

Water Quality Monitoring

Why?

Our water resources are of major environmental, social, and economic value. It is important to monitor because if water quality becomes degraded this resource will start to lose its value. Water quality is significant in protecting public health, providing habitat, and much more. If water quality is not maintained, it is not just the environment that will suffer.

Volunteer monitoring is a very effective tool in protecting our surrounding environment. Water quality monitoring meets the goals in attaining a healthy river and developing growth in the community that is compatible with the environment. The collected data is used to create a database that describes trends, changes, and current conditions within the waters. Continuously and consistently gathering information people in the community become aware and educated about the river. Therefore, unanticipated problems can be addressed allowing for intended water related regulations to be met.

How?

There are a variety of methods and instruments that are used when monitoring and testing water. Currently, our monitoring program consistently examines six commonly used measurements of water quality including: dissolved oxygen (DO), temperature, conductivity, turbidity, pH, and *E. coli*. In the future the program may expand to consistently monitor macro invertebrates and micro invertebrates.

Each parameter measures and extracts different information and therefore gives us an overall assessment on the quality of the water. Thus, in order to understand how we gauge water quality we must understand the parameters and units in which we measure the quality of water. With each measurement we want to attain the best quality data possible. Therefore it is very important that the data collection protocol is precisely and accurately followed. It is important to remember that the Willamette watershed is very large and therefore quite complex with respect to all monitoring parameters.

Who?

Water quality monitoring is popular with watershed councils, riverkeepers, and other stewardship groups. Due to its positive results monitoring has been embraced as a great method for education, surveillance, and research. Our organization, Willamette Riverkeeper, started monitoring water quality in 2001 on the Lower Willamette River. Due to the help of volunteers, we are now going into another year of developing our monitoring program. It is *you*, who understands why we must monitor and how we monitor that keeps our community educated and our rivers healthy for all the different beneficial uses.

PARAMETERS:

Dissolved Oxygen (DO):

Description:

Dissolved Oxygen (DO) is the amount of oxygen that is dissolved in water at a given temperature. Water at a lower temperature has a greater capacity to hold dissolved oxygen, and vice versa. Dissolved oxygen is measured on a weight per volume basis in milligrams per liter (mg/L). Milligrams per liter is the amount of oxygen in a liter, this is a unit of concentration that applies to dissolved material in solution.

Influences:

Dissolved oxygen levels are affected by both natural and unnatural surroundings. As you will see there are many factors that can play apart in altering the results. One major way oxygen becomes dissolved in water is via aquatic plant photosynthesis. Just like all plants, aquatic plants release oxygen into the water as a by-product. Another source is re-aeration, which is caused by any kind of turbulence in the water (i.e. waterfall, rapids). Dissolved oxygen is primarily removed from the water by plant and animal respiration and decomposition of organic material.

There are also daily and seasonal factors that constantly effect DO levels. Morning levels tend to be lowest since plants did not have sun in the previous evening requiring them to respire instead of photosynthesize. Conversely, levels generally peak in the afternoon along with a peak in plant photosynthesis. Seasonally, the cooler months of winter allow for higher levels of DO. In contrast, in the fall, large quantities of dead plant material build up and decompose resulting in a lower level of DO.

Human impacts greatly affect DO levels as well. Runoff fertilizer can support algal growth, leading to large oxygen consumption by plants in the dark hours of the day and a large amount of organic material to decompose when the plants die. Water that is artificially heated through industrial uses is discharged to the river and reservoirs, while also being increased through the natural heating of the sun can raise the overall temperature of the river. Thereby the amount of oxygen that can be dissolved in the water is decreased.

Biological Consequences:

Since access to oxygen is essential for virtually all aquatic organisms, DO is one of the principal parameters used to test water quality. As DO levels in water drop below 5.0 mg/L, the most important species in the river are put under stress. The lower the concentration, the greater the stress with fish kills occurring when dissolved oxygen levels remain below 1-2 mg/L for a few hours. Extreme aeration of the river, under certain conditions (certain types of spillways on dams) can lead to super-saturation of DO and other gasses that can also be harmful.

Methods and Standards:

Willamette Riverkeeper tests DO in the surface water of the Willamette River using the Winkler Titration method. The Department of Environmental Quality (DEQ) standard minimum for DO on the Willamette River is 6.5 mg/L

Conductivity:

Description:

Conductivity is a measure of water's ability to pass an electrical current. Conductivity in water is affected by the presence of inorganic compounds from minerals as opposed to organic compounds derived from organisms. The majority of dissolved solids effecting conductivity are chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). We use conductivity to estimate the Total Dissolved Solids (TDS) in a body of water.

Since conductivity is affected by temperature, we standardize all measurements. This is known as specific conductance (EC25). The reading is automatically adjusted to a calculated value which would have been read if the sample had been at 25 C. Conductivity measurements are recorded in micro Siemens per centimeter ($\mu\text{S}/\text{cm}$).

Influences:

Conductivity is affected primarily by the geology and size of area through which the water flows. As rock and soil erode into a watershed, minerals dissolve and increase the Total Dissolved Solids (TDS), thus increasing conductivity. Heavy rains pouring over larger basins increase runoff and erosion, thus raising the TDS. At the same time large volume of rain can also dilute the amount of TDS and lower conductivity. Vice versa in a dry spell, water evaporates and TDS are left behind resulting in higher conductivity.

