Utah Water Watch
Volunteer Monitoring Manual

Utah's Citizen Water Quality Monitoring Program

Monitoring - Education - Stewardship

Authors: Nancy Mesner, Brian Greene, Eli Robinson, Ellen Bailey, Cade Andrus, Jose Pacheco, and Lauren Houskeeper

Updated June 2020

This program supported with funding from Utah Division of Water Quality (CWA 319/State NPS funding). Other support from iUtah (NSF OIA – 1208732) and the Quinney College of Natural Resources is gratefully acknowledged.

UtahStateUniversity WATER QUALITY EXTENSION

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY

NR/WaterQuality/2019-01pr

Table of Contents

Welcome to Utah Water Watch 5

Why participate? 6

About Utah Water Watch 7

Water Pollution and Monitoring Concepts 9

What is clean water? 9

How do UWW volunteers fit in? 12

The value of UWW data 13

Natural and human induced variability 14

Utah Water Watch – Tier 1 Monitoring 16

Getting Started 16

Attend a Tier 1 Training 16

Monitoring sites 17

Monitoring equipment 18

Safety 18

Data collection 19

Data submission 19

Data collection, Quality Assurance / Quality Control (QAQC) 20

Standard operating procedures 20

Training 21

Equipment storage and maintenance 21

Replicability and representability 22

Sample collection and handling 22

Database 22

Data review 23

Tier 1 Monitoring General Protocols 25

Before going in the field 25

General protocol 25

Tier 1 Stream Monitoring Instructions 27

Qualitative observations in streams 27
Flow 27
Water surface 28
Water clarity 29
Water color 29
Water odor 30
Algae cover 31
Dead fish 32
Present weather and recent rainfall 33
Quantitative observations in streams 33
Air temperature 35
Water temperature 35
pH 36
Turbidity in streams (turbidity tube) 38
Dissolved oxygen 39
Salinity, conductivity, TDS 41
Bacteriological monitoring in streams 44
E. coli 44
Photo point monitoring in streams 48
Tier 1 Lake Monitoring Instructions 50
Qualitative observations in lakes 50
Water condition 51
Water surface 51
Water clarity 52
Water color 52
Water odor 53
Dead fish 54
Present weather and recent rainfall 54
Quantitative observations in lakes 55
Air temperature 56
Water temperature 56

pH ... 57
Transparency – Secchi reading ... 59
Salinity, conductivity, TDS ... 60
Community fishing observations ... 63
Algae monitoring in lakes ... 64
Bacteriological monitoring in lakes ... 68
E. coli ... 68
Photo point monitoring in lakes ... 72
UWW Database – CitSci.org ... 74
Submit UWW data ... 74
Upload photo point photos ... 77
View data ... 77
Download data ... 79
References ... 81
Appendices ... 82
Appendix A: Utah Water Watch Useful Webpages ... 82
Appendix B: Tier 1 Stream Datasheet ... 84
Appendix C: Tier 1 Lake Datasheet ... 87
Appendix D: Harmful Algae Field Guide ... 90
Appendix E: Microscope Locations and Local Health Department Contacts ... 92
Appendix F: Coliscan Easygel E. coli Guides ... 94
Appendix G: Chart to convert turbidity tube cm to NTU ... 97
Appendix H: Examples of conductivity and TDS ranges in Utah streams ... 98

List of Figures and Tables

Table 1. Monthly time commitment for volunteers.. 7
Figure 1. The difference in stream temperature between an upstream and downstream site on Castle Creek in Southeast Utah……13
Figure 2. Example of annual changes in dissolved oxygen and temperature…………………………………………14
Figure 3. Daily dissolved oxygen levels (mg/L) in East Canyon Creek………………………………………………….15

Welcome to Utah Water Watch

Utah Water Watch (UWW) is Utah's citizen water quality monitoring program. Developed by Utah State University's Water Quality Extension program, with funding and guidance from Utah's Division of Water Quality, UWW volunteers are active around the state.

The main goal of Utah Water Watch is to engage the public in the protection of their local water bodies and watersheds (the land draining to a specific water body). Volunteers are trained in sampling and evaluation techniques that can indicate the current health of waterbodies and help identify changes over time. Volunteers also learn about the science and management of our waters and often become active stewards of their local watersheds. An important concept is understanding how land uses and activities in a watershed may introduce pollutants or create risks for downstream waters. Because of this, most water quality management in Utah is actually watershed management.

Middle school student collects data in the Ogden Valley.

UWW is a two-tier program. Tier 1 monitoring is conducted primarily for educational and screening purposes. Using simple methods and basic observations, Tier 1 volunteers monitor the natural changes and fluctuations of their local water bodies as they learn about challenges that these waters face. Tier 2 volunteers are trained in more advanced monitoring techniques so they can assist scientists and managers in more rigorous data collection.

Castle Valley and nearby La Salle mountains, near Moab.

This manual provides background information about water quality, water quality monitoring, and detailed information about UWW's Tier 1 collection methods, data management, and reporting.

Why participate?

Utah is the 11th largest state in the United States, covering about 84,900 square miles. Although it is the 2nd driest state, winter snowmelt and summer monsoons feed over 14,750 miles of permanent streams and rivers, over 89,000 miles of intermittent streams, and at least 2,085 lakes and reservoirs, as well as sustaining approximately 558,000 acres of wetlands. While water quantity is critical, water quality is equally important for residential, agricultural and industrial needs, as well as the needs of aquatic life across the state. Broadly speaking, water pollution can be defined as any substance that inhibits any of these uses of the water. As Utah's population grows, water quality is increasingly affected by human influences. Pollution comes from many sources, but currently the biggest problem is "nonpoint source pollution", a term describing the mix of substances that are carried by runoff across the land to our waters. This type of pollution is transported by rain and snow runoff, and irrigation runoff from lawns or fields. Because there are so many sources, we all contribute to the problem. Through small changes in our daily habits and land management practices, each of us also plays an important part of the solution.

USU Water Quality Extension's combined Utah Water Watch and Stream Side Science logo.

Although local, state and federal agencies, industries, and educational institutions all monitor Utah's waters, these combined efforts are insufficient to meet the monitoring challenges in the state. This is where Utah Water Watch volunteers come in. Our volunteers collect data and report conditions for streams and lakes across Utah, helping to characterize the health of all our waters. UWW also creates a core of knowledgeable volunteers who can communicate the importance of water quality to their respective communities.

By participating in UWW, you are taking part in citizen science. Citizen science is scientific work undertaken by members of the public. Citizen science recognizes that anyone can be a scientist and participate in scientific research through observation of the world around them.

About Utah Water Watch

Utah Water Watch volunteers consist of a wide variety of age groups, ranging from students to retirees. UWW volunteers monitor sites that are of interest and convenient to the volunteer, but also are useful to the agencies charged with managing each watershed. Training is offered across the state, providing volunteers with the equipment and supplies they need. Continuous support is provided through direct contact, our website, social media, and newsletters. The data is entered into a secure online database and can be accessed by anyone. Data summaries and interpretation of volunteers' sites are conducted on a regular basis.

Tier 1 volunteers are provided equipment and training necessary to collect simple water quality data at a local water body. These volunteers are often unfamiliar with water science, but are interested in learning more about a local water body. As they return each month to the same site, they gain a deeper understanding of natural seasonal changes at their site and are often surprised to learn that the water they are monitoring is in good shape.

Volunteer Raymond Li Monitoring the Logan River.

Tier 1 volunteers use simple techniques to make field observations about water appearance, temperature, pH, dissolved oxygen, and turbidity. They also collect water for a simple scan of *E. coli* bacteria. The data collected by these volunteers is primarily for educational purposes, but also provides baseline data and helps identify previously undetected water quality problems.

We ask that all Tier 1 volunteers monitor at least once a month from April through October. We always welcome more frequent sampling, and are happy to accommodate different monitoring schedules or

Table 1. Monthly time commitment for volunteers. Time may vary depending on experience.

Activity	Time (minutes)
Travel (drive/walk)	Dependent on location
Collect data at site	20
Process E. coli sample	10
Analyze E. coli sample	10
Enter data in database	10
Total time (except travel)	**50**

arrangements. At the site, Tier 1 monitoring typically takes about 20 minutes. An additional 30 minutes or so is necessary to process the *E. coli* samples and to enter data to the online database (http://extension.usu.edu/utahwaterwatch/database).

Tier 1 volunteers with a year of experience or individuals with previous science and monitoring backgrounds may wish to participate in our Tier 2 monitoring activities. Tier 2 volunteers are provided additional training so they can assist water quality scientists and other partners with diverse monitoring needs, including research, evaluating the success of restoration activities, and assessing our lakes for presence of harmful algal blooms. Tier 2 monitoring may be conducted on a regular schedule but is often conducted on an "as-needed" basis. For more information, contact USU Water Quality Extension (http://extension.usu.edu/waterquality).

Water Pollution and Monitoring Concepts

Water quality is protected and managed at several levels and it is important to understand how volunteers fit in. Federal legislation sets the national framework, but much of the work is conducted at a local level with significant involvement by local citizens.

What is clean water?

The federal Clean Water Act (CWA) of 1972, and its subsequent amendments, remains the fundamental federal legislation for protecting and managing water quality in the U.S. The CWA is administered at the federal level by the EPA, although many states, including Utah, manage most of the CWA requirements at the state level. One of these requirements is to determine the water quality status of our different water bodies. Rather than trying to define "clean water" unambiguously, the CWA defines the benefits that are provided by natural waters. It then establishes a process for designating the appropriate "beneficial uses" that each water body should support and for evaluating whether these water bodies are, in fact, supporting these beneficial uses.

Cutler Marsh in the Bear River Watershed. Photo source: USU Water Quality Extension.

Utah's water quality is managed primarily by the Utah Division of Water Quality (UDWQ), with oversight by the EPA. Utah's law identifies the following broad categories of beneficial uses that our surface waters may support: sustaining aquatic life, use for agricultural purposes (irrigation and animal watering), recreational uses, and as a source of drinking water. Because the Great Salt Lake and its surrounding wetlands are so unique, Utah has given this water its own set of designations.

Irrigated field in Utah.

Within each of these beneficial use categories are sub-listings that capture the natural variability of waters throughout our state. For example, the aquatic life category includes designations for cold-water fisheries, warm-water fisheries, non-sport aquatic life, and water related wildlife. The recreational category includes designations for primary recreation (such as swimming) and secondary recreation (such as boating). The Clean Water Act takes into account that some unpolluted waters are naturally too warm for some types of fish and aquatic vegetation, while other waters may be naturally too salty to be used for irrigation (i.e. Great Salt Lake).

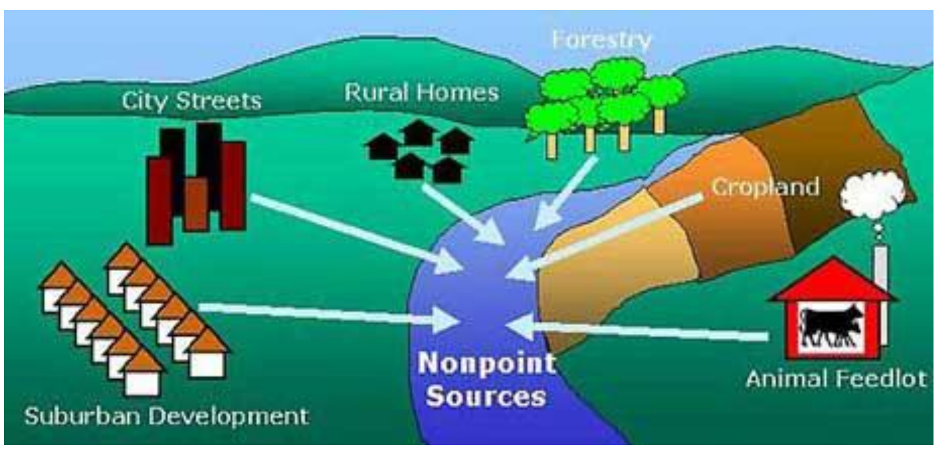
Every water body in the state has been assigned the “beneficial uses” it should be able to support. The UDWQ’s assessment monitoring program regularly monitors the current status of Utah’s water bodies to determine whether they are impaired in any way and therefore, no longer supporting their “designated beneficial uses.” Water samples are compared to measurable water quality criteria (benchmarks) which serve as indicators of whether a particular beneficial use is impaired by pollutants. In addition, aquatic macroinvertebrates and other biological samples are used to assess stream health compared to unimpaired streams.

Recreational kayaking on the Jordan River.

If monitoring data or water quality modeling indicate that a water body is not supporting its beneficial uses, it is considered “impaired.” Addressing this impairment depends on the magnitude and extent of the problem and the type of pollutants involved. Water pollution is divided into two main categories, which are addressed in very different ways. Point source pollutants are traceable back to a pipe or discharge point such as an industrial operation or a municipal wastewater treatment plant. Point sources are managed through a permit system that closely regulates the discharge of pollutants from these sources. The degree of treatment or reduction required is based on the best technology available. Each point source must obtain a "discharge permit" that sets limits on the amount and timing of pollutant discharges. The source is required to conduct regular monitoring and reporting. If the discharge exceeds pollutant limits, fines may be imposed, or additional treatment may be required.

In contrast, nonpoint source (NPS) pollutants are contaminants that cannot be easily traced to a single, identifiable source. These contaminants are picked up and transported to water bodies by rainwater, snowmelt or other runoff over the land that comes from a wide range of land uses in urban, rural, and wildland areas. This group of pollutants is not regulated, but controlled and reduced through a wide range of "voluntary, incentive-based" approaches. Education, technical support, and in some cases, financial incentives are provided to encourage individuals, businesses, and municipalities to use "best management practices" (BMPs), which are specific actions or structures that reduce or eliminate pollutant runoff from different types of land uses or activities.

When an impaired water body is identified, all potential pollutant sources in a contributing area are identified and evaluated with an acceptable target "load" from each source determined. The pollutant level is then reduced through a mix of improved technology for point sources and improved land management for nonpoint sources. The actual approach taken is typically chosen following public input and consideration of multiple factors such as cost and probability of success. Ongoing monitoring is required to determine to what extent the chosen approach has improved water quality. The process is "adaptive," designed to change as new and improved information becomes available.



Nonpoint sources come from all land uses and are often difficult to track.
https://oceanservice.noaa.gov/education/kits/pollution/04nonpointsource.html

As the popular slogan says, "*we all live downstream*", so we all benefit from these improved behaviors. See the USU Water Quality website (***http://extension.usu.edu/waterquality***) for more information on detecting and eliminating nonpoint source pollution.

How do UWW volunteers fit in?

Water quality monitoring is conducted for many different reasons. The approach taken is determined by clearly defined and specific objectives of a project or program. For example, point source discharges may be fairly constant throughout a year so regularly scheduled monitoring at a regular frequency may be sufficient to characterize the pollutant discharges.

Volunteer training in Escalante, October 2015.

In contrast, tracking changes in a river following implementation of a set of best management practices will need to consider how pollutants of concern move across the landscape to the waterbody and how pollutants change under different chemical conditions. For example, as water moves over the land or through the ground, metals picked up along the way may change solubility with changes in water alkalinity or pH. Concentrations may also change dramatically during runoff periods compared to low flow (base flow) periods.

Methods required for educational purposes may be far simpler (and less expensive) than those used for other monitoring purposes. None-the-less, these easy and inexpensive methods may be very effective at highlighting how physical, chemical, or biological processes change over time.

For more information on how to establish appropriate monitoring practices, see "Best management practices monitoring guide for stream systems" – https://extension.usu.edu/waterquality/bmps/bmp_guidance. Monitoring for all these different purposes requires coordination and communication between state, local, and federal agencies and partners. Utah Water Watch volunteers are an important part of this team.

The value of UWW data

The Utah Water Watch Tier 1 monitoring program data is of value for educational purposes, showing trends over time, and allowing for comparisons between different sites, such as in Figure 1. All data collected at the Tier 1 level are entered into an online, publicly available database, http://www.citsci.org, so the data are available for other educators, interested citizens or watershed partners for screening or educational purposes. Agency partners may use the

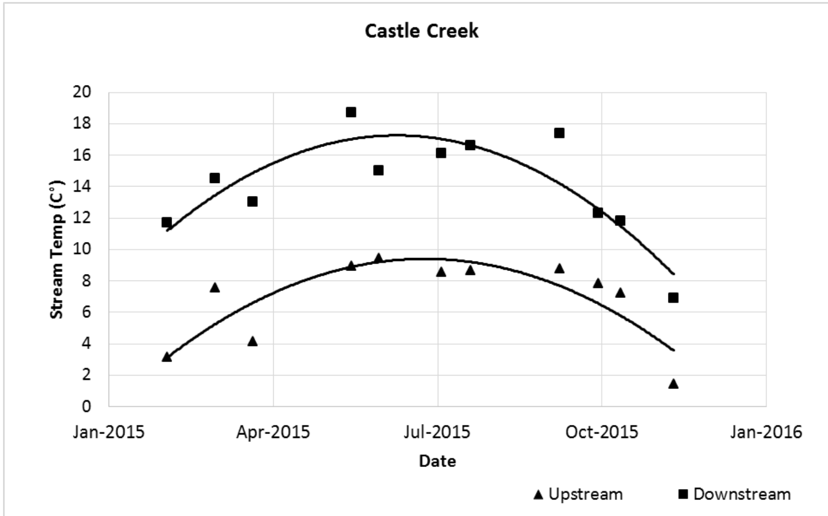


Figure 1. The difference in stream temperature between an upstream and downstream site on Castle Creek in Southeast Utah.

data to establish baseline conditions and screen for potential water quality issues. Educating the public is a critical element of managing our natural waters and for this reason, UWW Tier 1 volunteers are important partners in the process of protecting our water quality.

While UWW staff review the submitted data, it is helpful for volunteers to be aware of abnormal trends, (e.g. sustained high *E. coli*, high turbidity during low flow, etc.) and contact UWW with any concerns. In this way, Tier 1 UWW monitoring may also serve as a warning that a water quality problem exists. When unusual monitoring results occur, UWW watershed partners are notified by the UWW coordinator for possible follow up monitoring. It may be beneficial to develop a relationship with the local watershed coordinator (find contact information at www.utahcleanwater.org) to learn more about water quality at a specific site or water body. Attending local watershed meetings is an excellent way to learn about current issues and meet the partners working in the watershed. Many watershed meetings are posted on the UWW online calendar – http://extension.usu.edu/utahwaterwatch/Calendarandevents/.

UWW Tier 2 volunteers typically use more advanced monitoring techniques and work with agency partners or researchers to collect data with better quality control. This Tier 2 data may therefore, be used for assessing the quality of Utah's waters or for determining the impacts of projects implemented to improve water quality. Because the data is collected following higher standards, it may also be included in the Utah Ambient Water Quality Monitoring System database (https://awqms.utah.gov).

Natural and human induced variability

Monitoring a site throughout the year allows volunteers and students to better understand the difference between natural seasonal changes and other changes that may indicate human impacts. Annual patterns are somewhat predictable, but the timing, extent, and magnitude of seasonal effects may vary considerably from year to year.

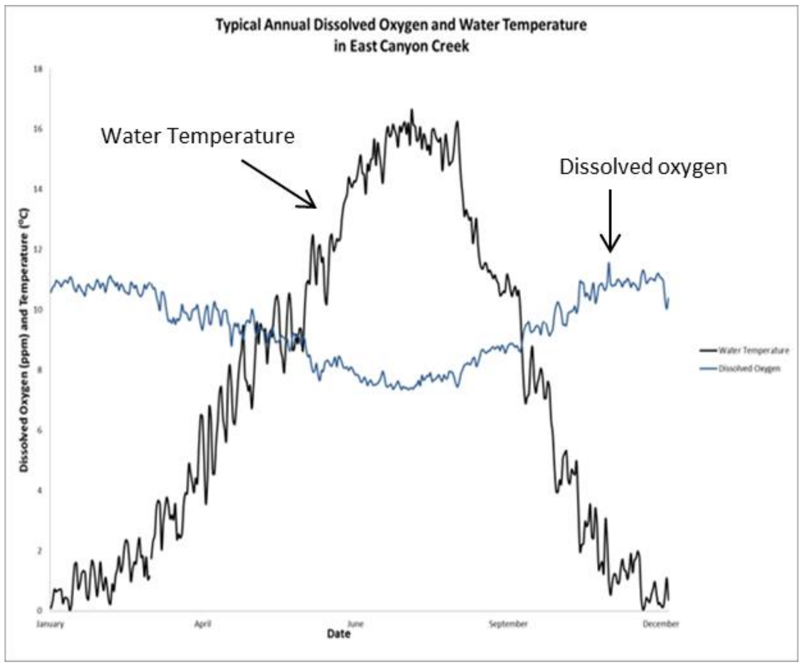


Figure 2. Annual changes in dissolved oxygen and temperature.

Many water bodies in Utah are fed by snowmelt from nearby mountains. Flows are likely to peak in the spring as the snow melts, followed by summer and fall baseflows, which are relatively low, stable, and clear as subsurface water slowly drains to the stream. In southern portions of Utah, monsoon (late summer) rain patterns or other extreme summer storms may lead to rapid and significant increases in flow, accompanied by increases in sediments and other materials carried with surface runoff.

Annual changes in water temperature follow air temperature changes-albeit less dramatically. Other water parameters, such as dissolved oxygen, are related to water temperature so we typically see an inverse relationship between the two (Figure 2).

Many parameters also vary considerably during the day. High levels of photosynthesis during the day result in higher dissolved oxygen and pH concentrations in many waters. When the sun goes down, pH and dissolved oxygen values may drop. This can result in oscillating patterns of dissolved oxygen and pH throughout a 24-hour period, as shown in Figure 3.

