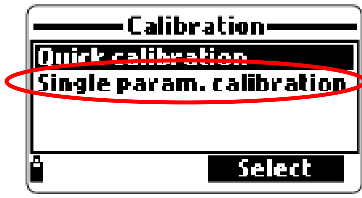
From the probe status screen, press the ESC key to return to Measurement Mode. Go to the Main Menu by pressing the Menu softkey. Use the arrow keys to select Calibration Mode.

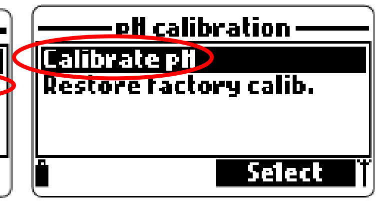


You will go through this menu to calibrate pH, conductivity, and dissolved oxygen independently. Select Single param. Calibration, pH, Calibrate pH.

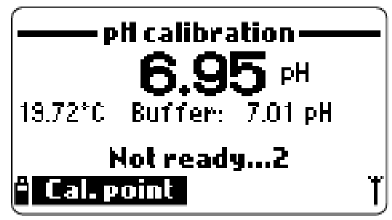
pH Calibration

Follow the instructions below to complete a one-point calibration for pH:

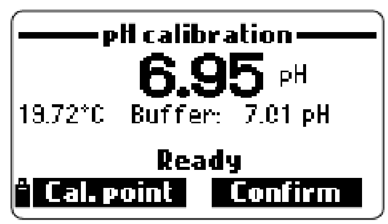




The measured pH value is displayed, along with the temperature and the buffer value on the second level. If necessary, press the Cal point softkey and use the arrow keys to select the 7.01 buffer.



1. Using the provided silicone beaker as a catch basin, rinse the sensor with the 7.01 pH buffer solution. Empty the solution in the beaker into your wastewater container. Rinse the beaker with distilled water.
2. Fill the calibration cup approximately halfway. Immerse the pH sensor and temperature probe into the buffer and stir gently. The temperature, pH buffer value and the “Not ready” message are displayed.

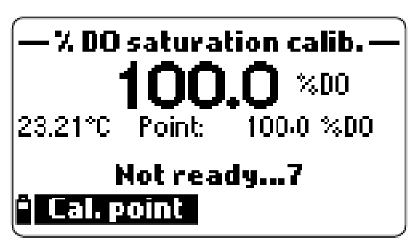


3. Once the reading has stabilized the countdown timer will count down until the display shows the “Ready” message.
4. Press Confirm to accept the calibration point. Empty the calibration cup into your wastewater container and rinse with distilled water.
5. After the calibration point is confirmed press the ESC key. The message “Storing” followed by “Calibration completed” will be displayed.
6. Press OK to return to the Calibration menu.

Dissolved Oxygen Calibration

Next, select dissolved oxygen from the single parameter calibration menu. Select %DO saturation and follow these instructions to complete a one-point calibration at 100%.

1. To calibrate at 100%, fill the bottom of the calibration beaker with water to the top of the black cap. Screw it onto the probe. The membrane should not be wet.
2. The reading, temperature, calibration point and the “Not ready” message are displayed. Once the reading has stabilized the countdown timer will count down until the display shows the “Ready” message.



3. Press Confirm to store the calibration. The following messages will appear: “Storing” and “Calibration completed”.
4. Press OK to return to the “Calibration” menu.

Conductivity Calibration

Finally, select conductivity calibration from the single parameter calibration menu. Select the "Conductivity" option and press Select to confirm. Follow these steps:

1. Fill the provided silicone beaker with approximately 60 ml of the conductivity standard.
2. Immerse the sensor into solution by raising and lowering the beaker a few times to ensure that the EC sensor channels are filled with fresh standard.
3. Fill the calibration beaker approximately halfway with the conductivity solution.
4. Place the calibration beaker over the EC sensor and dislodge any trapped bubbles. Screw the beaker into place. Wait for the reading to stabilize.
5. The main display shows the actual reading, while the secondary level displays the current temperature and the standard value.
6. To change the standard value, press Cal. point then Custom to insert the value of the calibration solution (100 µS/cm) using the keypad, then press Accept.

7. When the reading becomes stable, the stability timer will count down and Confirm will appear. Press Confirm to save the calibration.
8. After confirmation, the following messages are displayed: "Storing" and "Calibration completed". Empty both beakers into your wastewater container and rinse with distilled water.
9. Press OK to return to the "Calibration" menu. Press ESC twice to return to main menu.