Human impacts include discharges from industrial and municipal wastewater plants, road runoff (ice melting salts), agricultural runoff and mine runoff. For example, a failing sewage system would raise the conductivity, while an oil (organic matter) spill would lower the conductivity.

Biological Consequences:

Changes in a river's conductivity can alter and disturb the biological systems within. Significant changes in conductivity can then indicate a discharge or some other form of pollution that has entered the stream. Measuring conductivity can be an excellent source for identifying these inputs. Although extreme readings of conductivity may signify the presence of other toxic substances, we do not have the means to identify the source.

Methods and Standards:

Willamette Riverkeeper tests conductivity with the use of a digital probe. There is no water quality standard for conductivity, but conductivity can be a useful diagnostic tool for interpreting other water quality information. Through past monitoring Willamette Valley and Coast Range conductivities are typically 150 $\mu\text{S}/\text{cm}$ or less. Distilled or deionized water that has been in contact with the air is usually about 1 mhos/cm.

Temperature:

Description:

Probably the most easily measured parameter, temperature is a critical factor influencing several biological and chemical variables within the water. Temperature is measured in degrees Celsius (C).

Influences:

The most obvious natural cause for temperature change is the seasons. However, human disturbance has a great impact on temperature as well. One direct source of human impact is thermal pollution. This is effluent that is a greater temperature than the receiving water body. Thermal discharge is commonly found at municipal and industrial outfalls. Another source of thermal discharge is rainwater running over hot pavement and into streams during the summer months. One major issue affecting the Willamette is deforestation. With the removal of riparian forests the water is exposed to intense sunlight resulting in increased water temperature. Finally, turbidity (suspended particulate in the water column) can increase temperature as particles absorb sunlight.

Biological Consequences:

Temperature has an effect on both chemical and biological activities in water. For example, as water temperature increases the capacity of water to hold dissolved oxygen becomes lower. Water temperature influences the rate of plant photosynthesis, the metabolic rate of aquatic organisms, and the sensitivity of organisms to toxic waste, parasites and diseases.

Many species regulate the timing of reproduction and migration, according to specific water temperatures. Optimal temperatures allow organisms to function at maximum efficiency. A temperature shift of more than 1-2 degrees C can cause thermal stress and shock, making an ecosystem more hospitable to disease, invasive species, and death.

Methods and Standards:

Willamette Riverkeeper measures temperature using the same probe that measures conductivity. The DEQ standard for maximum temperature in the Willamette River is 20 degrees C.

Turbidity:

Description:

Turbidity is defined as the optical property of a sample that causes light to be scattered and absorbed. In theory, the more suspended material exists, the more light scattering (i.e. turbid) and hence, the less transparent. We use turbidity to estimate the amount of sediment being transported in the water column. The greater amount of Total Suspended Solids (TSS) in a sample, the murkier it will appear, and the greater the turbidity. Total Suspended Solids can be clay, silt, sand, and small organic material. It is important to note that turbidity represents TSS more realistically than suspended sediment since sediment does not include organic material. The measurement is reported in Nephelometric Turbidity Units (NTUs).

Influences:

Total Suspended Solids naturally increase after heavy rainfall and during high flow. Unnatural TSS increases can be a result of construction and agricultural activity, municipal and industrial wastewater discharge, runoff from roads and other impervious surfaces, eutrophication, vegetation removal, dredging, channelization, and recreation. To some degree all of the above TSS sources are present on the Willamette River.

Biological Consequences:

The removal, transportation, and deposition of sediment are important features in the life of a river. Features that support foraging, shelter, and breeding for certain organisms are formed by sediment movement. Nutrients and essential minerals are often transported with sediment. Sediment movement can also be detrimental. Fish eggs can be buried in sediment and thus suffocated. Spaces between rocks that are ideal for macro-invertebrate habitation can be filled by sediment. Visual processes of fish and other organisms such as hunting and mating can be hampered by heavy sedimentation. Water darkened by TSS will not transmit sunlight well to photosynthetic aquatic plants. This starts a collapse at the bottom of the aquatic food chain. Instead of transmitting sunlight, turbid water absorbs it and rises in temperature.

Sediment acts as a medium for “sticky” pollutants such as zinc, mercury, lead, and other heavy metals. These toxic pollutants adhere to small particles of sediment and then bioaccumulate on the floor of a water body (essentially permanent) or inside organisms such as insects, fish, and in turn: humans.

Methods and Standards:

Willamette Riverkeeper uses a “bench” turbidimeter which is essentially a portable photometer. The turbidimeter sends a beam of light through the sample and a light meter-like device takes a reading of the amount of light scattered. It is important to note that turbidity is a highly variable measurement, especially in regards to stream flow. Many factors can contribute to turbidity, requiring a large sample size in order to draw conclusions. Although there is not currently a DEQ standard for turbidity, proposals are being reviewed (2005).

pH:

Description

The pH is the measure of the hydrogen ion concentration in water. An ion is an electrically charged atom. Water exists as a balance between hydrogen ions (H^+) and hydroxide ions (OH^-) and has the formula H_2O . The pH scale ranges from 0 - 14 with 7 being neutral. Solutions with a pH over 7.0 are considered basic, solutions with a pH under 7.0 are considered acidic. pH is expressed in Standard Units (su).