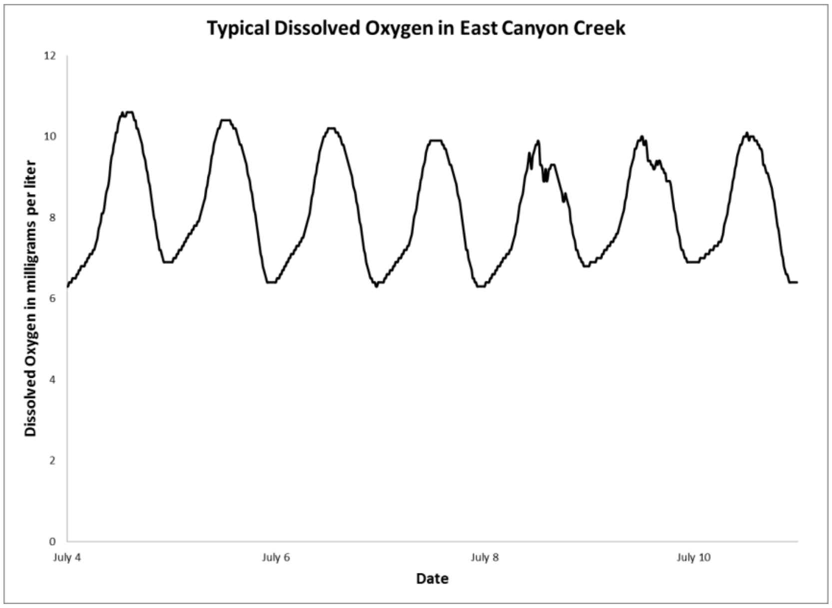


Figure 3. Daily dissolved oxygen levels (mg/L) in East Canyon Creek.

Land uses within a watershed may also significantly affect annual flow patterns. Upstream reservoirs may trap runoff waters resulting in lower spring flows and enhanced summer flows if water is released for irrigation downstream. In contrast, diversions for summer irrigation may lower natural river flows substantially or may even “de-water” reaches of a river. Return flows from irrigated lands often carry higher sediment loads and are warmer than the natural stream flow. Urban development results in increased pavement and buildings (impervious surfaces), which prevent water from soaking naturally back into the soil. The increase in impervious surfaces can result in higher peak flows immediately after a storm, increased pollutant runoff, and reduced summer flows. Increasingly, urban areas install different types of “best management practices” that reduce these impacts.

We encourage volunteers to be aware of these natural changes and human impacts. Human caused changes in water quality must be detected against this backdrop of natural variability, which can be a challenge. One way to “control” some of this natural variation is to consistently monitor a site at the same time of day. Even if this is not possible, recording the date and time when samples are taken helps interpret results.

Utah Water Watch – Tier 1 Monitoring

Getting started

Anyone is welcome to participate in the Utah Water Watch program. The monitoring season lasts from April through October, with volunteers monitoring at least once a month, although some volunteers have taken the initiative to monitor more frequently or year-round. Learn more about the program and view additional photos online at http://extension.usu.edu/utahwaterwatch/.

Attend a Tier 1 training

All new volunteers must attend a training session in order to start monitoring a site. These trainings are offered throughout the year at locations across the state. Watch our website for scheduled workshops or contact us about scheduling a workshop in your area.

Tier 1 trainings typically last about 4 hours. Volunteers spend 1-2 hours in a classroom setting, which provides the details of the UWW program and an overview of water quality principles and management in Utah. This session also includes some fundamental water quality and watershed science, and information about the specific types of data to be collected and how to enter these data into our online database. An outdoor session follows, with hands-on instruction on proper monitoring techniques. Throughout the training workshop, volunteers are evaluated for their ability to carry out the monitoring procedures and provide tips and guidance where volunteers have questions.

Volunteers at a suburban stream training.

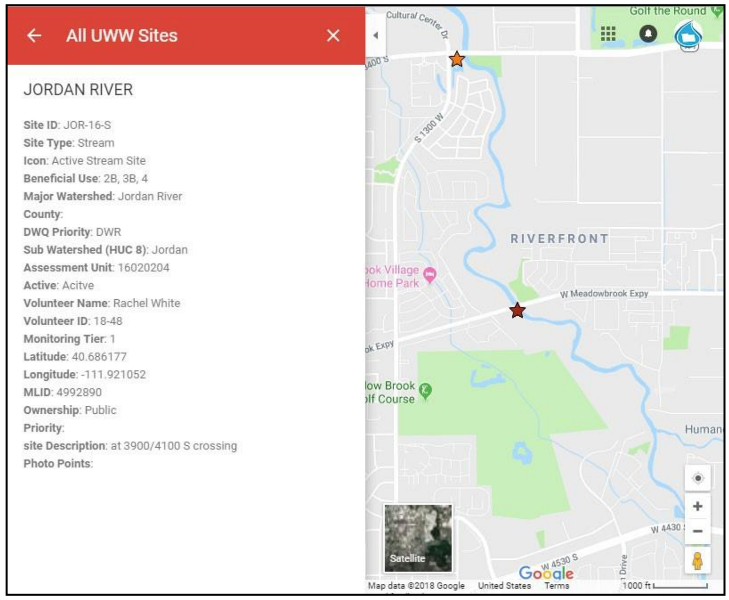
Additionally, an annual survey provides feedback opportunities for the volunteers.

To ensure UWW volunteers practice good science, volunteers are trained to follow UWW's Quality Assurance Quality Control protocols, discussed in more detail below.

Training ensures all volunteers follow the monitoring protocols, take representative samples, use correct units and decimals, understand the equipment capabilities, fill out the datasheet correctly, and submit data in a timely manner. Volunteers are provided a Certificate of Training to keep in their UWW Notebook.

Monitoring sites

Tier 1 volunteers monitor waterbodies ranging from small streams to large reservoirs. Our website includes a Utah map showing currently monitored sites, as well as available sites UWW and UDWQ would like to have monitored. It is helpful, but not necessary to identify sites or water bodies of interest before attending the training. The UDWQ must approve the final site to assure that it is representative of the water body and if possible, in a location that will fill a data need. If none of the available sites suit a volunteer's specific monitoring needs or interests, we are happy to work with volunteers and local watershed coordinators to designate a new site.



Google maps shows the location and information about one of Utah Water Watch's volunteer monitoring locations on the Jordan River.

Volunteers should consider the following factors about a site in order to have a successful and meaningful monitoring experience

- Choose a place you enjoy visiting or a site that has special significance to you, your family or your community.
- The site should be convenient and close enough that the travel time to the site is not a burden.
- Consider safety and ease of access throughout the entire sampling season. Pay special attention to nearby traffic, steep slopes, and deep or rapidly flowing waters.

Private Property - Never walk on or monitor at sites that are on private property, unless you have written permission from the landowner. Trespassing is a crime and a violation of Utah Water Watch volunteer ethics.

Monitoring equipment

After a training, volunteers are asked for a commitment to participate. At that point, volunteers are loaned the necessary equipment, which includes a monitoring notebook, a thermometer, pH test strips (with a measurement range of 5-10 pH), a field dissolved oxygen kit (stream sites), a turbidity tube (stream sites), a secchi disk (lake or reservoir sites), and sampling kits for *E. coli* bacteria analysis. UWW will regularly replace supplies that are used up or damaged. When volunteers retire from the program, UWW coordinators work with the volunteers to return the equipment. Quarterly photo point photos of the monitoring site are encouraged. Any available camera for these photos will do and is the responsibility of the volunteer.

Tier 1 monitoring equipment - thermometer, pH strips, dissolved oxygen kit, turbidity tube or Secchi disk, and E. coli testing supplies.

For more details about each method, see Monitoring Protocols on page 27.

Safety

Volunteer safety is the number one priority and ultimately the responsibility of the volunteer. We recommend:

- Take a partner when monitoring.
- Let someone know when and where you are going to monitor.
- Never enter a water body where dangerous conditions exist, such as dangerous weather, high water, flooding, fast flowing water or rapids, abnormally colored water, unnaturally foul odors or other conditions.
- Watch out for hidden barbed wire, metal, glass and other hazards such as failing, steep or slippery banks.
- Volunteers should take care to protect themselves from sunburn, insect bites, and stinging nettles, poison ivy or other dangerous plants; wear protective clothing, including good footwear.

- Keep an eye out for spiders, snakes, and other wildlife.
- Always wash your hands after monitoring.
- If going boating, wear personal flotation devices.

In case of environmental emergency, for Hazardous Waste Spills call 801-536-0200 or for Water Quality threats call 801-536-4300.

Data collection

Volunteers collect data on a monthly basis, from April to October. To ensure regular monitoring, we suggest scheduling a specific day or week of the month, make a note on a calendar, and collect at the same time of day if possible. Data collection takes about 20 minutes. *E. coli* samples, collected May to September, require about 30 minutes of additional processing time at home. All data needs to be recorded directly on the UWW datasheet or into the CitSci App in the field. Datasheets for data collection are available in Appendix B and on the website: http://extension.usu.edu/utahwaterwatch/monitoring/datasheets/index.

Data submission

Volunteers enter their own data into a database provided at www.citsci.org. Entering data into the UWW database in a timely manner is a critical step. Please enter the data within a week of data collection or send a scan or photo of the data sheets directly to UWW so the data can be entered for you. The database and instructions are available on the UWW website: http://extension.usu.edu/utahwaterwatch/database/. Volunteers must establish a personal login ID that allows data submission at their specific site(s) and for their specific monitoring protocols. Volunteer data and comments are checked on a weekly basis, however if there are any concerns, volunteers are also encouraged to contact the UWW coordinator (waterquality@usu.edu or 435-797-2580) directly. In case of environmental emergency for Hazardous Waste Spills call 801-536-0200, for Water Quality threats call 801-536-4300 or for a 24-HR emergency line, 801-536-4123.

Data collection, Quality Assurance / Quality Control (QAQC)

The key to a successful volunteer monitoring program is to have trained volunteers using methods that produce reliable and useful data that aligns with the project's objectives. Data that are poorly collected, poorly documented, or treated in a way to bias the results can be worse than no data. The UWW monitoring program carefully considers the data quality requirements and establishes a protocol that meets those requirements.

Quality assurance establishes the actions taken to assure that sample collection, analysis, and data submissions are followed properly. Quality assurance protocols include training for all volunteers, proper data collection and sample handling, and data management and checks. Quality controls are the measures taken to determine if the actual samples meet the necessary precision and accuracy required for a specific project. This includes checks of data as it is submitted.

Everyone plays a role in maintaining the integrity and quality of data produced by UWW. Volunteers help achieve this by paying attention to details during trainings, verifying their skills during field training, following official procedures during monitoring and noting any variance from these procedures on their data sheets.

Standard operating procedures

During the training, volunteers are provided equipment and trained using designated UWW monitoring protocols for each type of measurement. All monitoring programs establish a standard set of protocols that includes field monitoring, lab analysis, sample handling, and data management. These are important to ensure all data is collected using the same methods. These protocols are referred to as Standard Operating Procedures (SOPs).

Volunteers at a training, testing temperature.

Tier 1 UWW protocols differ from the protocols used by agencies such as the Utah Division of Water Quality or the USGS. UWW uses equipment and methods that are relatively simple and fit well with our mission, “educating and engaging citizens through monitoring activities and data collection.”

Tier 1 UWW data is not included in in the Division of Water Quality’s official database (https://awqms.utah.gov) and the data is not used for official reporting or assessments. This does not mean that UWW data are not useful.

UWW volunteer makes sure that samples are collected in moving water.

Training

At the volunteer training, we review the official methods (SOPs) contained in the volunteer handbook. Volunteers are also introduced to each piece of equipment and are trained with conducting field observations. This includes, but is not limited to, understanding the capabilities of each test, correct units, and safe handling. The trainer works with each attendee to make sure they demonstrate competence and understanding of the standard methods.

Volunteers are encouraged to attend a refresher training every two years. The refresher will ensure that volunteers are still following the proper protocols and provide a venue for questions that may have come up during sampling. Volunteers are also notified of any protocol changes throughout the year.

Equipment storage and maintenance

Equipment is provided by UWW but is maintained by the volunteer who is instructed in the proper way to store them. The equipment is kept at room temperature out of direct sunlight (with the exception of the *E. coli* gels, which are kept frozen). UWW provides replacements and updated equipment as needed.

Replicability and representability

Replicability, or the ability for one scientist to re-create the results of another, is an important tenant of the scientific method.

As scientists, we want to ensure that the sample is representative of the section of lake or stream we are monitoring. As you monitor your site, be sure that the water is flowing and well mixed (river) or deep enough (lake) to represent the entire reach of stream or lake as a whole. Measurements taken in a back eddy on the side of the stream or a side channel of the stream may produce different results (may not be *representative)* than the stream as a whole.

Some of these methods, such as *E. coli*, contain built in quality control by collecting duplicate samples.

Sample collection and handling

Most of the data collected by Tier 1 volunteers will be recorded immediately on the datasheet. However, the *E. coli* and algae tests require sample collection and handling procedures. Samples must be processed within 8 hours. Once processed, the results must be read within 72 hours. In addition, samples that are not processed within the first hour are kept chilled. See more detail in collection procedures. Algae samples also need to be kept chilled and viewed in the microscope or dropped off at a health department within 24 hours of collection.

www.CitSci.org database. UWW switched to this platform in 2018 from the old site (www.usu.edu). This is a platform used nationally by many groups to collect a variety of citizen science data.

Database

All data collected by Tier 1 volunteers is entered into a publicly available online database housed and maintained by CitSci.org, www.citsci.org. While anyone can download data, volunteers must be approved to enter data. To submit data, volunteers create a CitSci login and request access to the

Utah Water Watch project within Citsci.org. As a further safeguard, volunteers are able only to submit data for their own site and are required to submit metadata (time and date the sample was taken) when submitting data. The database also has a feature that allows Utah Water Watch staff to review data and make changes, if there are submission errors. Volunteers are also able to review and make edits, only to the data reports that they submitted.

Volunteers are encouraged to enter a partial submission even when the site is inaccessible due to high flows or other circumstances. Volunteers are encouraged to take photos of their sites, activities, etc. These can be submitted directly into the CitSci datasheet online. See additional information in the Photo Point Monitoring instructions.

Data review

Utah Water Watch staff reviews the data submitted by volunteers on a weekly basis (monthly during the off-season) to ensure quality and flags suspect data. We both manually review data submitted and use a program that flags anomalous values. Volunteer comments are invaluable and provide context for the data if values are atypical. We also make sure that data is within the acceptable ranges established by the state for each particular water body. We review past data submissions to see if the values are typical for the water body. If we see a trend toward reduced water quality, we contact the Utah Division of Water Quality.

Below is a summary of data review by UWW for each parameter:

1. Temperature – We check that the air and water temperature values are in degrees Celsius. We also check that water temperatures being reported are below the maximum water quality criterion standard for the specific water body being sampled.
2. pH – We check that pH values are within the normal 6.5 to 9.0 healthy range.
3. Dissolved oxygen – We check that reported concentrations are above 5.0 mg/L.
4. Turbidity and total depth (streams) – We check the turbidity and total stream depth measurements to make sure the values are appropriate and recorded in centimeters.
5. Secchi and depth (lakes) – We check that the Secchi depth is an appropriate value and reported in meters.
6. *E. coli* – We check that the incubation began within 8 hours of sampling and that the samples were kept cooled and in the dark prior to incubation. We also check that the values are

properly averaged and that the final value is below the 409 colonies / 100mL criterion for primary contact recreation or below 668 colonies / 100mL criterion for secondary contact recreation.

If data is out of the normal range for a site, we verify the values with the volunteer to ensure it was recorded correctly. If that value is confirmed by the volunteer, UWW notifies the UDWQ TMDL coordinator in charge of managing nonpoint source pollution in the watershed. If there is an immediate concern, volunteers may be asked to assist with additional collection.

Tier 1 Monitoring General Protocols

Parameters collected by volunteers include both field observations and measurements. Field observations include flow, water clarity, water color, water odor, algae cover, presence of dead fish, weather, and recent rainfall amounts. Measurements include temperature, pH, dissolved oxygen, turbidity (streams) or Secchi depth (lakes), and *E. coli*. Volunteers also create photo points at their sites and submit quarterly photos. Additional instructions and videos are available online (http://extension.usu.edu/utahwaterwatch/monitoring/tier1).

UWW Tier 1 parameters and methods are all described below. In each case, you will find an explanation of the parameter, why it is important, and instructions on how to conduct the field measurement or collect the sample. Instructions below follow the order of the UWW datasheet.

While monitoring, there are several simple guidelines to follow to ensure data is properly collected and recorded. See the General protocol below.

Before going in the field

Before going in the field, be sure to have all the equipment you need - thermometer, pH strips, turbidity tube or Secchi disk, dissolved oxygen kits, *E. coli* collection bag, camera, datasheets, pencil, permanent marker, and a waste container. Include sample bottles, protective gloves, and glasses where needed for algae collection. Check the dissolved oxygen kits and the *E. coli* supplies to assure that time sensitive supplies are not past their expiration date.

General protocol

Each time you monitor, fill out a datasheet completely at the field site, including the site ID, sample date, and time. If you sample more than one site, you need to fill out a datasheet for each site. When you complete the monitoring, enter the data in the UWW collaborative CitSci online database (www.citsci.org) as soon as possible. Save the original datasheet because sometimes UWW staff have questions about the online data (transcription errors, high values, etc.) and this serves as a good back up. Tier 1 Lake and Stream datasheets are located in Appendix B, as well as online (http://extension.usu.edu/utahwaterwatch/monitoring/datasheets/).

Stream Field Datasheet (Tier 1)
Utah Water Watch

Site Name: ______________ **Date Sampled:** ______________ **Time Sampled:** ______________
Field Monitor Name(s): ____
UWW ID: ______________ **Hours Sampling/traveling:** ____________ **Miles traveled:** ________
UWW Site ID: _________ **# of participants:** ______________ **Decontamination:** Yes No

FIELD OBSERVATIONS *(Circle one for each)*:

Stream Flow:	Flood	High/Runoff	Normal/Baseflow	Low	No flow		
Water Clarity:	Clear	Cloudy/Milky	Turbid				
Water Surface:	Sheen/Oily	Trash	Natural Debris	Foamy	Scummy	Clear	
Water Color *(Select one from each row)*:	Normal	Abnormal					
	Clear	Brownish	Greenish	Reddish	Blue	Orange	
Site Odor:	None	Chlorine	Sewage	Fishy	Musky	Oil	Rotten Egg
Algae Cover	Abundant Filamentous	Thick Substrate Layer	Little Filamentous	Moderate Substrate Layer	Little/Rare		
Dead Fish:	None	1 to 3	4 to 10	>10			
Current Weather:	Clear	Cloudy	Overcast	Light Rain	Heavy Rain	Snow	

Rainfall in past 24 hours (inches) __________
Comments: ____

Continued on back

extension.usu.edu/utahwaterwatch (435)797-2580 waterquality@usu.edu

Tier 1 stream data sheet for general site information.

When collecting samples and recording data, remember to pay close attention to the following guidelines to ensure that the data you record are accurate and meaningful.

- In streams, take the sample in the main flow where the water is well mixed. This will assure a sample that is representative of the entire stream.
- In lakes, take the sample at the surface, in the top 10cm.
- Check upstream for short term disturbances or activities that might affect the results. If you see these, make a note on your datasheet.

- If possible, collect samples at the same time of day each month.
- Be sure to use pencils to fill out datasheets (they don't run when wet).
- Label whirl-pacs and bacterial plates with the sample number, site, and date using a sharpie. This is especially important if you are collecting samples at multiple sites. See *E. coli* protocols for streams on page 44 and for lakes on page 67.
- Be careful to record your data in the correct units (for example: °C, meter vs centimeter). We use the metric system in UWW.
- Be careful to place decimal points in the correct location.

Be aware of typical ranges of values for the different parameters you are measuring. These ranges are identified for each parameter in the stream and lake instructions below. This will prevent you from mistakenly recording a value that would never actually occur in Utah's waters!

Tier 1 Monitoring Instructions - Streams

Qualitative observations in streams

The initial data recorded is a set of field observations. These recorded **qualitative observations** (i.e. subjective observations about habitat, water conditions, and weather) help us understand and interpret the other **quantitative**, or numerically measured, data that volunteers collect.

Recording field observations requires volunteers to select the most appropriate description of the current conditions. During trainings we review the descriptive terms used in these field observations.

These observations also require volunteers to become familiar with their site. Many of these observations are more meaningful when the volunteer understands what is "normal" and what is the result of seasonal variation or human caused impacts.

UtahStateUniversity WATER QUALITY EXTENSION

Stream Field Datasheet (Tier 1)
Utah Water Watch

Site Name: ______________ **Date Sampled:** ______________ **Time Sampled:** ______________
Field Monitor Name(s): ______________
UWW ID: ______________ **Hours Sampling/traveling:** ______________ **Miles traveled:** ________
UWW Site ID: ________ **# of participants:** ______________ **Decontamination: Yes No**

FIELD OBSERVATIONS *(Circle one for each)*:

Stream Flow:	Flood	High/Runoff	Normal/Baseflow	Low	No flow		
Water Clarity:	Clear	Cloudy/Milky	Turbid				
Water Surface:	Sheen/Oily	Trash	Natural Debris	Foamy	Scummy	Clear	
Water Color *(Select one from each row)*:	Normal	Abnormal					
	Clear	Brownish	Greenish	Reddish	Blue	Orange	
Site Odor:	None	Chlorine	Sewage	Fishy	Musky	Oil	Rotten Egg
Algae Cover	Abundant Filamentous	Thick Substrate Layer	Little Filamentous	Moderate Substrate Layer	Little/Rare		
Dead Fish:	None	1 to 3	4 to 10	>10			
Current Weather:	Clear	Cloudy	Overcast	Light Rain	Heavy Rain	Snow	

Rainfall in past 24 hours (inches) __________
Comments: ______________

Datasheet section for stream field observations.