Testing Procedures

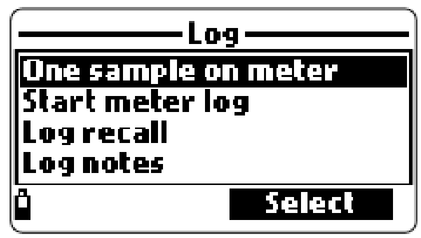
Visual Habitat Assessment

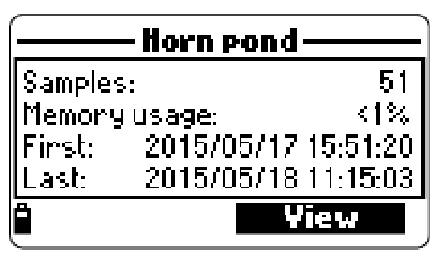
The purpose of the habitat assessment is to rate the various physical influences on the stream and to help determine the point and non-point sources of pollution that could be affecting the water quality. Volunteers collect information on stream flow, water odor, water color, recent and current weather conditions, and wildlife. The forms allow staff to assess site factors that may contribute to the bacteria levels found in the sample.

1. Note current and recent weather conditions.
2. Check the boxes next to the best description of water flow, color, and odor.
3. Take note of any wildlife, floatables, and comments that may affect sample results.

Log Meter Readings

1. Remove pH probe cap if necessary, turn on meter and Press ESC or Measure to go into Measurement Mode.
2. Allow the reading to stabilize. Record air temperature on data sheet exactly as displayed on the meter.
3. Wade to the center of the stream or reach as far as you can into the water body.
4. Submerge probe in water. Make sure all sensors are covered, but probe is not in contact with bottom.
5. Press 6 to show all parameters on the meter display. Allow 1-2 minutes for readings to stabilize.
6. Press Log > One sample on meter > Select. On the Meter log screen, ensure that the correct Site ID is showing.
7. If not, press Options to select or create the correct lot. Press OK.
8. Enter remarks as needed. Meter will display “Sample Logged” message. Return to shore to fill in data sheet.
9. Press Log > Log recall > Lots > select correct Site ID > View > View > Scroll or Jump to correct test
10. Press 6 to show all parameters and record them on the data sheet exactly as displayed. Power off meter.





<u>Help</u>
The HELP key on the meter is context sensitive and will provide information regarding the currently displayed screen.

You may use the included meter manual to troubleshoot any error messages displayed on the meter.

Should you have any trouble, please contact us at streamwatch@thewatershed.org or 609.737.3735 ext.54.

Collect Grab Samples

1. Ensure all bottles are labeled with your last name, the correct site ID, and date.
2. Wade to the center of the stream or reach as far as you can into the water body to collect samples.
3. Uncap and submerge the 150 ml clear bottle 6 inches below the surface to fill above the 100 ml line. Remove, make sure to leave a little bit of air space at the top, and cap.
4. Nestle the bottles into the ice to keep cool during transport to The Watershed Center. Do not freeze.
5. Samples must be delivered to The Watershed Institute within 24 hours of collection and must be kept below 10° C until that time.

After Testing

Delivering your Sample(s) to The Watershed Center

1. Bring your cooler to the StreamWatch cabinet at the side/delivery entrance to The Watershed Center.
2. Make sure you've completed the Chain of Custody section of your data sheet. Record your site name(s) and the number of bottles you have brought.
3. Record the bottle temperature of one sample bottle. Do not open the bottle.
    a. Wipe excess liquid from the side of the bottle.
    b. Aim the thermometer gun (provided in the supply cabinet) on the side of the bottle to read.
4. Sign your name legibly and record the time of sample delivery.
5. Make sure the sample bottles are labeled properly and the lids are tight and secure, then nestle them into the cooler of ice provided.
6. Leave your data sheet in the folder (provided in the supply cabinet). Have a great day!

References

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Rubin, A. E., & Zucker, I. (2022). Interactions of microplastics and organic compounds in aquatic environments: A case study of augmented joint toxicity. *Chemosphere, 289*(133212).

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Attachment: General Monitoring & Maintenance Schedule

Q1

January

Week	
Wk1	Meter Maintenance
Wk2	Meter Sign Out
Wk3	Sample
Wk4	
Wk5	
Wk6	

February

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	
Wk5	
Wk6	

March

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	Meter Drop Off
Wk5	Meter Maintenance
Wk6	*Meter Maintenance*

Q2

April

Week	
Wk1	Meter Maintenance
Wk2	Meter Sign Out
Wk3	Sample
Wk4	
Wk5	
Wk6	

May

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	
Wk5	
Wk6	

June

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	Meter Drop Off
Wk5	Meter Maintenance
Wk6	*Meter Maintenance*

Q3

July

Week	
Wk1	Meter Maintenance
Wk2	Meter Sign Out
Wk3	Sample
Wk4	
Wk5	
Wk6	

August

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	
Wk5	
Wk6	

September

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	Meter Drop Off
Wk5	Meter Maintenance
Wk6	*Meter Maintenance*

Q4

October

Week	
Wk1	Meter Maintenance
Wk2	Meter Sign Out
Wk3	Sample
Wk4	
Wk5	
Wk6	

November

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	
Wk5	
Wk6	

December

Week	
Wk1	
Wk2	
Wk3	Sample
Wk4	Meter Drop Off
Wk5	Meter Maintenance
Wk6	*Meter Maintenance*

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Attachment: Hanna Instructional Manual

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Attachment: MSDS Sheets

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Attachment: StreamWatch CAT Data Sheets

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