Influences

Natural variations in pH are caused primarily by photosynthesis and respiration. A main source of acid in the water column is carbon dioxide (CO_2). Carbon dioxide creates carbonic acid in water and is formed as a result of plant and animal respiration as well as decomposition. Carbon dioxide is absorbed in photosynthesis. As respiration occurs day and night while photosynthesis requires sunlight, we can imagine that there is a daily fluctuation in pH level. Large bodies of water have a natural buffering ability that accounts for localized fluctuations in pH.

Pollution can affect pH directly and indirectly. Direct input of acids or bases from industrial and municipal sources as well as acid rain can cause direct changes to pH which override the buffering capability of water bodies. A pH of 6 and lower has been demonstrated to have a direct toxic effect on fish. Indirectly, high inputs of plant fertilizer can increase pH. Phosphorous, for instance, will increase plant growth and thus photosynthesis. This will remove a greater amount of CO_2 from the water and increase pH. Important nutrients, as well as oxygen, will become insoluble.

Biological Consequences

pH is important because it determines the solubility of nutrients and chemicals in the water. Acidic water dissolves nutrients and chemicals at a greater rate than neutral water. Dissolution of nutrients makes them available to plants and animals. As with any water quality parameter, there is a happy mean for pH. A very low pH may make many nutrients available but it will also corrode organic structures and increase the toxicity of heavy metals by dissolving them. In water bodies with a high pH, nutrients will not dissolve and therefore be inaccessible to flora and fauna.

Methods and Standards

Willamette Riverkeeper uses a calibrated meter with pH probe to measure pH. As pH is affected by temperature, the meter also has a temperature probe. The probe measures pH by passing an electrical current through the water sample that is then converted from voltage to the pH scale by the calibrated meter. The DEQ standard for pH in the Willamette River is 6.5-8.5.

E. coli:

Description

Although the name *E. coli* (*Escherichia coli*) has dreadful connotations, this bacteria is present and serves an important function in all of our digestive systems. Actually, only one strain of *E. coli* is harmful to humans (*E. coli* O157:H7) because it produces fatal toxins (this is the type of *E. coli* that kills people who have visited petting zoos and not washed their hands, also found in ground beef). *E. coli* is used as diagnostic bacteria. Since it is present in the digestive system of most warm-blooded mammals, the presence of *E. coli* suggests that fecal matter is entering the water body. Fecal matter of mammals may contain many other bacteria (giardia, cryptosporidia) that are harmful to humans.

Influences

Two common sources of *E. coli* for the Willamette are combined sewage outfalls and natural draining. Rain events wash the feces of dogs, geese, humans and other animals into the Willamette through these two avenues. Therefore, swimming in the Willamette after a rain event and near an outfall is generally discouraged.

Biological Consequences

Unlike the other conventional water quality parameters, fecal coliform bacteria are living organisms. They do not simply mix with the water and float straight downstream. Instead they multiply quickly when conditions are favorable for growth, or die in large numbers when conditions are not. Because bacterial concentrations are dependent on specific conditions for growth, and these conditions change quickly, fecal coliform bacteria counts are not easy to predict. When fecal coliform bacteria are present in high numbers in a water sample, it means that the water has received fecal matter from one source or another. Although not necessarily agents of disease, fecal coliform bacteria may indicate the presence of disease-carrying organisms, which live in the same environment as the fecal coliform bacteria and have potential to harm humans and other animals.

Methods and Standards

Willamette Riverkeeper uses the Quanti-Tray 2000 Enumeration Test Procedure (IDEXX Laboratories, Inc.) to determine the most probable number (MPN) of *E. coli* in a 100 mL sample. Basically, a 100 mL sample is taken from the river, neutralized for chlorine, and fed a fluorescent marker to aid in identification. After a 24 hour incubation period, the MPN is visible in a Quanti-Tray under a blacklight.

A small amount of *E. coli* will almost always be present in a river like the Willamette and is not necessarily cause for alarm. *E. coli* concentrations over the state DEQ standard (126 MPN for a week or more) should prohibit swimming. It is important to note that *E. coli* is an organism and favorable environmental conditions will allow it to proliferate. Unfortunately, these conditions generally coincide with the summer months when people are more likely to swim.

Flow:

Description

The streamflow, is the volume of water passing a single point in the stream over time. It is measured by determining the cross-sectional area and velocity (speed and direction) of the flowing water. The measurement is usually expressed in cubic feet per second (cfs). One cubic meter per second (m/s) = 1000 liters per second (l/s) = 35.31 cubic feet per second (ft/s) = 264.2 gallons per second

Influences

There are many factors which affect the variation of flow. These include: rainfall and snow melt, land use/land cover, water control structures, water intakes, water discharges and geological characteristics.