Comments can also provide invaluable information about the monitoring site or changes that may have occurred since the previous visit. Comments may include sightings of animals in the stream, changes in the surrounding land use, and notes about vegetation, invasive species present or eroding banks.

Flow

Definition: The volume of water that flows past a specific point in a stream over a specific time. Also called stream discharge.

*Why we monitor flow***:** The amount of water in the stream can influence other water quality parameters such as temperature, dissolved oxygen, and turbidity, as well as the total amount of pollution a stream or river is carrying.

What influences flow: Stream flow changes based on the amount of precipitation, weather, size of the watershed, and human water withdrawals. Animals, such as beavers, can quickly change the flow of a stream by building dams which can change the location of the stream channel.

No flow
Water not moving; either no water or water only in isolated pools

Low flow
Some flow but lower than normal baseflow; portions of stream bed exposed.

Normal / baseflow
Natural flow of the stream due to infiltration.

High flow / runoff
At or near bank full due to recent precipitation or runoff.

Flood
Stream is over the banks.

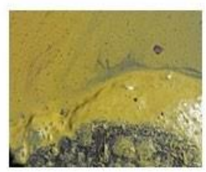
Water surface

Definition: The debris that are on the surface of the water.

Why we monitor water surface: The condition of the water surface may provide an indicator of pollution.

What influences water surface: While material on the surface like dust and pollen can be natural, trash and oily materials on the surface can indicate improper disposal of man-made materials. Some algae and cyanobacteria may also float or form a scum on the surface of the water.

Clear
No visible debris on the surface.



Scummy
A film of materials like dust or pollen coating the surface. (Image: Procsilas Moscas)

Foamy
Visible bubbles or foar on the surface. (Image: norman_baboo)

Natural debris
Leaves, sticks, feathers, etc. on the surface.(Image: giogog).

Trash
Man made materials like bags, cups, and bottles. (Image: Yves Mauerer)

Sheen / oily
Oils (occasionally natural) floating on the waters' surface.

Water clarity

Definition: The amount of material suspended in the water column, related to turbidity.

Why we monitor water clarity: Sediment and algae, the primary contributors to reduced clarity, may smother habitat for aquatic macroinvertebrates and reduce light penetration.

What influences water clarity: Activities in the watershed, such as forestry, agriculture, and development, influence the water clarity. Changes in land use can result in short- or long-term changes to the water clarity. Furthermore, natural seasonal changes like high runoff can temporarily shift water clarity.

Clear
Water is transparent and you can see through it to the bottom.

Cloudy / Milky
Water has a whitish or chalky appearance. Water not completely opaque, still somewhat transparent

Turbid
Water has a murky or muddy appearance. Lots of suspended sediment or algae. Cannot see through the water.

Water color

Definition: Color of the water in the stream. The color of healthy streams may range from clear to brown.

Why we monitor water color: Water color may indicate large scale changes in the watershed, such as increased sediment runoff from construction or mine drainage containing heavy metals. It may also indicate changes in the amount of algae in the water.

What influences water color: The size of the watershed, slope, geology, and land use all influence the water color. Color in streams is often related to the amount of runoff and sediments entering the stream. Sediments increase naturally during high runoff but may be enhanced by eroding banks and areas where riparianvegetation is removed. Deep green, or pea soup color, often results from an overabundance of algae (phytoplankton). Heavy nutrient loads from fertilizers, animal waste, and poor sewage treatments often promote heavy amounts of algae. Select the best color option that represents the color of the water and mark abnormal if the color is not typical.

Clear
Usually associated with healthy waters. However, clear waters may be polluted with colorless substances. Very clear water without any living organisms indicates a pollution problem.

Brownish
Often results from decaying organic matter in the stream or lots of sediment. Streams that drain wetlands may be stained a very dark brown.

Greenish
Slightly greenish water results from the presence of microscopic plants or algae and usually indicate healthy conditions.

Reddish
May result naturally from drainage through soils rich in iron and tannins.

Blue
Clear cool waters often have a blue color. Strong blue colors can result from glacial runoff.

Orange
May indicate runoff from mines or oil wells; may result naturally from drainage through soils rich in iron and tannins.

Water odor

Definition: Water may have an odor dependent on chemical or biological components or activity present.

Why we monitor water odor: The general smell of a water body can indicate potential contamination. Not all unpleasant odors indicate an unnatural cause.

What can influence water odor: Local biologic processes like decomposition influence water's odor. Bacteria have a strong influence on smell. Waste disposal or accidental spills can temporarily change the smell of the water and are sometimes cause for concern. If you are concerned about sewage, oil or chemical spills, contact the 24-hour emergency line of the Environmental Response at the Utah Division of Water Quality (801-536-4123). Make a note of this call on your field sheet.

Select the best option. An odor is usually obvious when you arrive at the site.

1. None – No strong or apparent odor associated with the water.
2. Oil – A strong chemical smell that could result from mishandling of industrial solutions.
3. Sewage – A foul smell of waste that can indicate possible contamination from animals or people. Be sure to wash your hands after sampling.
4. Rotten Egg – A sulfurous smell which often indicates an anaerobic (without oxygen) decomposition process or presence of some animal waste. Minerals from sulfur springs can also give off this smell.
5. Fishy – A strong smell that indicates the presence of dead fish.
6. Musty – A dank, moldy smell that can indicate mold, large algae presence, or decomposition.
7. Chlorine – Smells like a swimming pool. May result from a leak from an industrial source.

Algae cover

Definition: Algae is a diverse group of photosynthetic organisms lacking roots and commonly occur in streams. Many are microscopic, but individual cells may combine into long strands.

Why we monitor algae cover: Large amounts of algae may be harmful to the aquatic environment, reducing oxygen levels, and smothering important habitat. During the day, plants pump oxygen into the stream and use up carbon dioxide, which results in higher pH and dissolved oxygen. However, at night, this dynamic flips, so plants and algae consume oxygen and release carbon dioxide. In certain streams, dissolved oxygen swings low enough at night that fish and macroinvertebrates are stressed, or the increased carbon dioxide causes a dip in pH. Algal buildup can cause sags in dissolved oxygen as this material decays.

Presence of algae in large amounts may indicate excessive nutrient levels. Algae covering more than 25% of the stream bottom may indicate excessive nutrients.

What influences algae cover: Algae needs light and nutrients to grow. When nutrients become abundant, algal growth increases.

Some different types of algae found in streams are: Rock slime (attached to rocks), filamentous green algae (stringy), and Didymo (rock snot – covered with a thick "polysaccharide" layer). Some aquatic macrophytes are easily confused with algae. Cyanobacteria (harmful algae) are not typically found in streams but may occur if the site is downstream of a lake or reservoir. See more information about harmful algae on page 66 and in Appendix C.

Macrophytes (not algae) | Filamentous algae at surface | Benthic algae (attaches to substrates) | Didymo (rock snot)

Types of plants or algae commonly occurring in rivers and streams. Didymo photo credit: EPA - https://www.flickr.com/photos/usfwspacific/8030568001/.

Select the best option for the abundance of algae cover:

Algae Cover:	Abundant Filamentous	Thick Substrate Layer	Little Filamentous	Moderate Substrate Layer	Little/Rare

Dead Fish

Why we monitor dead fish: Fish are biological indicators of water quality. The presence of dead fish can indicate a potentially serious water quality problem.

What can influence the presence of dead fish: Seeing a few dead fish (3 or less) could be due to natural causes or improper handling of fish while fishing. A greater abundance of dead fish may indicate a water quality problem. Fish kills normally result from high water temperatures and low dissolved oxygen levels that suffocate the fish. Toxic chemicals or very high or low pH may also cause fish kills.

Dead Fish:	None	1 to 3	4 to 10	>10

Look around the immediate sampling location (10m in all directions) and count the number of dead fish floating or below the surface. If there is an abnormally large fish kill (greater than 4), take a photo if possible and report it to the Department of Environmental Quality information line: 800-458-0145 (M-F, 8-5). If you feel that this is an emergency, you may wish to contact the 24- hour emergency line of the Environmental Response at the Utah Division of Water Quality (801- 536-4123).

Present weather and recent rainfall

Why do we monitor weather: The current and past 24-hour weather can influence water quality observations by changing flows, in-stream concentrations, and producing short term upstream surface runoff. Knowing about recent weather helps to interpret the data that is collected. For example, rain the day before may increase surface runoff, resulting in increased turbidity for several days.

What influences weather: Local weather is made up of a combination of local factors (altitude, location, vegetation, etc.) and global factors like climate and weather systems.

Find local weather and rainfall at http://www.wunderground.com.

Current Weather:	Clear	Cloudy	Overcast	Light Rain	Heavy Rain	Snow
Rainfall in past 24 hours (inches) ____________						

Weather Observations found on the datasheet.

Quantitative observations in streams

UWW monitors also directly measure certain characteristics of the stream. These “quantitative” observations are often less ambiguous than the qualitative measures, but may only reflect present conditions, which can change rapidly. Remember to take measurements or collect water in the main channel so your sample is representative of most water in the stream.

FIELD SAMPLES:

Location *(circle one)*: Center Side

Habitat *(circle one)*: Pool Run Riffle

Parameter	Reading (measurement)	Unit	Allowable Range in Utah
Air Temperature		°C	
Water Temperature		°C	Max temp for warm water fish = 27 °C Max temp for cold water fish = 20 °C
pH		None	6.5-9.0
Dissolved Oxygen		mg/L	Min for warm water fish = 6.5 mg/L Min for cold water fish = 5.5 mg/L
Turbidity		cm (convert to NTUs using chart)	Turbidity should not change more than 10 NTUs
Salinity Parameters			
Conductivity		µS/cm	1880 µS/cm is approximately equal to 1200 mg/L
TDS		mg/L *(1 ppm = 1 mg/L)*	1200 mg/L maximum allowable value of TDS for water used for irrigation
Water Temperature (conductivity meter reading)		°C	

Quantitative observations section of the stream datasheet.

To learn more:

The Chemical Properties section of the Utah Stream Team Manual provides more in-depth information about these quantitative observations. This section defines each abiotic factor UWW volunteers measure and discusses how the factors change due to natural and human influences, why the factor is important in aquatic ecosystems, how to take a sample, and how to interpret the results. Learn more about abiotic factors in natural systems at https://extension.usu.edu/waterquality/files-ou/Publications/Utah-Stream-Team-updated-6-2020.pdf.

Air temperature

Units: Degrees Celsius
Range in Utah: -56.3 to 47.2 °C

Why we monitor air temperature: Air temperature influences the temperature of the water.

What influences air temperature: Air temperature is influenced by the energy from the sun, weather patterns, and the seasons.

Methods:

For this test, we use a Taylor Waterproof Digital thermometer.

1. Be sure the thermometer is set to Celsius.
2. Hold the thermometer in a shady location away from direct sunlight.
3. Let the thermometer adjust to the ambient conditions for at least 1 minute before recording the value on the datasheet.

A volunteer takes a reading using a digital thermometer.

Water temperature

Units: Degrees Celsius *Range in Utah*: 0.1 – 35 °C *Utah criteria*: Maximum temperatures: Cold water fish: 20 °C, Warm water and non-game: 27 °C

Why we monitor water temperature: Water temperature influences the rates of chemical and biological processes and affects other measured parameters (e.g. as temperature increases, the maximum amount of dissolved oxygen decreases). Water temperature is one of the most important parameters for aquatic organisms. Many animals have adapted to a specific range of temperatures and temperatures warmer than these can cause stress or even death. For example, trout are cold water fish that have trouble surviving when the water temperature is above 20 °C.

What influences water temperature: Water temperature is determined by the climate of the watershed, surrounding flora, and seasonal patterns. Local influences may include upstream discharges of warmer or cooler water from natural springs or warmer water from power plants, the degree of shading provided by the riparian zone (the vegetative zone near the stream), stream shape (deep and narrow or shallow and wide), and the amount of suspended material in the water. Upstream reservoirs also have profound impacts on streams. During the summer, reservoirs generally have a layer of warm and less dense water that floats above colder, denser water at the bottom of the reservoir. If the reservoir releases surface water, temperatures downstream will be warmer than they were before the dam was constructed. If the reservoir releases deep water, the downstream water is often cooler than the original river water.

Methods:

For this test, we use a Taylor Waterproof Digital thermometer.

1. Be sure the thermometer is set to Celsius.
2. Hold the metal probe end of the thermometer approximately 15 cm (6 inches) below the surface of the water. It is best to record the temperature of the stream in a central flowing location.
3. Let the thermometer adjust to the water temperature for at least 1 minute before removing the thermometer from the water and quickly record the temperature.

A volunteer tests the water temperature.

pH

Units: pH does not have a unit
Range in Utah: 4 - 10
Utah Criteria: 6.5 – 9.0

Definition: pH is a measurement of how acidic or basic the water is. It is measured on a logarithmic scale (like the Richter scale for earthquakes) so every unit represents a 10-fold change in acidity. The scale ranges from 0-14, where 7 is neutral. Lower numbers are increasingly acidic and higher numbers are increasingly basic.

Why we monitor pH: pH affects many chemical and biological processes. Many organisms are adapted to a specific pH range.

What influences pH: Rainfall is naturally somewhat acidic so pH may be influenced by recent precipitation. The types of rock and soils that runoff passes over and through also play an important role in buffering the water (increasing the pH). Natural geology, such as calcareous rocks and soils, provide this natural buffering, while granitic rocks do not. Aquatic plants also affect the pH by taking carbon dioxide directly from the water for photosynthesis, which can cause the pH to increase during the day. Human activities such as mining may result in acidic mine drainage due to a chemical reaction between water and rocks containing sulfur bearing minerals.

The pH test is color based. After dipping the test strip's tip in the stream, the volunteer compares the three colors to the scale on the box.

Methods:

We use the Millipore pH strips provided by UWW for this test. These strips measure pH ranging from 5.0-10.0, which encompasses the natural range of pH in most surface waters. The pH strip paper is infused with chemicals that change different colors depending on the pH of the water. Take care to keep this paper out of light and in a dry container or you will get inaccurate readings.

1. Remove a test strip from the container and hold it by the white end. Do not touch the colored end with your finger. Reseal the container.
2. Place colored end of test strip in the water for approximately 10 seconds.
3. Remove test strip from the water and shake off excess water. Wait 2 minutes for the strip to fully react.
4. Compare test strip to the color guide and select the closest color match for all three colors. Record the pH value on the datasheet.
5. Properly dispose of the used test in a waste container.

Turbidity in streams (turbidity tube)

Definition: Turbidity is a measurement of water clarity. Turbidity is the degree to which light penetration is blocked by suspended solids. Suspended solids are the materials suspended in the water (soil, sediment, algae, etc.) and affect how deeply light can penetrate.

Units: Nephelometric Turbidity Units (NTU)

We record our values in centimeters, then convert to turbidity units using a chart: https://extension.usu.edu/utahwaterwatch/monitoring/field-instructions/turbidity/turbiditytube/turbiditytubeconversionchart

Range in Utah: 6-240 NTU

Utah Criteria: Turbidity should not change more than 10 NTUs

Why we monitor turbidity: Excessively turbid water can block sunlight, cause habitat loss, and make it hard for predators to find prey. Turbid water can also impact recreational water use. Sediments fill in spaces between cobbles that are important habitat for aquatic life and may smother fish eggs.

What influences turbidity: Turbidity may be affected by seasons, such as increased runoff during snowmelt or large rain events. Human activities can increase erosion potential in the watershed and cause the turbidity to increase. Riparian plants along the banks play an important role to increase bank stability and reduce erosion. Large amounts of suspended plant materials, such as algae, may also increase turbidity.

A volunteer fills this turbidity tube with water and then uses the tubing at the bottom to lower the water level until the disk at the bottom is visible.

Methods:

A turbidity tube is used to measure the turbidity in streams.

1. Make sure the release valve of the tube is closed. Rinse the tube well with water from your site. Then fill to the top.

2. Standing downstream, fill the tube with flowing water from the middle of the water column and be careful to avoid the stream bottom and disturbed sediments.

3. Take the reading in an even light source with sunglasses removed. Look through the tube from the top down to the target disk on the bottom. If the disk is visible when the tube is full, record the depth as greater than ">" the length of the tube (60 cm).

4. If the disk is not visible, slowly release water from the valve while looking down through the water until the disk becomes visible. Stop the valve or otherwise plug the outlet and record this water level in cm and circle the "=".

Note: If a large piece of material enters the tube, then you will not be able to see the disk. In this case you should dump the water out and start again. Also, suspended materials tend to settle on the bottom of water samples, so you need to quickly complete the test or cover your hand over the top and invert the tube several times to re-suspend the sediment. You may have to do this several times as you slowly release water.

Dissolved oxygen

Units: Milligrams per liter (which is equivalent to parts per million)

Range in Utah: 2.0 to 14.0 mg/L

Utah Criteria:

Coldwater fisheries - 6.5 mg/L
Warmwater fisheries - 5.5 mg/L

Definition: A measure of oxygen molecules dissolved in the water. Dissolved oxygen cannot be seen (i.e. NOT the bubbles in the water).

Why we monitor dissolved oxygen: Dissolved oxygen is essential for aquatic organisms. This is what fish and many macroinvertebrates need to "breathe" underwater. If values get too low, then organisms can be stressed or may die.

What influences dissolved oxygen: Water temperature has a large effect on dissolved oxygen. As water warms, the amount of dissolved oxygen water can hold decreases. Therefore, human actions that increase stream temperature (removing water or riparian trees that create shade) lead to lower dissolved oxygen levels. Aquatic plants also influence dissolved oxygen because the photosynthesis process releases oxygen into the water so dissolved oxygen concentrations often increase throughout a day. At night, plants use oxygen but do not photosynthesize so dissolved oxygen concentrations decrease until the sun comes up again.

After breaking the ampoule in the collection cup, this volunteer compares the test ampoule against the color comparator, then determines the dissolved oxygen level.

Methods:

UWW uses a CHEMets Dissolved Oxygen Water Test Kit in which an indigo carmine dye reacts with dissolved oxygen and turns blue. The darker the blue, the more dissolved oxygen. The test is not very sensitive at higher concentrations, but this is acceptable because we are most interested in detecting low oxygen conditions. Keep the ampoules and the color comparator in a cool location and out of direct sunlight or you may get incorrect results.

1. Rinse the collection cup with stream water three times and then fill to 25 mL from flowing water below the surface.
2. Place glass ampoule in the cup and break tip under the water. Let ampoule fill with water (about 10 seconds).
3. Mix the ampoule by turning it up and down several times. *DO NOT PLACE FINGERS ON OR NEAR BROKEN GLASS TIP*. Wait 2 minutes.
4. With even light shining on the color comparator, place the test ampoule in front of the color standards. Place on both sides to determine the best color match. Record the concentration (in mg/liter) that the test ampule most closely matches. Do not assign a value in between two color standards.
5. Place the glass ampoule and liquid into a plastic waste bottle to dispose of at home.

Salinity, Conductivity, & Total Dissolved Solids

Salinity Units: Milligrams per liter (mg/liter) which is equivalent to parts per million (ppm).

Conductivity Units: Microsiemens per centimeter (μS/cm)

Utah Criterion for Agriculture: Maximum salinity (TDS) of 1200 mg/L is allowed in water used for irrigation. This is approximately equal to conductivity of 1880 μS/cm.

Definition: Salinity is the concentration of dissolved salts in water.

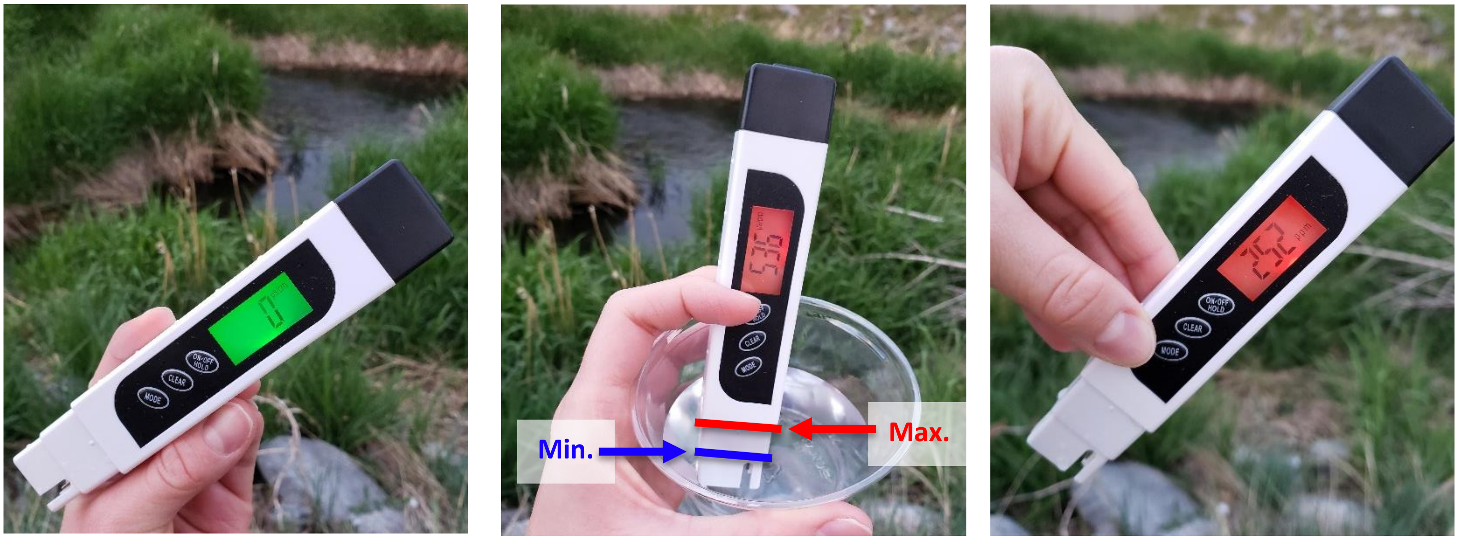
We can measure salinity in several ways. The most common field approach is to measure *conductivity*, using a field probe that measures the water's resistance to an electrical current passing from one point to another on the meter's probes. Water with more dissolved salts (higher salinity) has higher conductivity.