Most streams will illustrate annual variation that can be explained by seasonal changes in snowmelt, rainfall, and other factors. For many areas in the country, the lowest flows often occur near the end of the summer or beginning of fall. However, each stream is different and any particular year can be an anomaly in terms of if and when low flows occur. The magnitude and duration of low flows can vary significantly from year to year.

When looking at flow data, a sharp peak in flow can often be an indicator of a large amount of roads, because rainwater is quickly transferred to the stream. A broad peak is an indicator of a lot of wetlands, which capture water and then slowly release it back to the stream.

Biological Consequences

Flow affects the concentration of dissolved oxygen, natural substances, and pollutants in a water body. Low flows typically aggravate the effects of water pollution. Dilution is the primary mechanism by which the concentrations of contaminants discharged from point and some non-point sources are reduced. However, during a low flow event, there is less water available to dilute effluent loadings, resulting in higher in-stream concentration of pollutants. Additionally, winds, bank storage, spring seepage, tributary streams, and the warming effect of the sun have greater impacts on stream water temperatures during low-flow periods. The exaggerated effects of these factors could be additional stressors on aquatic life.

Methods and Standards

Generally, there are no water quality standards for flow. Therefore flow standards are dependent of their specific site. Flow can be measured with meters or gauges. Because we do not have the proper equipment we simply visually monitor the flow and depth of the stream. This is done by taking note of the water level and water current. To do this define a stable marker at you site which you can estimate if there is an influx in depth throughout your monitoring months (bridge pillar, pilings, steam bank). Has it gone up or down since last month and how much? When monitoring current categorize if the stream is moving, and if so, how fast? This will become a lot easier when you are more familiar with you monitoring site.

For a few sites there are USGS gauges located near or at the site. In this case, still take note of the surrounding conditions, but you can also go on-line to check the gauge at you site for the day that you sampled. This information is located on the last page of the manual.

Effects of Parameter Levels on Aquatic Organisms

	DO (mg/L)	Cndt. (μS/cm)	Turb. (NTU)	Temp. ($^{\circ}$C)	pHβ	E.coli (MPN)
Salmon survival/migration	6.0-11.0	n/q	<10 ϕ	5-13 25 (lethal)	6.5-8.5	-----
Amphibians	5.0-12.0	n/q	n/q	n/q	4.5-?	-----
Aquatic plants	5.0-12.0	n/q	n/q	0-32	4.5-?	-----
Macroinvertebrates	5.0-12.0	n/q	n/q	5-25#	6.0-?	-----
DEQ standard*	\geq 6.5	74.5 Ψ	**	\leq 20	6.5-8.5	126
Observed on the Willamette by WRK	5.7-11.9	63-150	.9-57.7	4.9-26.0	6.5-8.2	0-1956

n/q= not quantified.

β =Upper pH limits are not as well documented since they don't occur as frequently as lower pH levels (resulting from acid rain, etc.)

*=This is the Oregon DEQ standard for the Willamette Basin.

**= currently under review.

#=highly variable between types of macroinverts.

Ψ = EPA secondary drinking water standard (EC25 standard does not exist).

ϕ = effect of turbidity on fish depends strongly on duration of exposure (hours, days, weeks).

Sampling

Timing

Water Quality Monitors (WQMs) for WRK are asked to sample their river mile once a month. In a perfect world, we would get data more frequently in order to gain a better understanding of water quality in the Willamette. That way we could reduce the effect of the variability on our data. Without sampling more than once a month, the best way to reduce this variability is to be consistent with time.

Ideally, WQMs will sample between **the 10th and the 20th of each month**. Keeping a relatively consistent amount of time between sampling events will give us a more gradual demonstration of the seasonal changes in parameters, making bizarre results easier to detect.

On the 24 hour level, sampling **between 10a.m.-7p.m.** around the same time of day on each sampling event is ideal. This is because parameters like dissolved oxygen and pH vary throughout the day, lowest just before sunrise and peaking at late afternoon. By sampling around the same time every day, we will eliminate daily variations in our data.

Sampling in the same week each month and the same time each sampling day might make it easier to schedule your sampling and remember to take care of it. However, WRK understands that everybody has a different schedule so all data is accepted (aside from data collected in the dark!).

Reserving a Kit:

When you know the date that you'll be going out in the field, please reserve your kit ahead of time. To do this: call your local contact who has the kit and give them the date and time you'll pick up the kit, remember to sign-out when you pick up the kit and sign-in when you drop it off. It is preferable to return the kit the same day that way other volunteers will have more access to the kit.

Access

WRK believes that the best way to obtain your samples is from a bridge or dock. These are points of public access and you are able to sample from mid-stream in almost any weather conditions, which is what we prefer.

When sampling from a bridge the bucket method is ideal using the Bass-Rectenwald sampler. To retrieve a sample of stream water a weighted bucket is lowered over the side of a bridge. The bucket is weighted on one side allowing for a slight tilt so the bucket can be dipped in to the stream and slowly filled. Once the bucket is filled and brought to the top, the parameters can then be tested.

-1st Lowering of Bucket:

- (1) Initial rinse for the bucket and all sampling containers.
- (2) Dump water out of the bucket,
- (3) Record all necessary data and information.