The conductivity probes UWW use also provide *total dissolved solids (TDS)* measurements, which are calculated using a general relationship between conductivity and salinity/TDS. The TDS measurement provided by these probes is generally assumed to be equal to salinity. Note that the relationship between conductivity and TDS may be different if the water being measured has an unusual mix of salts. In these cases, scientists generally measure TDS directly in a laboratory.

Why we monitor salinity: Water salinity is especially important for the processes in aquatic organisms that are controlled by membranes, such as the functionality of gills or the development of eggs. Aquatic organisms have evolved to live within specific ranges of salinity. Organisms can usually adjust to some changes in salinity, but large or sudden changes may be more than they can handle. The absence or presence of different species in a stream or lake may be determined by differences in the salinity of the water.

What influences salinity: Salinity in natural waters is affected by many factors, including the underlying geology of a drainage area (e.g. sedimentary or igneous rock), the source of water (e.g. surface runoff or a spring), the length of a stream, soil and climate conditions, and the time of year. Individual streams, therefore, tend to have a relatively predictable range of salinity. Significant fluctuations from this expected range and known seasonal patterns can be caused by changes in climate, land uses, or discharges of pollutants into the waters.

Temperature also plays a role in water's salinity because salts and minerals tend to dissolve better at higher temperatures. This can result in a higher concentration of salts in warmer water bodies. Most conductivity probes perform an internal calculation that compensates for this increase and records the adjusted conductivity for a reference temperature of 25 ^{o}C.



The volunteer measures conductivity by submerging the meter into their water sample, making sure not to submerge the meter past the maximum immersion line, then records the reading.

Methods:

UWW volunteers use a meter that measures electrical conductivity, TDS, and temperature (^{o}C and ^{o}F). All three measurements are recorded.

Conductivity is reported in microsiemens per centimeter (μS/cm). TDS is reported as a concentration milligrams per liter (mg/L), which is equivalent to parts per million (ppm). Temperature is reported in degrees centigrade (^{o}C). Note that this temperature reading is an internal check on your meter and provides a comparison to the other temperature measurement you take with a thermometer.

The meter is easier to use with a water sample collected in a cup, rather than in the moving stream water.

1. Pre-rinse the collection cup with stream water two times (do not pour back into stream), then refill the collection container with stream water. Remember to collect water that is representative of the total stream flow. Take the measurement immediately after collecting the sample.
2. Remove the protective cap from the meter and turn it on. Click the MODE button, which toggles between conductivity, TDS, and temperature, until your meter is set for conductivity (μS/cm).

3. Submerge the end of the meter into the water but do not dip past the maximum immersion level (see figure above). Take care to not dip or drop the entire meter in the water. Wait for the display to stabilize (10-30 seconds).

4. Once the number stops changing, press the HOLD button. This will retain the reading even when you remove the probe from the water.

5. Record the conductivity results (µS/cm) on the datasheet. Record quickly as the reading will change after the meter has been out of the water for more than a minute.

6. Press the MODE button to switch to TDS. You do not need to submerge the probe again as the meter will retain the original reading. If you exceed the one-minute time frame, you may have to re-submerge the probe to get a new TDS reading. Record the TDS reading in mg/L.

7. Press the MODE button to switch to temperature, and record the temperature reading in oC on the datasheet.

8. After using, shake water off the meter or wipe it with a cloth and replace cap.

Learn more about salinity in natural systems at https://extension.usu.edu/waterquality/files-ou/Publications/Utah-Stream-Team.pdf.

Appendix H provides examples of conductivity and TDS ranges in many of Utah streams.

Contact UWW if you would like to participate in a USU study on how salinity (TDS) concentrations affect the absence or presence of certain stoneflies in a stream.

Bacteriological monitoring in streams

E. coli

Units: *E. coli* is measured as the number of coliform forming units per 100 mL of water (cfu/100mL)

Range: <1 to >2400 cfu / 100mL

Utah Criteria:

Primary contact (i.e. swimming): 409 colonies / 100mL

Drinking water and non-contact recreation (i.e. boating): 668 colonies / 100mL.

Definition: *Escherichia coli (E. coli)* is a species of coliform bacteria that lives in the lower intestine of warm bloodied animals.

Why we monitor E. coli: Scientists use *E. coli* as an indicator that water has been contaminated with fecal matter. The bacteria associated with fecal matter (not just *E. coli,* but many other types of bacteria and viruses) can make people sick if they come in contact with the contaminated water. Monitoring for *E. coli* helps protect water for recreation and drinking.

What influences E. coli: *E. coli* enters water ways when fecal matter from warm blooded animals goes into water bodies. While wild animal waste going into lakes and streams cause naturally low levels of *E. coli,* the problem comes when too much untreated domestic animal or human waste enters water bodies. Problems can arise if waste from septic tanks, wastewater treatment plants or animal production for food is not properly treated before it enters water ways.

To collect a sample, the volunteer pulls on the white tabs to open the Whirl-Pak, fills it with water, and then spins the pak to seal.

Methods:

This test uses the Coliscan Easygel method, in which bacteria are incubated on a patented medium designed specifically for testing surface waters. Instructions have been adapted for incubation at room temperature (see Coliscan Easygel Guide in Appendix E).

E. coli tests require steps in the field AND at home or in the lab.

In the Field:

Sample collection:

1. Label site ID/location on Whirl-Pak.
2. Pull off the top of the Whirl-Pak using the perforated line.
3. Gently pull the mouth of the bag open with the white tabs, making sure not to touch the top or inside the bag.
4. Collect your sample from a depth below 15 cm (6 in.) facing upstream, if possible. Be careful not to sample disturbed substrate or surface scum.
5. With bag open, in one quick motion, immerse the bag under water and fill making sure to leave some head space. Remove from water, hold yellow tabs and flip over twice. Seal by twisting the yellow ties closed.
6. Water samples kept longer than 1 hour before plating need to be stored on ice or refrigerated. Samples can be stored for up to 8 hours.

Watch the online video at http://extension.usu.edu/utahwaterwatch/monitoring/tier1 to see this technique demonstrated.

At your home or in a lab:

A note about sample size: The Coliscan method is effective for sample sizes ranging from 1ml-5ml. An increase in sample size leads to increased sensitivity in the test, and vice versa. Example: if I expected only trace amounts of E. coli in the waterbody, I would choose a larger sample size than if I expected high amounts.

This volunteer adds a sample to the Easygel media, labels the petri dish, and pours media in the bottom of the petri dish.

Plating the sample

1. Make sure Coliscan Easygel medium in the bottle has thawed.

2. Using a permanent marker record on the bottom of the petri dish the site ID or name, date, time sample was plated, volume of sample, and sample #1 or #2.

3. Shake Whirl-Pak to thoroughly mix the sample. Carefully open bag using white tabs so as not to touch the lip or inside.

4. Use a transfer pipette to deposit 1 mL up to 5 mL in the first Coliscan Easygel bottle, cap and gently swirl.

5. Remove lid from the petri dish, being careful not to touch the inside of the dish or lid. Slowly pour contents of the Coliscan Easygel bottle into the bottom of the dish. Place the top back on the petri dish and leave on a level surface for 45 minutes to solidify.

6. Repeat steps 4-5 for the duplicate sample using the second pipette, Coliscan Easygel bottle and petri dish.

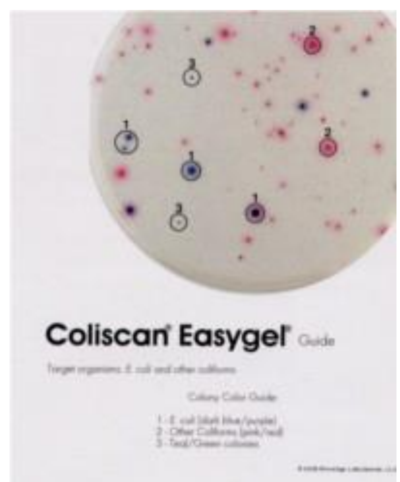
7. Once petri dishes have solidified, move to a warm, draft free location out of the direct sun to incubate. See “Incubating the Sample” below.

Incubating the Sample

1. Store petri dishes in a warm, draft free location out of direct sunlight. Use the thermometer to measure the temperature. At room temperature, 20 - 24 °C (68 – 75 °F), colored colonies will take at least 48 hours to develop.

2. Check every 10-12 hours to observe if colored colonies have started to form. Upon sighting the formation of colored colonies, note the time and allow for another 24-30 hours for the maturation of these colonies. This is usually 48-60 hours after you poured the medium into the petri dish. Counts should not be made after 72 hours.

3. When you believe the colonies have matured, record the total number of hours on the data sheet in the incubation time along with the normal temperature during incubation.



Coliscan Easygel Guide, available in Appendix E

Reading the Sample

1. In a bright area, count ONLY colonies that have a dark blue or purple color. Dark blue and purple colonies indicate E.coli. Do not count pink, red, or teal, colonies as these are other types of bacteria. Also ignore tiny, pin sized colonies. If you are unsure, look at examples provided during the training and on the website. If still uncertain take photos and send to UWW staff.

After letting your colonies develop for 48-60 hours the sample should look like the one shown above.

2. Record the number of dark blue or purple colonies on the data sheet for each sample. Enter the sample size (from 1 to 5 mLs) for each sample.

3. To calculate the *E.coli* per 100 mL, divide 100 by the sample size and multiply this dilution factor by the number of colonies counted. Example: [100ml divided by 3mL sample size] X 9 colonies counted = 297 cfu per 100 mL.

4. Record the results from each duplicate sample on the data sheet.

5. Average the two sample results to the nearest whole number on the data sheet and record.

E. coli BACTERIA - (Coliscan Easygel Method): *MONTHLY – May through Sept.*

Incubation start time: _____________ **Total hours:** ____________ **Incubation temp °C:** ____________

Concentration = $\left(\frac{100}{Sample\ size\ in\ mL}\right) \times \left(\frac{colonies}{counted}\right) = \frac{cfu}{100\ mL}$

Reading #1 $\left(\frac{100}{\quad}\right) \times (\quad) = \frac{cfu}{100\ mL}$

Reading #2 $\left(\frac{100}{\quad}\right) \times (\quad) = \frac{cfu}{100\ mL}$

Average Concentration = $\frac{(\text{Reading \#1} + \text{Reading \#2})}{2}$

Average E. coli: _______**cfu/100mL**

NOTE: If average is greater than 400 cfu/100 mL, contact UWW.

***E. coli* recording section on the stream datasheet.**

Disposal of sample

1. Place a teaspoon of bleach or spray a cleaning solution (i.e. Lysol) onto the surface of the medium. Close the lid and let it sit for five minutes.

2. Place both petri dishes in a sealed plastic bag and throw in the trash. Then place this in a trash receptacle that will be taken to a landfill.

3. Wash your hands and the work surface with soap and water.

Photo point monitoring in streams

Background: Photo point monitoring is utilized by many agencies, including the Utah Division of Water Quality, to document changes at a location. Photos are taken on a regular basis (once a month, quarterly, once a year etc.) from the same position and in the same direction(s). This ensures uniformity between pictures. Notice in the photos below how the stream and sky lineup the same way in each photo. Photos are uploaded to the CitSci.org database and will be available alongside the data.

Why Collect Photo Points? Photo point monitoring provides an easy way for water quality managers to observe and share changes on streams, rivers, and lakes. Photo points along rivers and lakes provide information on riparian area health, littoral zones, and stream condition to managers.

This photo shows a stream bank, before and after a restoration project fixed its erosion.

Method:

Determine a location: Most volunteers will take photo points at their existing site, which once established will not change. You will want to have as much of the site visible as possible and take a photo from that point upstream and downstream. Work with UWW or other coordinators to determine a good location for the photo point if you do not have a clear view from your monitoring site.

Note: If there are already photo point photos available from your previous visit or another volunteer's visit, print or refer to the photo to ensure the best match.

Taking of the photo:

a. Choose the camera settings that give the greatest depth of field. For digital cameras a "landscape" setting generally fulfills this requirement.
b. Hold the camera at eye level in the horizontal position. Try to include about 1/3 sky in the photo for scale and for consistent replication.
c. Take the photos in early morning, late afternoon, or slightly overcast days to eliminate harsh glares or dark shadows. Take the photos with the sun at your back and avoid days when visibility is poor due to fog or heavy rain.
d. For retake photos, bring a copy of the previous photo to ensure the photo view matches.

Photos will be uploaded into the CitSci database along with the data you collect.

Naming photo file:

For easy identification, name your photo files as follows: *site ID_direction taken_date.jpg*

<u>Lake example:</u> MANT-01-L_right bank_6.16.2020.jpg

<u>River example:</u> PRR-02-S_upstream_6.16.2020.jpg

Tier 1 Monitoring Instructions – Lakes

Qualitative observations in lakes

Qualitative observations or lake conditions (i.e. subjective observations about habitat, water conditions, and weather) help us understand and interpret the other **quantitative**, or more precisely measured, data that volunteers collect.

Recording field observations requires that volunteers select the most appropriate description of the current conditions. During trainings, we review the descriptive terms used in these field observations.

UtahStateUniversity WATER QUALITY EXTENSION

Lake Sampling Field Datasheet (Tier 1)
Utah Water Watch

Site Name:__________ **Date Sampled:**__________ **Time Sampled:** __________

Field Monitor Name(s):__________

UWW ID: __________ **Hours Sampling/traveling:** __________ **Miles traveled:** __________

UWW Site ID:__________ **# of participants:**__________ **Decontamination: Yes No**

FIELD OBSERVATIONS *(Circle one for each)*:

Water Odor:	None	Chlorine	Oil	Musty	Sewage	Fishy	Rotten Egg
Water Surface:	Clear	Scummy	Foamy	Natural Debris	Trash	Sheen/ Oily	
Water Clarity:	Clear	Cloudy/ Murky	Turbid				
Water Condition:	Calm	Ripples	Small Waves	Moderate Waves	Whitecaps		
Water Color *(Select one from*	Normal	Abnormal					
each row):	Clear	Brownish	Greenish	Reddish	Blue	Orange	
Dead Fish:	None	1 to 3	4 to 10	>10			
Current Weather:	Clear	Cloudy	Overcast	Light Right	Heavy Rain	Snow	

Recent rainfall in last 24 hours (inches) _______

Comments: __________

Datasheet section for lake field observations

These observations also require volunteers to become familiar with their site. Many of these observations are more meaningful when the volunteer understands what is “normal” and what is the result of seasonal variation or human caused impacts.

Comments can also provide invaluable information about the monitoring site or changes that may have occurred since the previous visit. Comments may include animal sightings near or in the water body, impacts of the surrounding land use, and notes about vegetation, invasive species present, or recreation activities seen at the site.

Water condition

Definition: How calm or rough the surface of the lake water is.

Why we monitor water condition: Lakes do not have flow like streams do, but the water condition of the surface can influence the mixing of the water within the lake.

What influences water condition: Weather, especially winds, are the largest factor affecting lake surface conditions.

Calm
Little to no movement on the surface of the lake.

Ripples
Consistent subtle to slight movement on the surface of the lake.

Waves
Peaks and troughs on the surface of the lake.

White caps
Large breaking waves on the surface of the lake.

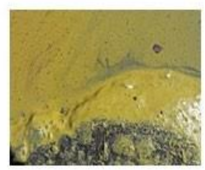
Water surface

Definition: The debris that is on the surface of the water.

Why we monitor water surface: Volunteers record visual observations of what is on the surface of the water, an indicator of pollution.

What influences water surface: While material on the surface, like dust and pollen, can be natural, trash and oily materials on the surface can indicate improper disposal of pollutants. Some algae or cyanobacteria may also form a scum on the surface of the water.

Clear
No visible debris on the surface.



Scummy
A film of materials like dust or pollen coating the surface. (Image: Procsilas Moscas)

Foamy
Visible bubbles or foar on the surface. (Image: norman_baboo)

Natural debris
Leaves, sticks, feathers, etc. on the surface.(Image: giogog).

Trash
Man made materials like bags, cups, and bottles. (Image: Yves Mauerer)

Sheen / oily
Oils (occasionally natural) floating on the waters' surface.

Water clarity

Definition: The amount of material suspended in the water column, related to turbidity or transparency.

Why we monitor water clarity: Sediment and algae smother habitat for aquatic macroinvertebrates and reduce light penetration.

What influences water clarity: Activities in the watershed, such as forestry, agriculture, and development influence the water clarity. Changes in land use can result in short- or long-term changes to the water clarity. Furthermore, natural seasonal changes like high runoff can temporarily shift water clarity.

Select the best option:

Clear
Water is transparent and you can see through it to the bottom.

Cloudy / Milky
Water has a whitish or chalky appearance. Water not completely opaque, still somewhat transparent

Turbid
Water has a murky or muddy appearance. Lots of suspended sediment or algae. Cannot see through the water.

Water color

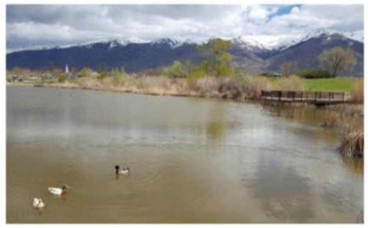
Background: The color of healthy lakes and ponds may be clear, brown or green.

Why we monitor water color: Volunteers monitor water color to track large scale changes in the watershed. If the waters of a clear lake changed to a muddy brown color, that could indicate a change in the land use in the watershed.

What influences water color: The size of the watershed, slope, geology, and land use all influence the water color. Lakes have small changes in color throughout the year due to physical and biological seasonal shifts. Deep green, or pea soup color, often results from an overabundance of algae (phytoplankton). Heavy nutrient loads from fertilizers, animal waste, and poor sewage treatments often promote heavy amounts of algae.

Select the best option:

Clear
Usually associated with healthy waters. However clear waters may be polluted with colorless substances. Very clear water with no living organisms indicates a pollution problem.



Brownish
Often results from decaying organic matter in the lake or lots of sediment.

Blue
Clear, cool waters often have a blue color. Strong blue colors can result from glacial runoff.

Reddish
May result naturally from drainage through soils rich in iron and tannins

Greenish
Slightly green water results from the presence of microscopic plants or algae and usually indicate healthy conditions.

Orange
May indicate runoff from mines or oil wells; may result naturally from drainage through soils rich in iron and tannins.

Water odor

Why we monitor water odor: The general smell of a water body can indicate potential contamination. Not all unpleasant odors indicate an unnatural cause.

What can influence water odor: Local biologic processes like decomposition influence water's odor. Bacteria have a strong influence on smell. Waste disposal or accidental spills can temporarily change the smell of the water and are sometimes cause for concern. If you are concerned about sewage, oil or chemical spills, contact the 24-hour Environmental Response emergency line at the Utah Division of Water Quality (801-536-4123). Make a note of this call on your field sheet. Select the best option (odors are usually most obvious when you first get to the site).

1. None – No strong or apparent odor associated with the water.
2. Oil – A strong chemical smell that could result from mishandling of industrial solutions.

3. Sewage – A foul smell of waste that can indicate possible contamination from animals or people. Be sure to wash your hands after sampling.

4. Rotten Egg – A sulfurous smell which often indicates anaerobic (without oxygen) decomposition process or some animal waste. Minerals from sulfur springs can also give this smell.

5. Fishy – A strong smell that indicates the presence of dead fish.

6. Musty – A dank moldy smell that can indicate mold, large algae presence or decomposition.

7. Chlorine – Smells like a swimming pool. May result from a leak or industrial source.

Water Odor:	None	Chlorine	Oil	Musty	Sewage	Fishy	Rotten Egg

Dead fish

Look around your sampling location (10m in all directions or nearby lake shore) and count the number of dead fish floating or below the surface. If there is an abnormally large fish kill (greater than 4), take a photo if possible and report it to the Department of Environmental Quality information line: 800-458-0145 (M-F, 8-5). If you feel that this is an emergency, you may wish to contact the 24-hour Environmental Response emergency line at the Utah Division of Water Quality (801-536-4123).

Why we monitor dead fish: Fish are biological indicators of water quality. Seeing dead fish can indicate a potentially serious water quality problem.

What influences the presence of dead fish: Seeing a few dead fish (3 or less) could be due to natural causes or improper handling of fish while fishing. When you see 4 or more dead fish, this indicates a serious problem. Fish kills normally result from high temperatures and low dissolved oxygen levels that suffocate the fish. Other causes could be severe pollution or toxic chemicals.

Dead Fish:	None	1 to 3	4 to 10	>10

Present weather and recent rainfall

Why do we monitor weather: Volunteers record the current and past 24-hour weather because this can influence their observations and quantitative measurements. Knowing about recent weather helps to interpret the data that is collected. For example, rain the day before may increase surface runoff, resulting in increased turbidity for several days. Storm winds and rainfall may also increase mixing of water in a lake.

What influences weather: Local weather is made up of a combination of local factors (altitude, location, vegetation, etc.) and global factors like climate and weather systems.

Select the most accurate description for the day's weather and find rainfall amounts by going to the history tab at http://www.wunderground.com.

Current Weather:	Clear	Cloudy	Overcast	Light Right	Heavy Rain	Snow
Recent rainfall in last 24 hours (inches) ________						

Quantitative observations in lakes

UWW sampling techniques are generally limited to surface conditions. Throughout the year, however, lake conditions change with depth. These changes may be extremely important in understanding and interpreting lake conditions. For this reason, caution must be taken in generalizing from surface conditions to the entire lake.

To learn more about changes in lakes throughout a year, go to: http://extension.usu.edu/waterquality/learnaboutsurfacewater/watersheds/index.

Also, see more under water temperature and dissolved oxygen below.

FIELD SAMPLES:
Location *(circle one)*: On Shore Dock/Pier Boat

Parameter	Reading (measurement)	Unit	Allowable Range in Utah
Air Temperature		°C	
Water Temperature		°C	Max temp for warm water fish = 27 °C Max temp for cold water fish = 20 °C
pH		None	6.5 to 9.0
Secchi depth		Meter(s)	0.1 to 13 meters

Salinity Parameters	Reading (measurement)	Unit	Allowable Range in Utah
Conductivity		µS/cm	1880 µS/cm is approximately equal to 1200 mg/L
TDS		mg/L *(1 ppm = 1 mg/L)*	1200 mg/L maximum allowable value of TDS for water used for irrigation
Water Temperature (conductivity meter reading)		°C	

Datasheet section for lake quantitative observation.

Air temperature

Units: Degrees Celsius
Range in Utah: -56.3 – 47.2 °C

Why we monitor air temperature: Air temperature influences the temperature of the water.

What influences air temperature: Air temperature is influenced by the energy from the sun, weather patterns, and the seasons.

A volunteer takes a reading using a digital thermometer.

Methods:

For this test, we use a Taylor Waterproof Digital thermometer.

1. Be sure the thermometer is set to Celsius.
2. Hold the thermometer in a shady location away from direct sunlight.
3. Let the thermometer adjust to the ambient conditions for at least 1 minute before recording the value on the datasheet.

Water temperature

Units: Degrees Celsius
Range in Utah: 0.1 – 35 °C
Utah criteria: Maximum temperatures
Cold water fish: 20 °C.,
Warm water and non-game: 27 °C

Why we monitor water temperature: Water temperature influences the rates of chemical and biological processes and affects other measured parameters (e.g. as temperature increases, the maximum amount of dissolved oxygen decreases). Water temperature is one of the most important parameters for aquatic organisms. Many animals have adapted to a specific range of temperatures and temperatures warmer than these can cause stress or even death. For example, trout are cold water fish that have trouble surviving when the water temperature is above 20 °C.

What influences water temperature: Water temperature is determined by the climate of the watershed, seasonal patterns, and local influences. During the summer, lakes and reservoirs generally have a layer of warm and less dense water that floats above colder, denser water at the bottom of the reservoir. The density difference between these two layers creates a surprising amount of resistance to mixing so the two layers stay separate for much of the summer. In the fall, the temperatures cool at the surface and the lake eventually mixes from top to bottom. A winter lake, especially one with ice cover, may have "reverse stratification" where slightly warmer water floats above the densest water, which occurs at about 4.5 C. In the spring, the lake mixes from top to bottom. The warming of the late spring and summer sun creates the warm later again.

Local influences on lake temperatures include upstream discharges of warmer water from natural springs or cooling water from power plants, shading provided by the littoral zone (the vegetation along the edge of the lake), lake depth, and the amount of suspended material in the water.

Methods:

For this test, we use a Taylor Waterproof Digital thermometer. Note that this method provides surface temperature ONLY.

1. Be sure the thermometer is set to Celsius.
2. Hold the thermometer approximately 15 cm (6 inches) below the surface of the water. It is best to record the temperature of the lake in a well-mixed area.
3. Let the thermometer adjust to the water temperature for at least 1 minute before removing the thermometer from the water and quickly record the temperature.

A volunteer tests the water temperature.

pH

Units: pH does not have a unit
Range in Utah: 4 - 10
Utah Criteria: 6.5 - 9

Definition: pH is a measurement of how acidic or basic the water is. It is measured on a logarithmic scale (like the Richter Scale for earthquakes) so every unit represents a 10-fold change in acidity. The scale ranges from 0-14 where 7 is neutral, lower numbers are increasingly acidic, and higher numbers are increasingly basic.

Why we monitor pH: pH affects many chemical and biological processes. Many organisms are adapted to a specific pH range.

What influences pH: Rainfall is naturally acidic so pH may be influenced by recent precipitation. The types of rock and soils that runoff passes over and through play an important role in buffering the water (increasing the pH). Natural geology, such as calcareous rocks and soils, provide this natural buffering, while granitic rocks do not. Aquatic plants also affect the pH by taking carbon dioxide directly from the water for photosynthesis, which can cause the pH to increase during the day. This can be a problem in areas where there are excessive amounts of algae due to fertilizer inputs. Human activities, such as mining, may result in acidic mine drainage due to a chemical reaction between water and rocks containing sulfur bearing minerals.

The pH test is color based. After dipping the test strip's tip in the stream, the volunteer compares the three colors to the scale on the box.

Methods:

We use the Millipore pH strips provided by UWW for this test. These strips measure pH ranging from 5.0-10.0, which encompasses the natural range of pH in most surface waters. Take care to keep this paper out of light and in a dry container or you will get inaccurate readings.

1. Remove a test strip from the container and hold it by the white end. Do not touch the colored end with your finger. Reseal the container.
2. Place colored end of test strip in the water for approximately 10 seconds.
3. Remove test strip from the water and shake off excess water. Wait 2 minutes for the strip to fully react.
4. Compare test strip to the color guide and select the closest color match for all three colors. Record the pH value on the datasheet.
5. Properly dispose of the used test in a waste container.

Transparency - Secchi reading

Units: We record the depth in meters.

Range in Utah: From 0.1 meters to 13 meters below the surface

Definition: Secchi depth is a measurement of water transparency, which is affected by water color, algae, and suspended sediments.

Why we monitor transparency: Secchi disks were originally designed to allow a simple measurement by any interested citizen. This measurement of lake transparency has been used to determine a lake's health, often by relating transparency to a lake's "trophic state," or how "productive" the lake is at any point throughout the year. Productivity in a lake refers to the rate at which carbon dioxide is converted by the sun's energy into plant material. High productivity may result in low water transparency because of the high concentrations of microscopic plants (algae) in the water. Transparency is measured by the Secchi depth. Increases in dissolved nutrients within the lake may increase productivity. Excessive nutrient inputs to a lake are often the result of human activity in the lake's watershed. Turbid or cloudy water also affects fish directly by limiting their ability to see predators and affects our aesthetic enjoyment of a lake we use for recreation.

What influences transparency: Algae abundance the largest driver of transparency in most lakes and is influenced by the available nitrogen and phosphorus. Excessive nutrients are the results of fertilizer overuse, leaking septic systems, wastewater treatment plants or manure runoff. Disturbances to the bottom sediments of shallow lakes from carp, wind or loss of stabilizing rooted plants may also result in increased turbidity.

Secchi is taken by slowly lowering the Secchi disk in the shade until the black and white triangles are barely visible, then take a measurement of that depth.

Methods:

The measurement needs to be taken in deep water, usually from a dock or boat. Secchi disks are weighted black and white disks attached to a metered rope. The disks are lowered into the water until they are no longer visible, then slowly returned the surface. The depth at which the disk is first visible is called the Secchi depth.

The Secchi reading is best taken when the sun is near its apex, generally between 10 AM and 2 PM. You should also remove sunglasses before measuring.

1. On the shady side of a boat or dock, begin to lower the disk into the water.
2. Lower the Secchi disk until it completely disappears. Then slowly retrieve the disk. As soon as you can make out the faint black and white markings, stop.
3. Mark the tape at the surface of the water to record the depth to the nearest centimeter.
4. If you are on a dock and out of arm's reach of the water, use a clothespin to mark the height of the dock and then measure to the surface of the water. Subtract this from your final measurement.

Note: While Secchi depth is the preferred method to measure transparency in standing water, some volunteers may use turbidity tubes from the bank for small ponds or when shallow water is all that can be reached. In these cases, follow the Stream Instructions for turbidity tube (page 41), taking care to avoid disturbing the bottom sediments. Be sure to convert the units from centimeter (cm) to meter (m) when recording on the data sheet and note the type of equipment used.

Salinity, Conductivity, & Total Dissolved Solids

Salinity Units: Milligrams per liter (mg/liter) which is equivalent to parts per million (ppm).

Conductivity Units: Microsiemens per centimeter (µS/cm)

Utah Criterion for Agriculture: Maximum salinity (TDS) of 1200 mg/L is allowed in water used for irrigation. This is approximately equal to conductivity of 1880 µS/cm.

Definition: Salinity is the concentration of dissolved salts in water.

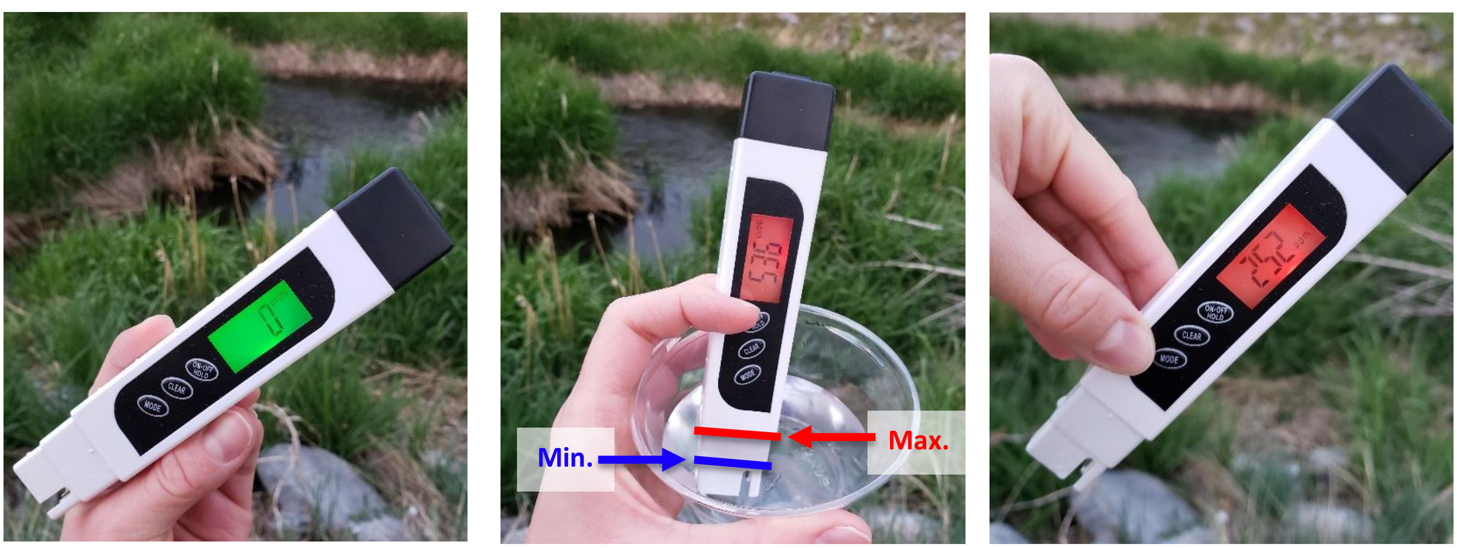
We can measure salinity in several ways. The most common field approach is to measure *conductivity*, using a field probe that measures the water's resistance to an electrical current passing from one point to another on the meter's probes. Water with more dissolved salts (higher salinity) has higher conductivity.

The conductivity probes UWW use also provide *total dissolved solids (TDS)* measurements, which are calculated using a general relationship between conductivity and salinity/TDS. The TDS measurement provided by these probes is generally assumed to be equal to salinity. Note that the relationship between conductivity and TDS may be different if the water being measured has an unusual mix of salts. In these cases, scientists generally measure TDS directly in a laboratory.

Why we monitor salinity: Water salinity is especially important for the processes in aquatic organisms that are controlled by membranes, such as the functionality of gills or the development of eggs. Aquatic organisms have evolved to live within specific ranges of salinity. Organisms can usually adjust to some changes in salinity, but large or sudden changes may be more than they can handle. The absence or presence of different species in a stream or lake may be determined by differences in the salinity of the water.

What influences salinity: Salinity in natural waters is affected by many factors, including the underlying geology of a drainage area (e.g. sedimentary or igneous rock), the source of water (e.g. surface runoff or a spring), the length of a stream, soil and climate conditions, and the time of year. Individual streams, therefore, tend to have a relatively predictable range of salinity. Significant fluctuations from this expected range and known seasonal patterns can be caused by changes in climate, land uses, or discharges of pollutants into the waters.

Temperature also plays a role in water's salinity because salts and minerals tend to dissolve better at higher temperatures. This can result in a higher concentration of salts in warmer water bodies. Most conductivity probes perform an internal calculation that compensates for this increase and records the adjusted conductivity for a reference temperature of 25 ^{o}C.



The volunteer measures conductivity by submerging the meter into their water sample, making sure not to submerge the meter past the maximum immersion line, then records the reading.

Methods:

UWW volunteers use a meter that measures electrical conductivity, TDS, and temperature (°C and °F). All three measurements are recorded.

Conductivity is reported in microsiemens per centimeter (µS/cm). TDS is reported as a concentration milligrams per liter (mg/L), which is equivalent to parts per million (ppm). Temperature is reported in degrees centigrade (°C). Note that this temperature reading is an internal check on your meter and provides a comparison to the other temperature measurement you take with a thermometer.

The meter is easier to use with a water sample collected in a cup, rather than in the moving stream water.

1. Pre-rinse the collection cup with stream water two times (do not pour back into stream), then refill the collection container with stream water. Remember to collect water that is representative of the total stream flow. Take the measurement immediately after collecting the sample.
2. Remove the protective cap from the meter and turn it on. Click the MODE button, which toggles between conductivity, TDS, and temperature, until your meter is set for conductivity (µS/cm).
3. Submerge the end of the meter into the water but do not dip past the maximum immersion level (see figure above). Take care to not dip or drop the entire meter in the water. Wait for the display to stabilize (10-30 seconds).
4. Once the number stops changing, press the HOLD button. This will retain the reading even when you remove the meter from the water.
5. Record the conductivity results (µS/cm) on the datasheet. Record quickly as the reading will change after the meter has been out of the water for more than a minute.
6. Press the MODE button to switch to TDS. You do not need to submerge the probe again as the meter will retain the original reading. If you exceed the one-minute time frame, you may have to re-submerge the probe to get a new TDS reading. Record the TDS reading in mg/L.
7. Press the MODE button to switch to temperature, and record the temperature reading in oC on the datasheet.
8. After using, shake water off the meter or wipe it with a cloth and replace cap.

Learn more about salinity in natural systems at https://extension.usu.edu/waterquality/files-ou/Publications/Utah-Stream-Team.pdf.

Appendix H provides examples of conductivity and TDS ranges in many of Utah streams.

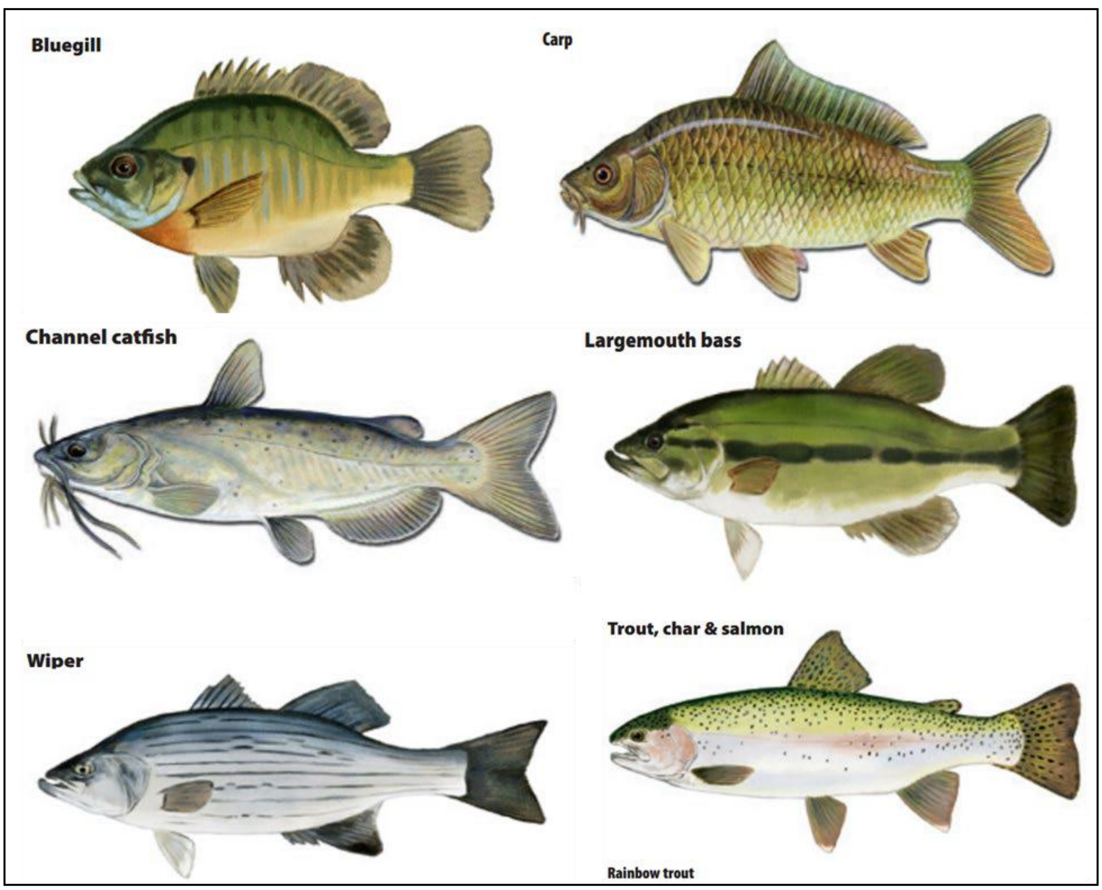
Contact UWW if you would like to participate in a USU study on how salinity (TDS) concentrations affect the absence or presence of certain stoneflies in a stream.

Fishing and fishing observations

Why we monitor fishing information: Community fishing areas are maintained by the Division of Wildlife Resources. This agency is interested in learning more about how these areas are used and what type of fish are being caught.

Fishing data may include direct observation or may be obtained by surveying people fishing at the site. Document the types and number of fish you or others catch while out. Also, look around for cormorants and pelicans, known fish predators. Record any additional species in the "other" section.

If surveying multiple fisherpeople, combine the number of fish and hours spent fishing.



Several common Utah fish you may catch.

.

COMMUNITY FISHING INFORMATION:

Number of people fishing: __________

Hours spent fishing: _______________

Birds Observed while Fishing:

# of Cormorants: _________

# of Pelicans: _________

Fish caught	**Number**
Bluegill	
Wiper (hybrid)	
Carp	
Rainbow Trout	
Catfish	
Bass	
Other	

Data sheet section for recording fish and birds on lakes.

Algae monitoring in lakes

Background: Algae are a type of plant that do not form flowers or seeds and do not have true stems or roots. Most algae in lakes are one celled and therefore, not visible without a microscope. Although, when they are abundant, we can see a change in the water color. Some algae form long chains of cells (“filaments”) or large colonies, which are easily visible. Algae are often classified into large groups based on the pigments they contain. When they are abundant in water, the water may take on the color of those pigments. Some of the common types of lake algae are diatoms (golden brown algae), chlorophytes (green algae), dinoflagellates (sometimes called blue-green algae, even though they are a type of bacteria and not a true algae).

Algae bloom in Mantua Reservoir.

Rapid increases in algal abundance may occur under favorable growth conditions and are called "algal blooms". Some algae, especially cyanobacteria and dinoflagellates, can create toxins when they become extremely abundant. Cyanobacteria, in particular, appear to be increasing in water bodies in Utah due in part to high levels of nutrients and warmer summer temperatures. A cyanobacteria bloom that includes production of harmful toxins is referred to as a harmful algal bloom.

Why we monitor algae: We monitor algae as an indicator of the productivity in the lake due to the presence and cycling of nutrients. Large amounts of algae may cause low night-time oxygen concentrations in the lake due to nighttime respiration and microbial decomposition. Presence of cyanobacteria may also be a health concern if they are producing cyanobacteria toxins. Cyanobacteria toxins, when present, can be harmful or deadly for humans, pets, and livestock. The presence of cyanobacteria does not mean that toxins are present, so toxin tests are often performed by the state and local health departments. For this reason, recording and collecting samples of potential blooms is important for human and animal safety.

What influences algae: Algae occurs when there are nutrient and light conditions favorable to its growth. Harmful algal blooms tend to occur in warm waters that are nutrient enriched and because of their ability to change buoyancy and position in the water column, often outcompete green algae and diatoms when water is warm. Often these blooms occur in reservoirs during the summer. Nutrients can enter a lake through runoff (agricultural, urban, or suburban), wastewater treatment plants or may be released from lake sediments.

ALGAL MONITORING *(Circle one for each)*:

Algae Observed In lake?	Yes	No	
Types Observed	Floating Scum	Water column	Filamentous
Harmful bloom suspected?	Yes	No	
Bloomwatch / UWW contacted?	Yes	No	

Data sheet section for lake algal observations.