-2nd Lowering of Bucket:

- (1) Fill **Dissolved Oxygen** sample bottle.
 - Making sure to grab the sample right after the bucket is raised, thus limiting the samples exposure to any contamination (oxygen) that may skew results.
- (2) Grab a sample for **turbidity**.
 - Make sure to grab the sample right after you take the DO sample so that the sediment does not get a chance to settle on the bottom of the bucket. Once you take the sample it can settle in the container as long as you invert/mix the sample before the test.

- (3) Start the **DO** test.
- (4) While you are working on the DO test you can:
 - grab a sample for **pH**.
 - do the **accuracy check** for the turbidimeter
 - perform the **turbidity, conductivity** and **temperature** test.**NOTE:** You can place the conductivity/temperature probe directly into the bucket of water.

-3rd Lowering of Bucket:

(1) Retrieve one more sample of water from stream to perform a **duplicate** on one of the parameters. **NOTE:** All duplicate samples must be taken from a different bucket load. You cannot take two grab samples for the same bucket of water, you must perform another lowering to retrieve a different sample from the stream in order to call it a “duplicate.”

If there is not a bridge at your sampling site the next best way is via a boat dock or a human powered craft (i.e. kayak, canoe, drift boat, etc). If you prefer to use a canoe but don't have one (you must have sufficient canoe experience) contact WRK. These are the ideal access points so please remember that we do not sample from the shoreline as several parameters will be greatly affected by shallow, slow moving water.

Quality Control

It is important to remember that our data is only meaningful if it is acquired using calibrated equipment with the proper technique. There are several steps we take to ensure quality in our results including calibration, accuracy checks, and duplication. Calibration is performed on the pH meter while accuracy checks are performed upon the turbidimeter and conductivity meter. Calibration and accuracy checks must be performed for each sampling day to ensure that the equipment is functioning properly. Duplication is simply testing a parameter twice. It is recommended that you have one duplicate for every ten samples. To simplify this, WRK recommends that you duplicate one parameter every sampling day. Please duplicate a different parameter each time (yes, even dissolved oxygen). If you find a considerable difference between your first sample and your duplicate, you may infer that something is amiss with your sampling technique or conditions.

DEQ lends us the water quality monitoring equipment with the understanding that we will provide data that can be considered “level A”. Level A data is submitted to the DEQ water quality database and can be used as historical information and in court. WRK can use this data for investigating pollution sources and general trends in water quality. So when removing fingerprints from a sample cell, checking accuracy on the conductivity meter or making sure there are no air bubbles in the DO bottle- remember that proper technique and use of the equipment gives us confidence in the accuracy of our results. Also remember to record all accuracy results in both the field notebook and Data sheet to ensure all information is recorded.

If you can't sample

It happens. If you become a WQM, WRK will provide you with a contact list for other WQMs who sample nearby. This way you will have a network of folks who can help you out. If that doesn't work, WRK can take care of your sample. Whoever does take your sample for you must first attend a WRK training.

Hopefully, you will never be limited in your sampling due to a lack of reagents or an equipment malfunction. If you notice a problem or shortage of supplies (including batteries), please contact WRK.

Safety Considerations:

Emergency Phone Number: Willamette Riverkeeper: 503.223.6418

Basic Safety Rules:

Develop a safety plan:

- Find out the location and telephone number of the nearest telephone
Locate the nearest medical center and write down directions on how to get between the center and your site(s) so that you can direct emergency personnel.
- Have each member of the sampling team complete a medical form that includes emergency contacts, insurance information, and pertinent health information such as allergies, diabetes, epilepsy, etc.

At the site:

- Monitor with at least one partner.
- Always let someone else know where you are, when you intend to return, and what to do if you don't come back at the appointed time.
- Have a first aid kit handy.
- Listen to weather reports. Never go out if severe weather is predicted.
- Never wade in swift or high water.
- If you drive, park in a safe location. Be sure your car doesn't pose a hazard to other drivers and that you don't block traffic.
- Put your wallet and keys in a safe place.
- Never cross private property without the permission of the landowner. Better yet, sample at public access points such as bridge or road crossings or public parks.
- Confirm that you are at the proper site location by checking maps, site descriptions, or directions.
- Watch for irate dogs, farm animals, wildlife (particularly snakes), and insects. Watch for poison ivy, poison oak, and other types of vegetation in your area that can cause rashes and irritation.
- Never drink the water in a stream. After monitoring, wash your hands with antibacterial soap.
- Do not monitor if the stream is posted as unsafe for body contact. If the water appears to be severely polluted, contact your program coordinator.
- Do not walk on unstable stream banks. Disturb streamside vegetation as little as possible.
- If you are sampling from a bridge, be wary of passing traffic. Never lean over bridge rails unless you are firmly anchored to the ground.
- Avoid contact between chemical reagents and skin, eye, nose, and mouth.
- Wear safety goggles/gloves when performing any chemical test.
- Keep all equipment and chemicals away from small children.

If at any time you feel uncomfortable about the condition of the stream or your surroundings, stop monitoring. Your safety is more important than data!

Basic Field Equipment Check List:

Some of this equipment is optional but will enhance your safety and effectiveness.

- Field data sheet
- Monitoring equipment and materials
- Watch
- Note book
- Clipboard
- Several pencils/waterproof pens
- Information sheet with safety instructions, site location information, and numbers to call in emergencies
- Camera and film, to document particular conditions
- Boots or waders; life jackets if you are sampling by boat
- Walking stick of known length for balance, probing, and measuring
- Bright-colored clothes; long sleeves and pants are best
- Rubber gloves to guard against contamination
- Insect repellent/sunscreen
- Small first aid kit, flashlight, and extra batteries
- Whistle to summon help in emergencies
- Refreshments and drinking water

Dissolved Oxygen

Equipment List

Dissolved Oxygen Kit containing:

- glass sample bottle with lid
- plastic volumetric flask (round bottom and thin neck)
- funnel
- 3 boxes of reagents
- Starch indicator
- Digital Titrator
- Several delivery tubes
- Thiosulfate cartridge
- Scissors

Items you will need from the sampling box:

- Glass erlenmeyer flask (flat bottom with triangular shape)
- Distilled water
- Waste jar
- Gloves

Considerations:

Dissolved oxygen levels vary with time of day, lowest just before sunrise and peaking at late afternoon. Aerated or turbulent water will have a greater level of DO than still water. Summer levels of DO will generally be lower than winter levels.

How to Collect a Sample:

Step I.

Collection and Preparation:

- a. Rinse the glass sample bottle in the water to be sampled---slowly submerge, avoiding bubbles “glugging” through the neck of the bottle. Fill to ~1/4 inch from the top to avoid losing any reagents when you cap the bottle.
- b. Add the contents of 1 powder pillow of Manganous Sulfate (long and skinny packet) and 1 powder pillow of Alkaline Azide (short and stout packet).
- c. Avoiding sealing in any bubbles, close with the glass stopper and mix vigorously for 15-20 seconds, try to dissolve reagents in solution
Note: A flocculent precipitate (a cloudy substance) will form in the sample (brownish-orange if oxygen is present, white if oxygen is absent.) Some of the powdered reagents may not have completely dissolved – this is normal.
- d. Allow the sample to stand until the “floc” has settled approximately one-third of the way to the bottom of the bottle.
- e.
- f. **REPEAT** the vigorous mixing for 15-20 seconds. Allow the sample to stand until the floc settles a second time.

- g. After the floc has settled again, remove the glass stopper and add 1 powder pillow of Sulfamic Acid. Replace the glass stopper and mix vigorously 15-20 seconds. **The sample should turn a clear amber color.**

Step II.

Titration:

- a. Remove the glass stopper and fill a clean 200 mL volumetric flask with a sample (use funnel if needed). Transfer this 200 mL portion to a 250 or 500 mL Erlenmeyer flask that has been rinsed with distilled water.
- b. Clean a delivery tube with distilled water. Insert clean delivery tube into the sodium thiosulfate delivery cartridge.
- c. Insert sodium thiosulfate cartridge into the titrator and lock into place.
- d. Lower the titrator plunger gently until it contacts the sodium thiosulfate cartridge.
- e. Turn the delivery knob to eject a few drops of sodium thiosulfate (titrant) and clear any air bubbles in the tube.
- f. Reset the counter to zero and.
- g. Place the delivery tube tip into the sample. Turn the delivery knob clockwise to add titrant to the sample. **Note: swirl the flask while adding titrant to make sure it mixes.** This can take several hundred drops so **at first** you can add one hundred at a time, just make sure to swirl the flask. As you continue to add titrant, lessen the amount added between swirls. The sample will gradually turn a pale yellow color.
- h. Once the sample is pale yellow, the endpoint of the titration is approaching. Add a 1 mL dropper of Starch Indicator Solution and swirl to mix. **A dark blue color will develop.**
- i. Continue the titration until the sample turns from blue to colorless. As the sample approaches light blue, *slowly* add the titrant, this means you are nearing the endpoint! **Be careful to not overshoot the endpoint.** Hold a white piece of paper behind the flask for comparison if necessary.
- j. Record the number of digits on the Digital Titrator's counter. Multiply the number on the counter by 0.01 (move decimal over 2 places). The result is the sample DO in mg/L. Record this reading on the data sheet.
- k. Disassemble the tritrator and flush the delivery tube with distilled water.
- l. Dump your extra sample and tritrated sample into the waste jar, not the river.

Conductivity and Temperature

Equipment List

Things you will need from the sampling box;

- 1 Conductivity/Temperature Probe
- Distilled water
- Plastic beaker

Considerations

Make sure that you are measuring specific conductance rather than conductance at a given temperature (see 4 below). Conductivity will be affected by significant rainfall. Temperature measurements taken in shallow, slow moving water at the edge of a river will often be warmer than the main body of water. **Do not sample from shore.**

How to Collect a Sample:

- a. Turn on the meter and rinse the probe in distilled water.
- b. Rinse the probe with the water sample.
- c. Put the probe directly in the water body. Submerge to 3 feet, which is marked on the cord with a band of duct tape. (If the water is moving fast, pour about 125 ml of a sample into a clean plastic beaker and immerse the probe. Make sure the probe is fully submerged.)
- d. Set the meter to display the blinking °C and conductivity in $\mu\text{S}/\text{cm}$ by pressing the mode button.
- e. Agitate the probe in the solution, but do not allow probe to contact the walls of the container.
- f. Record the solution temperature and conductivity in the notebook when the reading is stable.
- g. Rinse the probe with distilled water, then dry and place in storage cavity.