Methods:

Use the information below to help fill out the datasheet.

1. Algae observed in the lake? Mark yes if any algae, regardless of type, were observed.
2. Types observed: Select each type that was observed (filamentous, water column and/or floating scum). See below for pictures and definitions.
3. Harmful algae bloom suspected? Mark yes if you suspect a bloom. See guidance below when to collect a sample.
4. If you suspect a bloom, contact the UWW coordinator (waterquality@usu.edu, 435-919-1324) or fill out the form in the bloomWatch App (available on both Android and iOS). The bloomWatch App (https://cyanos.org/bloomwatch/) notifies the DWQ when Utah is selected. Call the DEQ Spill Line (801-536-4123) directly if there is immediate concern. See the microscope and health department contacts in Appendix D.
5. Comments: Make note where the algae was found – is it at a beach, out in the middle of the lake, by the dock, etc. Also, the extent of any blooms - % of the lake it covers.

Below are some field identification tips:

Filamentous green algae (not cyanobacteria)

Green algae may be common at your site. These algae can be filamentous, forming silky "clouds" below the surface or viscous mats on the surface. **While bothersome, filamentous green algae is harmless.**

Filamentous green algae. Sources: Clemson University (left), New York State Department of Environmental Conservation (middle, right).

Confirm filamentous algae using the stick test:

1. Find a long sturdy stick.
2. Put on rubber or latex gloves before attempting to retrieve a sample of the green material from the pond to prevent skin exposure.
3. Drag the stick through the surface mat and slowly lift out of the water. Be careful not to fall into the water while retrieving material.
4. Look at the end of the stick to see what came out of the water.
    a. If the stick comes out looking like it has been thrust into a can of paint, the mat on the pond is likely to be a cyanobacteria scum (potentially toxic).
    b. If the stick pulls out strands that look like green hair or threads, the mat on the pond is likely filamentous green algae (non-toxic).

<u>Algae in the water column (potential cyanobacteria)</u>

Many types of phytoplankton live in the water column. Cyanobacteria is sometimes dispersed in the water column after wind or other mixing events.

Collect a sample, as further analysis will help determine if it is cyanobacteria and will be used to test for toxins, if necessary. Take photographs of the bloom (close up and from of the full scope and email them to waterquality@usu.edu).

Algae in the water column. Sources: Raymond Li (left), Ohio Environmental Protection Agency (middle), New York State Department of Environmental Conservation (right).

To collect a sample, fill a dedicated sample bottle or disposable bottle. Wear gloves and glasses to protect your skin and eyes from splash and wash your hands well with soap and water after collection. For more details see our HAB Sampling Manual. Contact your local microscope location or health department to drop off the sample. Locations and contacts available in Appendix D.

Surface scum algae (likely cyanobacteria)

Cyanobacteria, which unlike other types of algae, can regulate their buoyancy and move throughout the water column tend to float to the surface of the water. During periods of calm winds, thick surface mats can develop. These mats can be blue, green or white and are often described as looking like spilled paint.

Surface scum algae. Sources: New York State Department of Environmental Conservation (left) Utah Health Department (middle, right).

Collect a sample, as further analysis will help determine if it is cyanobacteria and be used to test for toxins, if necessary. Take photographs of the bloom (close up and from of the full scope and email them to waterquality@usu.edu).

To collect a sample, fill a dedicated sample bottle or disposable bottle. Wear gloves and glasses to protect your skin and eyes from splash and wash your hands well with soap and water after collection. For more details see our HAB Sampling Manual. Contact your local microscope location or health department to drop off the sample. Locations and contacts available in Appendix D.

Bacteriological monitoring in lakes

E. coli

Units: *E. coli* is measured as the number of coliform forming units per 100 mL of water (cfu/100mL)

Range: <1 to >2400 cfu / 100mL

Utah Criteria: Primary contact (i.e. swimming): 409 colonies / 100mL, Drinking water and non-contact recreation (i.e. boating): 668 colonies / 100mL

Definition: *Escherichia coli (E. coli)* is a species of coliform bacteria that lives in the lower intestine of warm bloodied animals.

Why we monitor E. coli: Scientists use *E. coli* as an indicator of water that has been contaminated with fecal matter. The bacteria associated with fecal matter (not just *E. coli* but many other types of bacteria and viruses) can make people sick if they come in contact with contaminated water. Monitoring for *E. coli* helps protect water for recreation and drinking water.

What influences E. coli: *E. coli* enters water ways when fecal matter from warm blooded animals goes into water bodies. While wild animal waste going into lakes and streams cause naturally low levels of *E. coli,* the problem comes when too much untreated domestic animal or human waste enters water bodies. Problems can arise if waste from septic tanks, wastewater treatment plants or animal production for food is not properly treated before it enters water ways.

Method:

This test uses the Coliscan Easygel method, in which bacteria are incubated on a patented medium designed specifically for testing surface waters. Instructions have been adapted for incubation at room temperature. E. coli tests require steps in the field AND at home or in the lab.

In the Field:

Pull on the white tabs to open the Whirl-Pak, fill it with water and then spin the pak to seal.

Sample collection:

1. Label Site ID/location on Whirl-Pak.
2. Pull off the top of the Whirl-Pak using the perforated line.
3. Gently pull the mouth of the bag open with the white tabs, making sure not to touch the top or inside the bag.
4. Collect your sample from a depth below 15 cm (6 in.) if possible, being careful not to sample disturbed substrate or surface scum.
5. With bag open, in one quick motion, immerse the bag under water and fill to 100mL, making sure to leave some head space. Remove from water, hold yellow tabs, and flip over twice. Seal by twisting the yellow ties closed. Note: If there is a large amount of scum and debris at the surface, you can open the bag after submersing underwater.

6. Water samples kept longer than 1 hour before plating need to be stored on ice or refrigerated. Samples can be stored for up to 8 hours.

Watch the online video at the UWW website to see this and the next technique demonstrated: (http://extension.usu.edu/utahwaterwatch/monitoring/tier1).

At your home or lab:

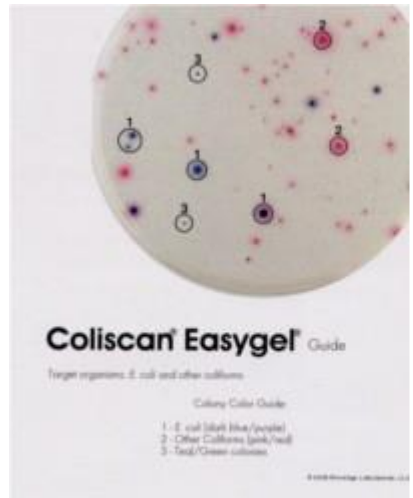
A note about sample size: The Coliscan method is effective for sample sizes ranging from 1ml-5ml. An increase in sample size leads to increased sensitivity in the test, and vice versa. Example: if I expected only trace amounts of *E. coli* in the waterbody, I would choose a larger sample size than if I expected high amounts.

This volunteer uses a sterile dropper to add sample water to the Easygel media and pour the solution in the bottom of the pre-labeled petri dish.

Plating the sample

1. Make sure Coliscan Easygel medium in the bottle has thawed.
2. Using a permanent marker, record on the bottom of the petri dish the site ID or name, date, time sample was plated, volume of sample, and sample #1 or #2.
3. Shake Whirl-Pak to thoroughly mix the sample. Carefully open bag using white tabs so as not to touch the lip or inside.
4. Use a transfer pipette, and deposit 1 mL up to 5 mL in the first Coliscan Easygel bottle, cap and gently swirl.
5. Remove lid from the petri dish, careful not to touch the inside of the dish or lid. Slowly pour contents of the Coliscan Easygel bottle into the bottom of the dish. Place the top back on the petri dish and leave on a level surface for 45 minutes to solidify.
6. Repeat steps 4-5 for the duplicate sample with the second pipette, Coliscan Easygel bottle, and petri dish.
7. Once petri dishes have solidified, move to a warm, draft free location out of the direct sun to incubate. See "Incubating the Sample" below.
8. Wash hands and work surface.

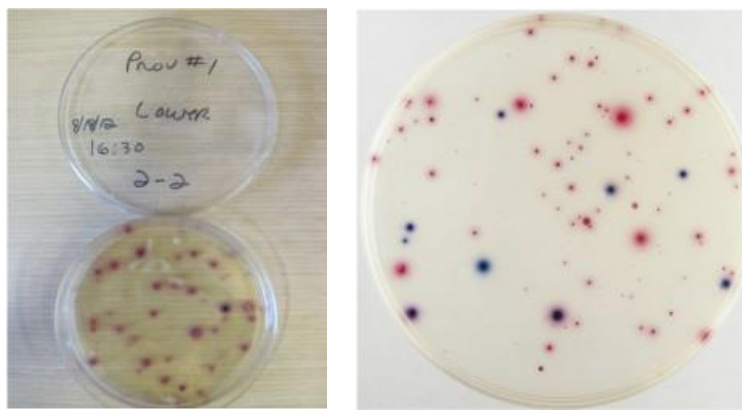
Incubating the Sample



Coliscan Easygel guide, available in Appendix E.

1. Store petri dishes in a warm, draft free location out of direct sunlight. Use the thermometer to measure the temperature. At room temperature, 20 - 24 °C (68 – 75 °F), colored colonies will take at least 48 hours to develop.
2. Check every 10-12 hours to observe if colored colonies have started to form. Upon sighting the formation of colored colonies, note the time and allow for another 24-30 hours for the maturation of these colonies. This is usually 48-60 hours after you poured the medium into the petri dish. Counts should not be made after 72 hours.
3. When you believe the colonies have matured, record the total number of hours on the data sheet in the Incubation time along with the normal temperature during incubation .

Reading the Sample



After letting your colonies develop for 48-72 hours the sample should look like the one shown above

1. In a bright area, count ONLY colonies that have a dark blue or purple color**. Dark blue and purple colonies indicate *E.coli*.** Do not count pink, red, or teal, colonies as these are other types of bacteria. Also, ignore tiny, pin-sized colonies. If you are unsure, look at examples provided during the training and on the website. If still uncertain check with another UWW volunteer or take photos and send to UWW staff.
2. Record the number of dark blue or purple colonies on the data sheet for each sample.
3. Enter the sample size (from 1 to 5 mLs) for each sample.
4. To calculate the *E.coli* per 100 mL, divide 100 by the sample size and multiply this dilution factor by the number of colonies counted.

   Example: [100ml divided by 3mL sample size] X 9 colonies counted = 297 cfu per 100 mL. Record the results from each duplicate sample on the data sheet.
5. Average the two sample results to the nearest whole number on the data sheet and record.

E. coli BACTERIA- (Coliscan Easygel Method): *Monthly- May through Sept.*	
Incubation start time: ________ **Total hours:** ________ **Incubation temp °C:** ________	
Concentration = $\left(\frac{100}{Sample\ size\ in\ mL}\right) \times \left(\frac{colonies}{counted}\right) = \frac{cfu}{100\ mL}$	
Reading #1 $\left(\frac{100}{\quad}\right) \times (\qquad) = \frac{cfu}{100\ mL}$	Average Concentration = $\frac{(\text{Reading \#1} + \text{Reading \#2})}{2}$ **Average E. coli = ________ cfu / 100 ml**
Reading #2 $\left(\frac{100}{\quad}\right) \times (\qquad) = \frac{cfu}{100\ mL}$	*NOTE: If average is greater than 400 cfu / 100 ml, contact UWW.*

Data sheet section for lake E. coli recording.

Disposal of sample

1. Place a teaspoon of bleach or spray a cleaning solution (i.e. Lysol) onto the surface of the medium. Close the lid and let it sit for five minutes.

2. Place both petri dishes in a sealed plastic bag and throw in the trash. Then place this in a trash receptacle that will be taken to a landfill.

3. Wash your hands after handling samples, plates, and water.

Photo point monitoring in lakes

Background: Photo point monitoring is utilized by many agencies, including the Utah Division of Water Quality, to document changes at a location. Photos are taken on a regular basis (once a month, quarterly, once a year etc.) from the same position and in the same direction(s) . This ensures uniformity between pictures. Photos are uploaded into the CitSci database along with your recorded data, see the next section on CitSci database (page 76).

Why Collect Photo Points? Photo point monitoring provides an easy way for water quality managers to observe and share changes on streams, rivers, and lakes. Photo points along rivers and lakes provide managers information on riparian area health, littoral zones, and stream condition.

Right bank of Mantua Reservoir in 2017 and 2018 showing different algae blooms.

Methods:

1. Determine a location: Most volunteers will take photo points at their existing site which once established, will not change. You will want to have as much of the site visible as possible and take a photo from that point (i.e. right bank, left bank, and/or scope of the lake). **Note: if you or previous volunteers have already collected photo points, refer to the previous photos to ensure a best match.**
2. Taking of the photo:

a. Choose the camera settings that give the greatest depth of field. For digital cameras, a "landscape" setting generally fulfills this requirement.

b. Hold the camera at eye level in the horizontal position. Try to include about 1/3 sky in the photo for scale and for consistent replication.

c. Take the photos in early morning, late afternoon, or slightly overcast days to eliminate harsh glares or dark shadows. Take the photos with the sun at your back and avoid days when visibility is poor due to fog or heavy rain.

For retake photos, bring a copy of the previous photo to ensure the photo view matches.

Naming photo file:

For easy identification, name your photo files as follows: *site ID_direction taken_date.jpg*

<u>Lake example:</u> MANT-01-L_right bank_6.16.2020.jpg

<u>River example:</u> PRR-02-S_upstream_6.16.2020.jpg

UWW Database – CitSci.org

All of our Tier 1 data and some Tier 2 data are stored on the collaborative database, www.citsci.org. The database is designed to be secure while still providing the public with open access to data produced by volunteers. Anyone may download data, but only trained Utah Water Watch volunteers may enter data. UWW is only one of many projects on CitSci.org. Each volunteer creates a Login and requests to join the Utah Water Watch project. Volunteers can only enter data for their assigned sites.

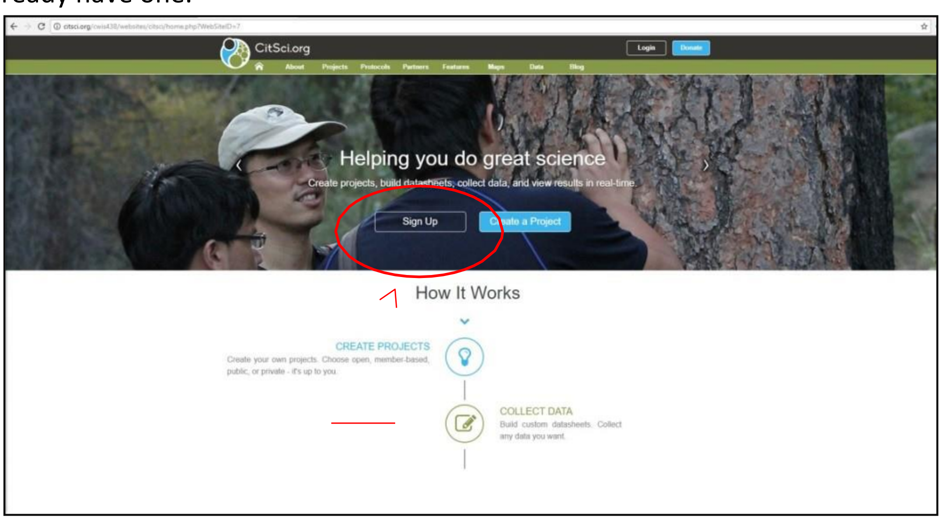
Below are detailed instructions on entering data from the online portal. If you have trouble logging in or with any of the fields, please contact us at waterquality@usu.edu and we will help you get your data entered. If you would prefer that we enter the data for you, you can email a picture of the datasheet or mail us a paper copy (5210 Old Main Hill Logan, UT 84322).

Submit UWW data

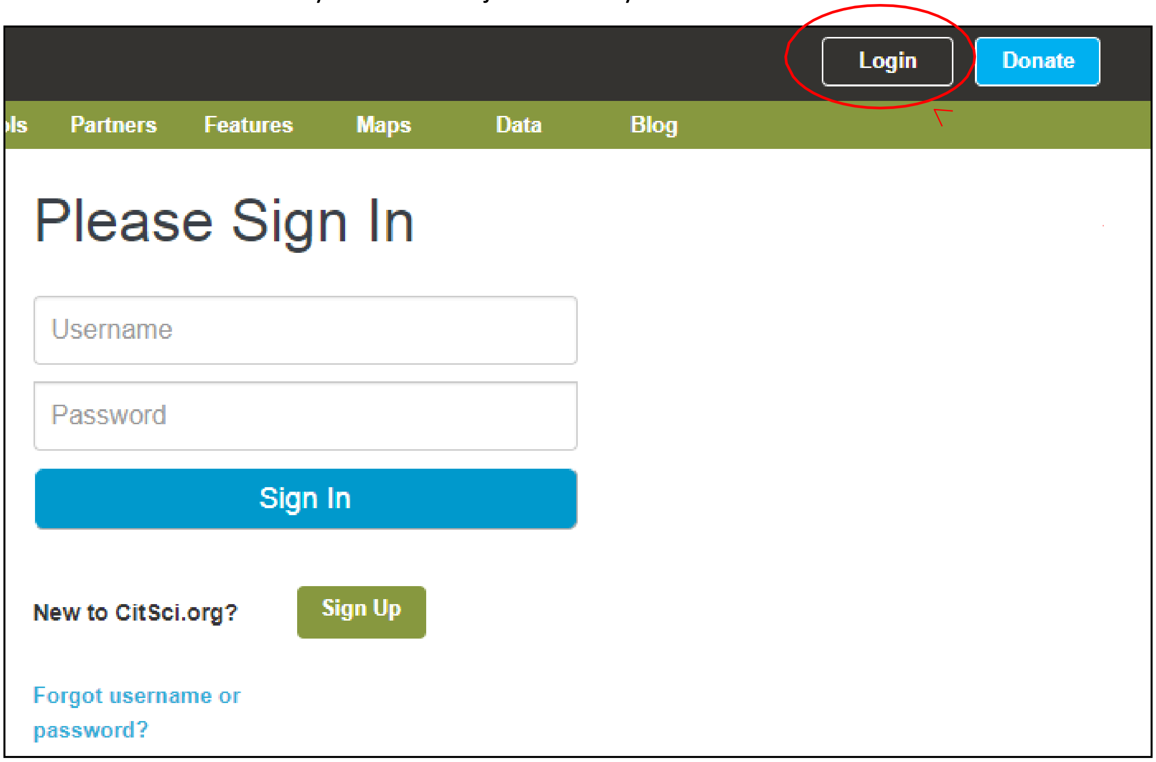
The first step in entering data is to navigate to the website (www.citsci.org). Here you will find information to view previous data, resources, and helpful tools and location to add your data.

Instructions for Login and Data Entry

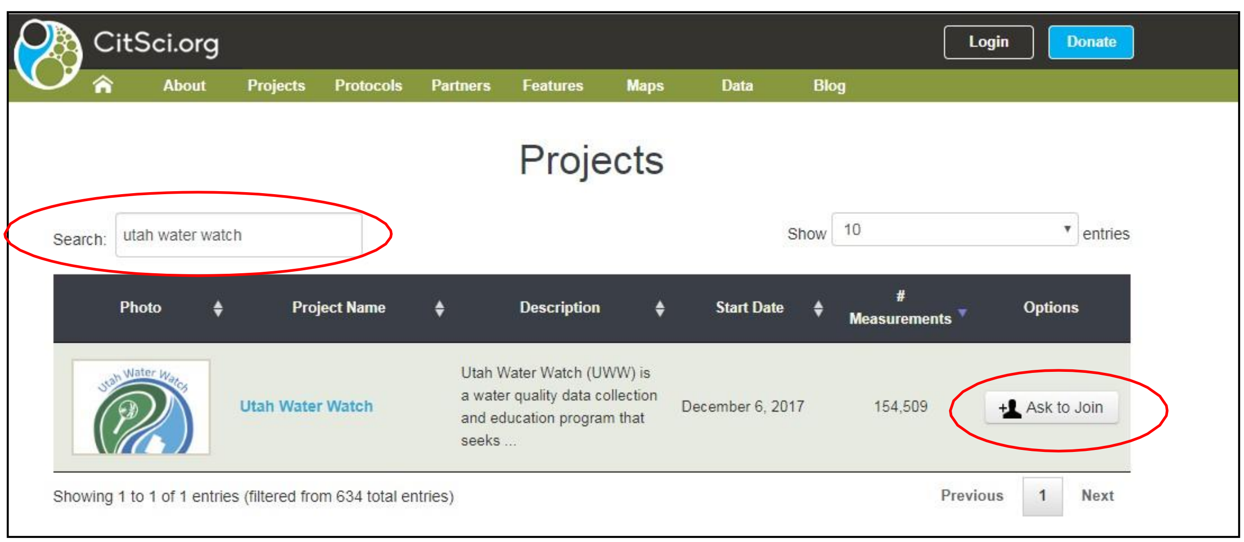
1. Click **"Sign Up"** located in the middle of the page. Create a username and password if you do not already have one.



2. **To Login, click the button at the top right and enter your Username and Password**, click "Sign In." If you have issues, click the "Forgot username or password link." You will be sent an email from CitSci. *Be sure to check your SPAM or junk mail if you do not see the email*



3. Search Projects for "Utah Water Watch" and "Ask to Join". This may take a few days for approval and set up in the system. Once you have been approved you will receive an email that you are ready to enter your data.



4. To enter data, go to “My Projects”, in the top left – Utah Water Watch will drop down. Click on it.

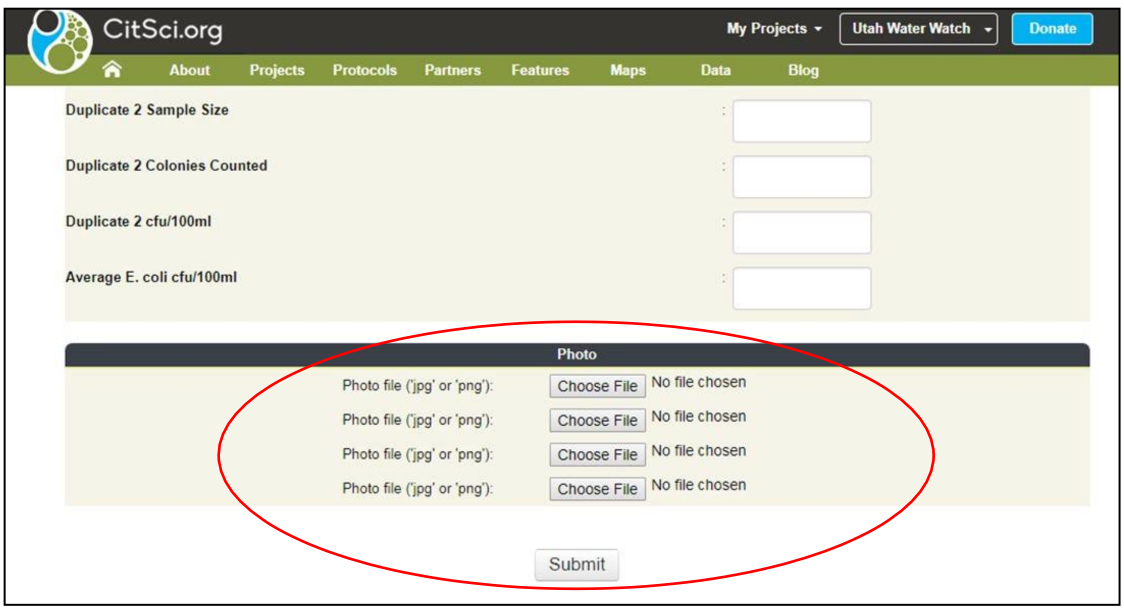
5. Once in the project, you will see a blue “Add Data” button, which will drop down with different datasheets. Select the datasheet that corresponds to the data you are collecting (i.e. Tier 1 Stream or Tier 1 Lake).

6. Review the instructions at the top of the datasheet and add data as it is shown on your datasheet. **Be careful to enter the correct date and time and your data is in the proper units.** Only your specific monitoring locations will show up in the "location" dropdown.

7. It is best if you submit the data correctly the first time. However, if you do need to go back in and make edits, an edit button will show up next to the datasheets you submitted. You can make edits by clicking "Edit."

Upload photo point photos

Before you attach your photos in the database, it is best to rename them. Include the site name, date, upstream/downstream, etc. EXAMPLE: Weber River WER-01-S, upstream, August 22, 2016 = "WER01S-up-08222016"



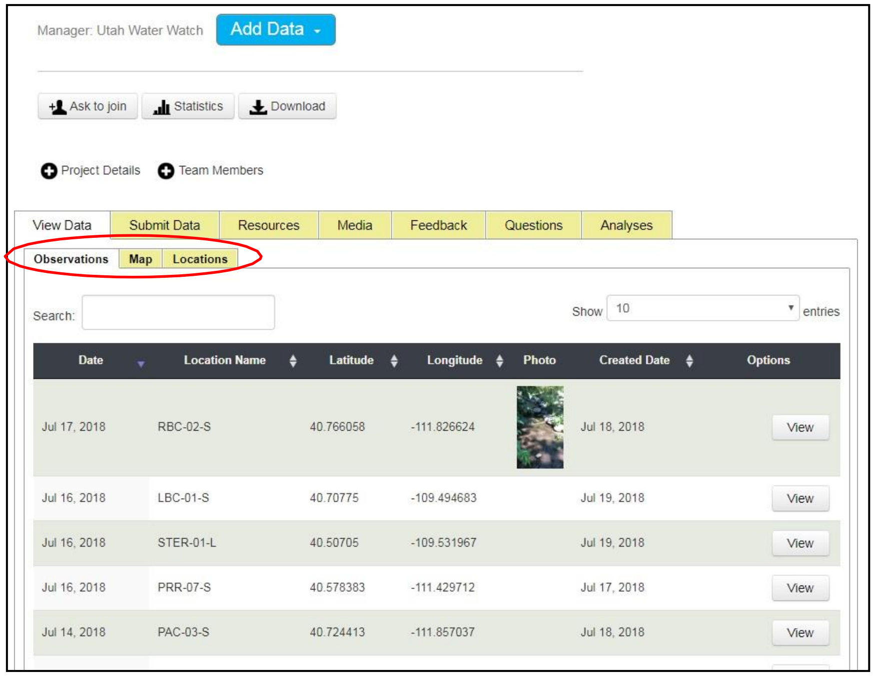
At the end of the datasheet, there will be a location to attach your photos. This is where you should add your photo point photos and any additional photos you choose to attach of your site (i.e. *E. coli* samples, monitoring crew, animals at or near the site, etc.).

View data

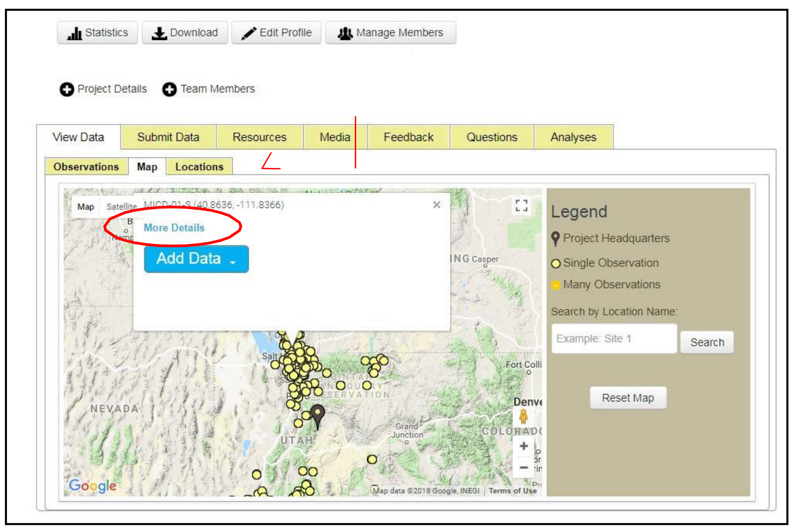
Anyone can easily view the data by going to the Utah Water Watch project page. View the data directly on the CitSci page. To find the Site ID for a particular stream or lake, go to the Resources tab for a list of the sites (i.e. find the UWW Site ID for Red Butte Creek is RBC-01-S).

1. Click on the "View Data" tab.

2. Search by individual “Observations”, “Map” or “Locations”.

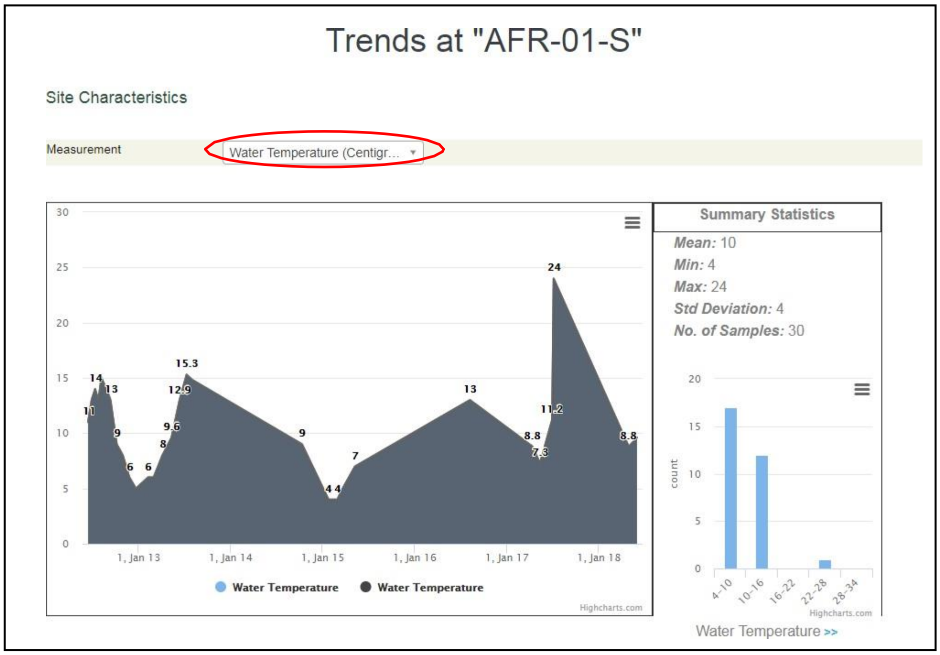


3. In “Observations”, click on the “View” button on the right. You can also use the search function to help find a site.



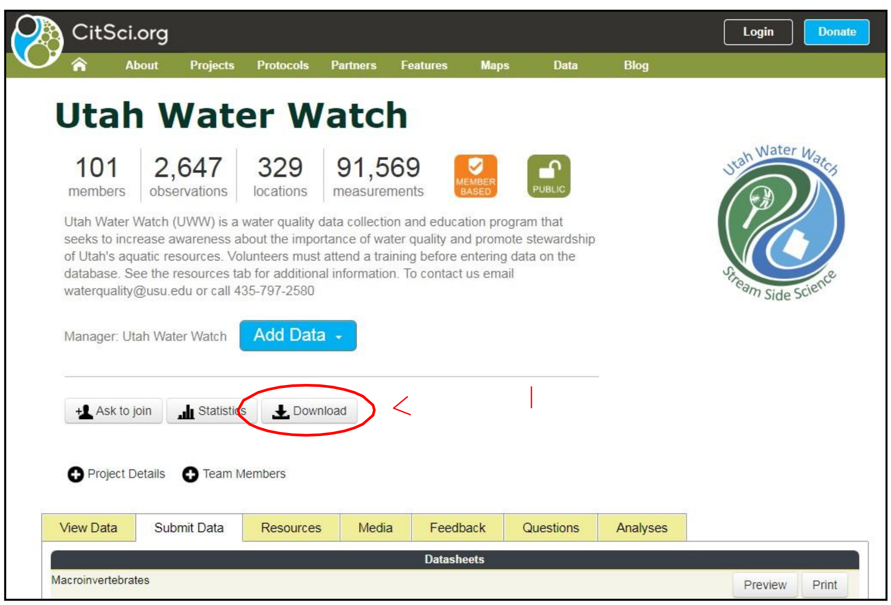
4. In “Map”, click on a yellow dot to view location. A white box will pop up for that Site ID - select “More Details” to see all the data for that Site ID.

5. In “Locations”, select the Site ID of interest to see all the data submitted for that Site ID. View the data in two ways – Visual analysis, select Measurements above the graph OR see individual observations below by selecting the “View” button next to each observation.

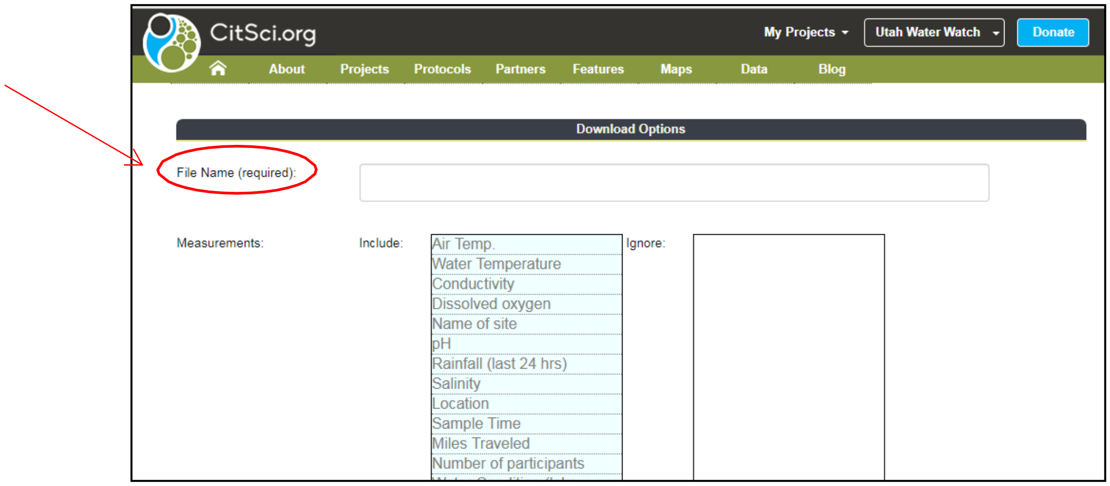


Download data

Anyone can download data, though a CitSci login is required. Simply create a username and password. You do not need to join the project.



1. Under projects, select Utah Water Watch. The Download button is in the middle of the page.
2. Enter a name to call the file once it downloads.



3. Drag any fields you are NOT interested in to the "Ignore" column. You can also clean up the fields after you have downloaded the file to highlight the data you are interested in.
4. "Include units in file?" – If you leave this checked, it will add an additional column for the units.
5. Select the file type, either XLXS or CSV. The CSV file download is smaller so if your system is slow it may be a better option. If you plan to work with the data, you can Save As and Excel file after it is downloaded.
6. Photos are not available for batch download but can be selected from the "view data" section".

References

Anderson, J.A. and D.U. Blahna. (1998). Interpreting Utah's Wetlands . No NR/RF/002. Retrieved from http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2155&context=extension_curall.

Chemetrics. (2008). Oxygen CHEMets Kit. Retrieved from https://pim-resources.coleparmer.com/instruction-manual/05540-40.pdf.

Department of Water and Environmental Regulation. (2017). Understanding Salinity. Retrieved from https://www.water.wa.gov.au/water-topics/water-quality/managing-water-quality/understanding-salinity.

Friedl, S. (n.d.) What is Salinity? Definition & Effects. Retrieved from https://study.com/academy/lesson/what-is-salinity-definition-effects-quiz.html.

Micrology Labs. Detection of Waterborne Coliforms and Fecal Coliforms with Coliscan Easygel. Retrieved from http://www.micrologylabs.com/files/coliscan_water_inst.pdf.

Micrology Labs. (2016). Guide for E. coli and Coliform CFU's in Coliscan Easygel. Retrieved from https://www.micrologylabs.com/files/VA_DEQ_Coliscan_ID.pdf.

Mining and Water Quality. (2017, April 4). Retrieved from https://water.usgs.gov/edu/mining-waterquality.html.

Quick Facts. Retrieved from http://utah.gov/about/quickfacts.

State of Utah Department of Environmental Quality Division of Water Quality (2014). Standard Operating Procedure for Secchi Disk Depth Measurements. Retrieved from https://deq.utah.gov/legacy/monitoring/waterquality/docs/2014/05May/SOP_SecchiDisk_5.1.14_Rev0.pdf.

United States Environmental Protection Agency. (2012). 5.9 Conductivity. Retrieved from https://archive.epa.gov/water/archive/web/html/vms59.html.

Utah Water Watch Useful Webpages

- Homepage: http://extension.usu.edu/utahwaterwatch
- UWW database: www.citsci.org
- USU Water Quality Extension: http://extension.usu.edu/waterquality
- Facebook Group: https://www.facebook.com/groups/3417528201651636/
- Twitter: https://twitter.com/UtahWaterWatch
- Instagram: https://www.instagram.com/utahwaterwatch/
- Stream Side Science curriculum: http://streamsidescience.usu.edu

Utah Water Quality Monitoring Agencies and Resources

- Utah Division of Water Quality: http
  - Utah Standard Operating Procedures (SOPs) and other QAQC procedures: http://www.deq.utah.gov/Compliance/monitoring/water/qaqc.htm
  - Approved Total Maximum Daily Loads (TMDLs): http://www.deq.utah.gov/ProgramsServices/programs/water/watersheds/approved tmdls.htm
- Utah Clean Water Partnership: www.utahcleanwater.org

Utah Water Quality Laws

- Utah Administrative Code R 317 - Environmental Quality, Water Quality: https://rules.utah.gov/publicat/code/r317/r317.htm
- Utah Administrative Code R 317.2 - Standards of Quality for Waters of the State: https://rules.utah.gov/publicat/code/r317/r317-002.htm

National Water Quality Agencies and Resources

- Environmental Protection Agency, Water: https://epa.gov
- My Waters Mapper: http://watersgeo.epa.gov/mwm/
- National Water Quality Monitoring Council: https://acwi.gov/monitoring/
- USGS Water Watch: https://waterwatch.usgs.gov/
- NOAA Phytoplankton Monitoring Network: https://products.coastalscience.noaa.gov/pmn
- National Aquatic Center Monitoring Center – BugLab: http:// www.usu.edu/buglab

Weather

- Weather Underground: http://www.wunderground.com
- Community Collaborative Rain, Hail & Snow Network: http://www.cocorahs.org/state.aspx?state=ut

Preventing the Spread of Invasive Species

- Utah Division of Wildlife Resources decontamination methods: http://wildlife.utah.gov/dwr/decontaminate.html

UtahStateUniversity WATER QUALITY EXTENSION

Stream Field Datasheet (Tier 1)
Utah Water Watch

Site Name: ________________ **Date Sampled:** ________________ **Time Sampled:** __________________

Field Monitor Name(s): ____

UWW ID: _________________ **Hours Sampling/traveling:** ______________ **Miles traveled:** __________

UWW Site ID: __________ **# of participants:** ________________ **Decontamination:** **Yes** **No**

FIELD OBSERVATIONS *(Circle one for each, unless instructed otherwise):*

Stream Flow:	Flood	High/Runoff	Normal/Baseflow	Low	No flow		
Water Clarity:	Clear	Cloudy/Milky	Turbid				
Water Surface:	Sheen/Oily	Trash	Natural Debris	Foamy	Scummy	Clear	
Water Color:	Clear	Brownish	Greenish	Reddish	Blue	Orange	
Site Odor:	None	Chlorine	Sewage	Fishy	Musky	Oil	Rotten Egg
Algae Cover:	Abundant Filamentous	Thick Substrate Layer	Little Filamentous	Moderate Substrate Layer	Little/Rare		
Dead Fish:	None	1 to 3	4 to 10	>10			
Current Weather:	Clear	Cloudy	Overcast	Light Rain	Heavy Rain	Snow	
Photo Point: *(Circle one for each photo taken):*		Upstream	Downstream				

Provide short description of each photo:

____
____
____

Rainfall in past 24 hours (inches) ____________

Comments: ____
____
____

Continued on back

FIELD SAMPLES:

Location *(circle one):* Center Side

Habitat *(circle one):* Pool Run Riffle

Parameter	Reading (measurement)	Unit	Allowable Range in Utah
Air Temperature		°C	
Water Temperature		°C	Max temp for warm water fish = 27 °C Max temp for cold water fish = 20 °C
pH		None	6.5-9.0
Dissolved Oxygen		mg/L	Min for warm water fish = 6.5 mg/L Min for cold water fish = 5.5 mg/L
Turbidity		cm (convert to NTUs using chart)	Turbidity should not change more than 10 NTUs
Salinity Parameters			
Conductivity		µS/cm	1880 µS/cm is approximately equal to TDS of 1200 mg/L
TDS		mg/L *(1 ppm = 1 mg/L)*	1200 mg/L maximum allowable value of TDS for water used for irrigation
Water Temperature (conductivity meter reading)		°C	

ALGAL MONITORING *(Circle one for each)*:

Algae Observed in stream?	***Yes***	***No***	
Types Observed	*Floating Scum*	*Water column*	*Filamentous*
Harmful bloom suspected?	*Yes*	*No*	
Bloomwatch / UWW contacted?	*Yes*	*No*	

Comments *(location of blooms and percent cover)*:

____

____

Continued on next page

E. coli BACTERIA - (Coliscan Easygel Method): *MONTHLY – May through Sept.*

Incubation start time: _______________ **Total hours:** ______________ **Incubation temp °C:** ______________

Concentration = $\left(\frac{100}{Sample\ size\ in\ mL}\right) \times \left(\begin{matrix} colonies \\ counted \end{matrix}\right) = \frac{\_\_\_\_\ cfu}{100\ mL}$

Reading #1 $\left(\frac{100}{\_\_\_\_}\right) \times (\qquad) = \frac{\_\_\_\_\ cfu}{100\ mL}$

Reading #2 $\left(\frac{100}{\_\_\_\_}\right) \times (\qquad) = \frac{\_\_\_\_\ cfu}{100\ mL}$

Average Concentration = $\frac{(\textbf{Reading \#1+Reading \#2})}{\textbf{2}}$

Average E. coli = ________ cfu / 100 ml

NOTE: If average is greater than 400 cfu / 100 ml, contact UWW.