Turbidity

Equipment List

1 Turbidity Kit containing;

- Turbidity meter-always use on level, stationary surface
- Box containing 3 gel standards and 3 empty cells
- Oil
- Cloth
- Notebook
- Nalgene bottle, small w/ lid

Considerations

Human recreation disturbs sediment and increases turbidity. Turbidity is usually greater in shallow water. If possible, sample from mid-stream. Significant rainfall greatly effects turbidity.

Accuracy Check

1. Clean gel standards with cloth and oil if needed
2. Holding from the lid to avoid fingerprints on glass, place the first Standard (0-10 range) in the cell compartment of the meter with the white diamond on the vial aligning with the orientation mark on the meter. Close the lid.
3. Press power. Be sure the automatic range is set and the display shows “AUTO RNG.” If not, set by pressing the “RANGE” key until displayed. Press “READ.” The display will show “----- NTU”.
4. Record the NTU value in the notebook and data sheet. If the reading is not within 5% of the Standard ($(\frac{|\text{reading}-\text{standard}|}{\text{standard}} \times 100)=\text{Percent Difference}$), clean the standard and try again. If it is still off, contact Willamette Riverkeeper.
5. Repeat this procedure with the remaining two Standards (0-100 and 01-1000 ranges).

Sample Measurement

1. Collect a sample in a plastic beaker or bottle by submerging your arm to your elbow. If you are measuring more than 10 minutes after collecting the sample, be sure to gently invert the sample container to re-suspend the sediment. Do not shake as this will introduce NTU-altering air bubbles. Fill one of the glass sample cells to the white line.
2. Wipe the bottle with a soft, lint-free cloth to remove water spots and fingerprints. Beware of fogging cells in cooler weather.
3. Holding from the lid, place the sample cell in the cell compartment of the meter with the white diamond on the vial aligning with the orientation mark on the meter. Close the lid.
4. Press power. Be sure the automatic range is set and the display shows “AUTO RNG.” If not, set with the “RANGE” key until displayed. Press “READ.” The display will show “----- NTU”. Record the value and clean the sample cell.

pH

Equipment List

- Orion 210A pH meter with temperature and pH probes
- pH 7 and 10 buffers
- pHisa ionic strength buffer
- 1 mL syringe
- distilled water squirt bottle
- spare containers for pH buffers
- sample container
- filling solution
- 9 V battery

Considerations:

Please **do not** set down probe, it is very fragile. Only place in solution or its storage container. Please do your best to **conserve** buffer!

Calibration

- 1) Ensure that there is no crystal build-up on the inside of the pH probe and that the filling solution is within one inch of the vent.
- 2) Place battery in the pH meter. The meter runs through batteries quickly!
- 3) Expose the vent by removing the plastic cover or plug. Expose the temperature probe by removing the black plastic cap.
- 4) Rinse the pH and Temperature probes with the distilled water
- 5) Then rinse both probes with the pH 7 buffer. Place both probes in a small container of pH 7 buffer filled to 1-2 inches. Turn on the probe on (press power), the screen should automatically say “measure.” At this point **record** the temperature of the pH 7 buffer in the pH log book.
- 6) Press the mode until the screen reads “calibrate 7-4”. Press the no button until the screen reads “calibrate 7-10” and then press yes. The screen will display “P1 ATC” along with a reading.
- 7) Swirl the probes for several seconds and hold away from the walls of the container. When meter beeps and displays “ready” record the pH reading and press yes. The screen will display “P2 ATC”.
- 8) Repeat the probe rinse with distilled water followed by pH 10 buffer. Place both probes in a small container with 1-2 inches full of pH 10 buffer and swirl. When meter reads “ready”, record the pH reading and press yes. **Note:** the slope will appear briefly on the display, be prepared to record!
- 9) Record the slope value that is *briefly* displayed (should be close to 100%). The meter will automatically go to the measure function. At this point you can record the temperature of the pH 10 buffer.

10) Make sure to record both theoretical value and the tested value. Theoretical value can be found on the side of each pH bottle in the column labeled “calculated pH” and at the bottom of this page. Match up the resulting temperature as best as you can and record the corresponding pH value in the log book. Do it for both pH 7 and pH 10.

NOTE: If calibration is not successful. Start over from the beginning. This instrument can be fickle, but should work if you’re persistent.

Sample Measurement

- 1) If you must wait a long period of time before testing the pH of your sample, keep sample sealed and cool.
- 2) Turn on pH meter. It will automatically go to the “measure” function.
- 3) Rinse the pH and temperature probes with distilled water and place in the sample. Swirl for several seconds. Do not let the probe touch the walls of the container.
- 4) When the screen displays “ready” record the pH value and the sample temperature. If your sample is cold or the probe is old, it might take a long time for the meter to get a reading. Stirring the probes for a longer period of time might help. On the first “ready” swirl the probe more to be certain. Wait until the numbers are relatively stable after every swirl.
- 5) Remove the battery by opening the battery cap with the quarter inside the kit.