Lake Field Datasheet (Tier 1)

Utah Water Watch

Site Name:________________________**Date Sampled:**_________________**Time Sampled:** ________________________

Field Monitor Name(s):____

UWW ID: ________________________ **Hours Sampling/traveling:** _____________ **Miles traveled:** ________________

UWW Site ID:______________________**# of participants:**__________________**Decontamination: Yes No**

FIELD OBSERVATIONS *(Circle one for each, unless instructed otherwise)*:

Water Odor:	None	Chlorine	Oil	Musty	Sewage	Fishy	Rotten Egg
Water Surface:	Clear	Scummy	Foamy	Natural Debris	Trash	Sheen/ Oily	
Water Clarity:	Clear	Cloudy/ Murky	Turbid				
Water Condition:	Calm	Ripples	Small Waves	Moderate Waves	Whitecaps		
Water Color:	Clear	Brownish	Greenish	Reddish	Blue	Orange	
Dead Fish:	None	1 to 3	4 to 10	>10			
Current Weather:	Clear	Cloudy	Overcast	Light Right	Heavy Rain	Snow	
Photo Point *(Circle one for each photo taken)*:	Right Bank	Left Bank	Scope of the Lake				
	On Shore	Dock/Pier	Boat	Other:________________			

Provide short description of each photo:

____

____

____

Rainfall in last 24 hours (inches) ________

Comments: ____

____

FIELD SAMPLES:

Location *(circle one)*: On Shore Dock/Pier Boat

Parameter	Reading (measurement)	Unit	Allowable Range in Utah
Air Temperature		°C	
Water Temperature		°C	Max temp for warm water fish = 27 °C Max temp for cold water fish = 20 °C
pH		None	6.5 to 9.0
Secchi depth		Meter(s)	0.1 to 13 meters

Continued on back

Salinity Parameters	Reading (measurement)	Unit	Allowable Range in Utah
Conductivity		µS/cm	1880 µS/cm is approximately equal to TDS of 1200 mg/L
TDS		mg/L *(1 ppm = 1 mg/L)*	1200 mg/L maximum allowable value of TDS for water used for irrigation
Water Temperature (conductivity meter reading)		°C	

ALGAL MONITORING *(Circle one for each)*:

Algae Observed in lake?	***Yes***	***No***	
Types Observed	*Floating Scum*	*Water column*	*Filamentous*
Harmful bloom suspected?	*Yes*	*No*	
Bloomwatch / UWW contacted?	*Yes*	*No*	

Comments *(location of blooms and percent cover)*:

____

____

E. coli BACTERIA- (Coliscan Easygel Method): *Monthly- May through Sept.*

Incubation start time: ________________ **Total hours**: __________ **Incubation temp °C:** _____________

Concentration = $\left(\frac{100}{Sample\ size\ in\ mL}\right) \times \left(\frac{colonies}{counted}\right) = \frac{cfu}{100\ mL}$

Reading #1 $\left(\frac{100}{\quad}\right) \times (\qquad) = \frac{cfu}{100\ mL}$

Reading #2 $\left(\frac{100}{\quad}\right) \times (\qquad) = \frac{cfu}{100\ mL}$

Average Concentration = $\frac{(\textbf{Reading \#1}+\textbf{Reading \#2})}{2}$

Average E. coli = ________ cfu / 100 ml

NOTE: If average is greater than 400 cfu / 100 ml, contact UWW.

Continued on next page

COMMUNITY FISHING INFORMATION:

Number of people fishing: ___________

Hours spent fishing: ________________

Birds Observed while Fishing:

# of Cormorants: ____________

# of Pelicans: __________

Fish caught	Number
Bluegill	
Wiper (hybrid)	
Carp	
Rainbow Trout	
Catfish	
Bass	
Other	

Utah Water Watch Field Algae ID Guide

Examples of Cyanobacteria Harmful Algae Blooms (HABs)

Cyanobacteria can be distributed throughout the water or they can float on the surface to form scums on or near the surface. For more images of different forms of cyanobacteria visit this website:

http://health.utah.gov/enviroepi/appletree/HAB/identify.html

Up close, cyanobacterial colonies form small clumps (some look like grass-clippings) When conditions are right, cyanobacteria float to the surface to form the thick mats seen below.

Sometimes HABs only cover a small portion of the lake. Wind blows the cyanobacteria around rocks, green algae mats, or plants.

Often, HABs are described as looking like "spilled paint", green, white or blue. Their color may change over time; the above photos were all taken at Utah Lake.

Examples of Green Algae Blooms and Duckweed (Harmless)

Not all algal blooms or surface scums are cyanobacteria. Some green algae like Cladophora and Spirogyra can also create large blooms, but they do not produce harmful algal toxins. **Green algae** come in many forms and may look like underwater moss, thick stringy mats or floating slimy scum. **Duckweed** are tiny aquatic plants with a grainy or couscous-like texture. They may resemble miniature lily pads and are generally beneficial to the environment.

Examples of *Cladophora* green algae blooms.

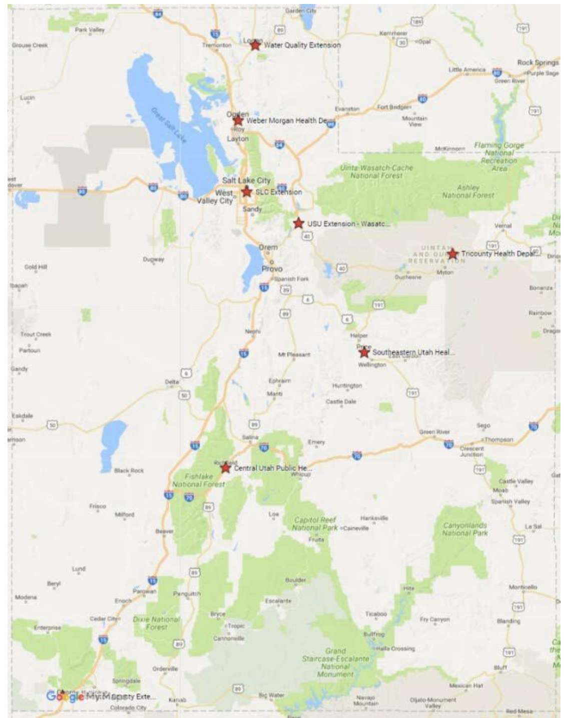
Examples of *Spirogyra* green algae blooms.

Examples of the aquatic plant duckweed.

Green algae / duckweed Image credit: Ohio Environmental Protection Agency.

Regional Harmful Algal Bloom Scopes and DWQ Contacts

Please call ahead. Bring 1L sealed samples, along with filled out label, to these locations. (If you have access to other microscopes, you may use that for identification, but be sure to notify UWW, DWQ or local health department if there is a concern).



Logan, USU - 5230 Old Main Hill, Logan, UT 84321

- Water Quality Extension: (435)797-2580
- 8am -4pm

Salt Lake City, Salt Lake County USU Extension - 2001 State St S1200, SLC, UT 84190

- Call ahead (385) 468-4820; ask for Sunny Day
- 8am –5pm

Provo, BYU Campus

- Contact Erin Jones
- Call ahead (10am -5pm) (801) 473-6338
- Email:erinfjones3@gmail.com

Heber City, Wasatch County USU Extension - 55 S 5th E, Heber City, UT 84032

- Call ahead, (435) 657-3235; ask for Allan
- 8-5pm

Vernal, Tri-County Health - 133 S 500 E, Vernal, UT 84078,

- Call ahead: (435) 247-1177;
  ask for environmental health
- 8:30am –4:30pm

Price, SE Utah Health - 28 S 100 E, Price, UT 84501

- Call ahead (435) 637-3671; ask for environmental health.
- 8am –5pm

Richfield, Central Utah Public Health - 70 Westview Dr., Richfield, UT 84701

- Call ahead (435) 896-5451; ask for environmental health
- 8am –5pm

St. George, Washington County USU Extension - 339 S 5500 W Hurricane, UT 84737

- Call ahead: (435)634-5706
- 8am –5pm

Ogden, Weber-Morgan Health Department - 477 23rd Street, Ogden, UT 84401

- Call ahead: 801-399-7160; ask for environmental health
- 8am –5pm

Cedar City, SUU Biology Department – 351 West University Blvd.

- Call or email ahead: Roger Gold, rogergold@suu.edu, (435) 586-7931

Utah Division of Water Quality Contacts

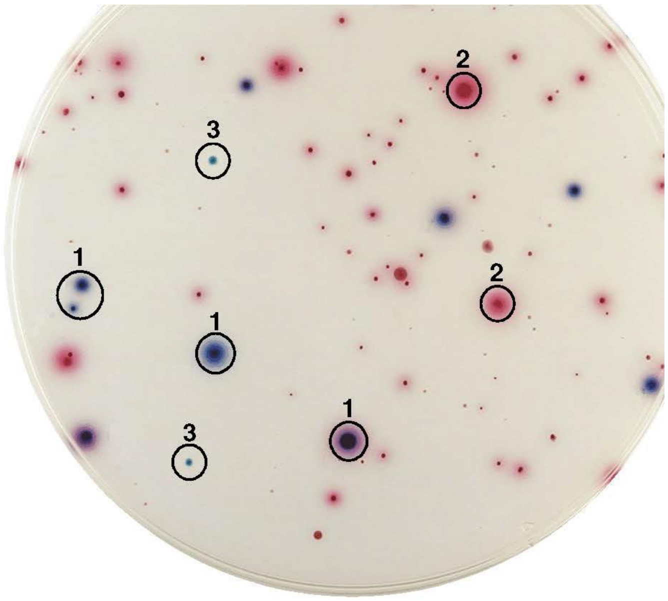
- Ben Holcomb, (801) 536-4373,bholcomb@utah.gov
- Jodi Gardberg, (801) 536-4372,jgardberg@utah.gov

Local Health Department Contacts:

- Ogden, Weber-Morgan Health Department - 477 23rd Street, Ogden, UT 84401 (801) 399-7160
- Price, SE Utah Health Department - 28 S 100 E, Price, UT 84501, (435) 637-3671
- Richfield, Central Utah Public Health - 70 Westview Dr, Richfield, UT 84701, (435) 896-5451
- Vernal, Tri-County Health - 133 S 500 E, Vernal, UT 84078, (435) 247-1177
- Wasatch County Health Department - 55 South 500 East Heber City, Utah 84032, (435) 657-3264
- Logan area - Bear River Health Department - 655 East 1300 North Logan, Utah 84341, (435) 792-6500
- Salt Lake County Health Department - 788 East Woodoak Lane (5380 South) Murray, UT 84107, (385) 468-3862
- Cedar City - SW Utah Health Department - (435) 865-5180 - 260 E. DL Sargent Dr. Cedar City, UT
- St. George - SW Utah Health Department - (435) 986-2580 - 620 S. 400 E. St. George, UT

USU Water Quality Extension / Utah Water Watch

- Main office in Logan at USU – (435) 797-2580, waterquality@usu.edu
- Hope Braithwaite – (435) 919-1324, hope.braithwaite@usu.edu



Coliscan® Easygel® Guide

Targetorganisms:*E. coli* andothercoliforms

Colony Color Guide:

1 - *E. coli*(darkblue/purple)
2 - Other Coliforms (pink/red)
3 - Teal/Green colonies

Guide for *E. coli* and Coliform CFU's in Coliscan® Easygel®

The photographs and definitions portrayed on the opposite side of this page were compiled by James Beckley, QA Coordinator of the Dept. of Environmental Quality, Richmond, VA and were collected by James Beckley, Jennifer McDonnell of the Arlington Co. Dept. of Environmental Services, and volunteer James White of the Prince William Soil and Water Conservation District. The photos are used with their written permission.

Throughout the United States, there are many Citizen Volunteer Water Quality Monitoring Programs that collect and tabulate data on local watersheds. One important part of most of these programs includes testing for the presence of bacterial indicator organisms such as *Escherichia coli* (a primary indicator of fecal pollution), and related bacteria (General Coliforms and similar microbes such as *Aeromonas* and *Salmonella spp*). The excessive presence of these indicator organisms can be correlated with disease outbreaks in humans that contact such polluted waters. Originally, many programs did not test for bacterial indicators due to the difficulty of the then available Methods. Not long after the invention of a novel Pectin Gel method developed by Dr. Jonathan Roth (founder of RCR Scientific Inc. and Micrology Laboratories LLC), the Coliscan Easygel Medium was noted by Dr. William Deutsch of the Fisheries Dept. of Auburn University, the originator of the Alabama Water Watch program. He did comparative testing against traditional methods that resulted in the Coliscan Easygel's approval (1999) by the UESPA for use in volunteer water monitoring in his Region 4. AWW has developed a manual titled "Alabama Water Watch Bacteriological Monitoring" that is based on the Coliscan Easygel Method and is available from AWW of Auburn University.

Protocols and detailed information on Coliscan Easygel are available on the Micrology Laboratory website (www.micrologylabs.com) Briefly, the medium is based upon two chromogenic enzyme indicators (galactosidase & glucuronidase), both enzymes which are produced by *E. coli* and only one (galactosidase) by general coliforms.

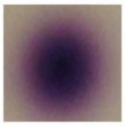
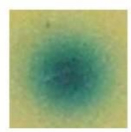
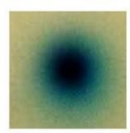
The result is that general coliforms that form colonies in the Coliscan Easygel will grow as pink colored colonies due to the fact that the galactosidase substrate + active enzyme results in a pink color. On the other hand, *E. coli* produces both enzymes and the glucuronidase sensing substrate + glucuronidase enzyme results in a teal green color when galactosidase is not present. But the combination of the two enzymes (inherent in almost all *E. coli strains*) results in a mixed color that can range from dark navy blue to a dark magenta. If there is much glucuronidase and little galactosidase present, the colony color will tend to be dark blue or purple. If there is much galactosidase and little glucuronidase present, the colony color will tend to be magenta and often with a pink surrounding ring.

Since *E. coli* virtually always indicates fecal contamination, it is the most important indicator. Unfortunately for the microbiologist or technician, there are thousands of different strains of *E. coli*, most of which do not produce the same ratio of the two enzymes. Hence, there is a gamut of variation in the appearance of the different strains. However, the presence of both enzymes regardless of quantity is considered diagnostic for *E. coli*. That is the reason for the illustrations on the opposite side of this page.

You will note the differences in the lighting (background) for the photos as they were selected by the photographers as examples that attracted their attention in various Coliscan Easygel dishes that were inoculated with natural waters.

It should also be noted that there are sets of Confirmation Media (#25901) from Micrology Laboratories that will confirm the identity of any colonies that remain questionable in the eye of the technician. As in every method, experience in interpretation is valuable in increasing confidence of the technician.

Micrology Laboratories, LLC. Phone 574-533-3351 or 888-327-9435

E. coli		**Not *E. coli***	
	Purple, with purple halo		White
	Purple, no halo		Pink, no halo
	Purple with pink halo		Pink with pink halo
	Blue with purple or pink halo		Pinpoints* (If after incubation period)
	Blue or dark blue, no halo		Teal green, no halo
	Dark blue with teal halo		Teal with teal halo
	Dark blue with blue halo		Red

*Do not count pinpoints if the plate is dominated by larger colonies. Pinpoints may be counted if they make up >50% of colonies. If possible, incubate a few additional hours to see if colonies will grow larger.

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

Distance from bottom of tube (cm)	NTU's
< 6.25	> 240
6.25 to 7	240
7 to 8	185
8 to 9.5	150
9.5 to 10.5	120
10.5 to 12	100
12 to 13.75	90
13.75 to 16.25	65
16.25 to 18.75	50
18.75 to 21.25	40
21.25 to 23.75	35
23.75 to 26.25	30
26.25 to 28.75	27
28.75 to 31.25	24
31.25 to 33.75	21
33.75 to 36.25	19
36.25 to 38.75	17
38.75 to 41.25	15
41.25 to 43.75	14
43.75 to 46.25	13
46.25 to 48.75	12
48.75 to 51.25	11
51.25 to 53.75	10
53.75 to 57.5	9
57.5 to 60	8
Over the top	6

Examples of Conductivity Ranges in Utah Streams

Summary of conductivity in Utah streams and rivers from Utah's Ambient Water Quality Data Management System (AWQMS) database: https://deq.utah.gov/water-quality/databases-and-information#awqms.

The sampling locations for each river are listed from higher elevation to lower elevation in the watershed demonstrating how conductivity changes as the water travels through the watershed.

Sampling Location	Average Value (µS/cm)	Minimum Value (µS/cm)	Maximum value (µS/cm)	# of samples	Latitude	Longitude
Bear River						
Below Salt Creek	1778	623	4330	13	41.576487471	-112.098061285
East of Woodruff	551	349	880	29	41.531608939	-111.133249929
Big Cottonwood Creek						
above Jordan River at 500 W 4200 S	1022	8	3400	76	40.679951274	-111.9057651
at Creekside Park	657	210	1326	8	40.665070081	-111.845038927
Blacksmith Fork River						
Below Hardware Ranch	354	308	388	16	41.606043268	-111.591323404
Above 1700 S crossing W of Providence	487	404	659	13	41.701774218	-111.842139672
Jordan River						
at 1700 S above drain outfall	1436	8	2590	73	40.733555251	-111.923545039
At 6400 S crossing	1613	1056	2022	27	40.630502	-111.922987
Little Bear River						
At County Road R376 Crossing (Mendon Road)	575	348	700	59	41.718819753	-111.945785515
1/4 mile above Mcmurdie	560	560	560	1	41.568262618	-111.852996987

Creek confluence						
Logan River						
@ 1000 West	416	333	508	12	41.70639899	-111.86222447
above Beaver Creek	269	46	320	23	41.933266592	-111.566328078
Price River						
above Willow Creek (Price River Coal)	489	303	1224	60	39.73473721	-110.87323941
below confluence with White River	442	350	554	39	39.843567679	-110.99711294
Provo River						
at U-114 crossing	428	279	675	88	40.238007289	-111.695202784
at Midway Cutoff Road Crossing N of Heber	211	148	264	94	40.554124082	-111.431578987
San Juan River						
above Lake Powell	633	272	988	35	37.294157998	-110.406798156
at Sand Island	458	100	769	100	37.260278628	-109.613734342
San Pitch River						
above confluence with Pleasant Creek at Farley Property	739	732	746	2	39.568574605	-111.482137092
at River Lane Road crossing	993	260	1985	5	39.364948079	-111.643527331
Sevier River						
at Panguitch Airport Road crossing	406	307	552	14	37.85164008	-112.436035987
above Yuba Reservoir SW of Fayette	1906	1145	3077	61	39.209685652	-111.863264223
Spanish Fork						
about 2.5 miles below confluence with	551	314	737	12	40.04164	-111.54425

Diamond Fork						
above Utah Lake	698	2	1263	87	40.1502589	-111.726981795
Virgin River						
at Hwy 9 crossing W of Hurricane	2770	1425	3543	48	37.162759416	-113.395501092
Below First Narrows & New St. George WWTP	3014	336	4385	67	37.020122035	-113.672715965
Weber River						
above confluence with Lost Creek	776	447	1509	35	41.05938938	-111.539367685
below bridge at Riverdale Road Crossing	723	719	726	2	41.18217	-111.99201

Examples of TDS Ranges in Utah Streams

Summary of TDS concentrations in Utah streams and rivers from Utah's Ambient Water Quality Data Management System (AWQMS) database: https://deq.utah.gov/water-quality/databases-and-information#awqms.

The sampling locations for each river are listed from higher elevation to lower elevation in the watershed demonstrating how TDS concentrations change as the water travels through the watershed.

Sampling Location	Average Value (mg/L)	Minimum Value (mg/L)	Maximum value (mg/L)	# of samples	Latitude	Longitude
Bear River						
Below Salt Creek	66	30	90	14	41.576487471	-112.098061285
East of Woodruff	1526	748	1866	44	41.531608939	-111.133249929
Big Cottonwood Creek						
above Jordan River at 500 W 4200 S	445	276	1360	79	40.679951274	-111.9057651
at Creekside Park	254	154	462	23	40.665070081	-111.845038927

Blacksmith Fork River						
Below Hardware Ranch	4	0	14	7	41.606043268	-111.591323404
Above 1700 S crossing W of Providence	4231	2292	6858	24	41.701774218	-111.842139672
Jordan River						
at 1700 S above drain outfall	1209	58	3876	102	40.733555251	-111.923545039
At 6400 S crossing	184	52	232	60	40.630502	-111.922987
Little Bear River						
At County Road R376 Crossing (Mendon Road)	578	298	834	11	41.718819753	-111.945785515
1/4 mile above Mcmurdie Creek confluence	241	120	344	57	41.568262618	-111.852996987
Logan River						
@ 1000 West	416	333	508	12	41.70639899	-111.86222447
above Beaver Creek	269	46	320	23	41.933266592	-111.566328078
Price River						
above Willow Creek (Price River Coal)	54	14	96	42	39.73473721	-110.87323941
below confluence with White River	740	500	1036	55	39.843567679	-110.99711294
Provo River						
at Midway Cutoff Road Crossing N of Heber	179	124	216	26	40.554124082	-111.431578987
at U-114 crossing	939	288	1586	25	40.238007289	-111.695202784
San Juan River						
above Lake Powell	272	238	308	12	37.294157998	-110.406798156
at Sand Island	1355	144	1880	34	37.260278628	-109.613734342
San Pitch River						

above confluence with Pleasant Creek at Farley Property	885	638	1512	85	39.568574605	-111.482137092
at River Lane Road crossing	63	30	108	14	39.364948079	-111.643527331
Sevier River						
at Panguitch Airport Road crossing	3755	2148	5266	84	37.85164008	-112.436035987
above Yuba Reservoir SW of Fayette	309	14	382	110	39.209685652	-111.863264223
Spanish Fork						
about 2.5 miles below confluence with Diamond Fork	110	32	196	98	40.04164	-111.54425
above Utah Lake	519	284	900	25	40.1502589	-111.726981795
Virgin River						
at Hwy 9 crossing W of Hurricane	222	126	290	33	37.162759416	-113.395501092
Below First Narrows & New t. George WWTP	2723	636	4224	9	37.020122035	-113.672715965
Weber River						
above confluence with Lost Creek	196	114	242	26	41.05938938	-111.539367685
below bridge at Riverdale Road Crossing	2760	610	9584	76	41.18217	-111.99201