THEORETICAL VALUES FOR pH

pH 7.00 Buffer

<u>°C</u>	<u>pH</u>
0	7.12
10	7.06
20	7.02
25	7.00
30	6.99
35	6.98
40	6.97
60	6.98
80	7.04
90	7.09

pH 10.00 Buffer

<u>°C</u>	<u>pH</u>
0	10.31
5	10.23
10	10.17
15	10.11
20	10.05
25	10.00
30	9.95
35	9.91
40	9.87
45	9.84
50	9.81

WATER QUALITY SAMPLING FIELD DATA SHEET

Forms must be submitted within **7 days** of sampling.

Site ID/River Mile/Name:	Sample Date:
Monitor Name:	Time (24 hr time):

Please record the ACCURACY CHECK in the log book and here on the data sheet

CALCULATION: ((reading-standard)/standard) x 100 = Percent Difference (PD)

Turbidity Standard Rang	Standard	Reading	Difference	PD
Turbidimeter 0-10				
Turbidimeter 0-100				
Turbidimeter 0-1000				

pH accuracy check and Calibration

(If you're not doing pH in the field you do not need to fill this out.)

pH Std.	Temp	Reading	Theoretical pH	Slope
7				
10				

Duplicate a different parameter each sampling day.

Parameter	Kit/meter ID	Result	Duplicate	Comments:
pH				
Dissolved Oxygen (Mg/L)				
Temperature (°C)				
Conductivity (µS/cm)				
Turbidity (NTU)				

FLOW: (high, low, fast, slow, check gauge (if there's one at your site or on the internet)):

WEATHER CONDITIONS:

Current conditions (rainfall, temperature, wind, overcast, clear):

Past/Recent significant weather (when was it, how long did it last):

COMMENTS (unusual results, surrounding conditions, anything worth noting):

Please use the back of the sheet if necessary.

Monitor Signature: _____ Date: _____

Reviewer Name: _____ Signature: _____ Date: _____

Data Reporting

Results are to be recorded on the data sheet above. This report form can be dropped off or mailed to the WRK office. Some day this form will be available for online submission. Until then, it is acceptable to submit data as an email to WRK as long as all the above information is included. An electronic version of this form is available from WRK. When you adopt a river mile for water quality monitoring, you will be assigned a site ID along with river mile and name.

Please remember to include the ID number of the kit for each parameter. This allows us to track data recorded by a piece of equipment that is faulty. It is recommended that you duplicate a different parameter each sampling day.

See the table at the end of the parameter background section of this manual for parameter values that have been observed by WRK. If in the course of your testing, you get values well outside of these bounds, duplicate the test. If the results are still abnormal, consider possible causes of these values and write them in the designated section at the bottom of the form. In addition, please answer the weather related questions on the form. Weather can have a significant effect on all parameters.

Any problems, concerns, or relevant factors may be reported in the “Notes” section. Be sure to sign and date your forms so that we know that a pirate water quality monitor is not submitting bogus data in your name.

Focused Studies

If you have a specific question that can not be answered by monthly sampling and are willing to put in the effort to seek out an answer, WRK may be able to help. Given a meaningful investigation and well-planned design we may be able to provide you with resources, logistical assistance and advice.

For instance, say you wanted to investigate E. coli levels in relation to significant rainfall. WRK could provide you with sampling and analysis equipment, information about where to sample, watercraft to reach the sampling, and an overall sampling plan. You would receive direct assistance from the water quality coordinator in the field, lab, and in front of the computer. As we have a small staff, we are excited about opportunities like these to gain more information about the Willamette. Results may also influence our actions on river management decisions.

There are many opportunities on the Willamette for independent studies using any and all of the parameters. All you need is a creative, well thought out question. Start by asking yourself, What aspect of water quality on the Willamette is most important to me?

A Final Note

Whatever your level of participation in water quality monitoring, Willamette Riverkeeper greatly appreciates your help. Volunteer WQMs broaden our survey of water quality in the Willamette River. With your help Willamette Riverkeeper will monitor the health of the Willamette, attend to problem areas, and influence river management decisions. It wouldn't be possible without volunteers!

Water Quality monitoring related websites:

<http://or.water.usgs.gov/>

daily stream flow data, technical publications (whole section for the Willamette), and tons more information than you can handle.

<http://waterontheweb.org/under/waterquality/index.html>

-good intro to the parameters featuring cool figures and pictures as well as some case studies.

<http://www.deq.state.or.us/wq/>

-water quality info, TMDLs for the Willamette, DEQ standards, crazy maps, DEQ water quality database (our data eventually goes here).

<http://www.pesticide.org/default.htm>

pesticides used in the Willamette Valley and our backyards make their way into the Willamette and bio-accumulate in sediment, fish, and other organisms. Learn about pesticides here.

<http://www.scorecard.org>

find out about polluters on the Willamette and in your home town.

<http://www.willamette-riverkeeper.org>

look for water quality information here some day! Become a member! Come on Paddle Oregon! Look for pictures of yourself!

Contact Willamette Riverkeeper

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