



# Willamette Riverkeeper 2011 Volunteer Monitoring Manual

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# Water Quality Monitor Position Description

## **Supervisor**

Willamette Riverkeeper Water Quality Program Coordinator (WQC)

## **Description of Program**

Willamette Riverkeeper seeks to collect accurate data to evaluate specific water quality questions and gain an understanding of general water quality trends over time on the Willamette and its tributaries. Volunteer Water Quality Monitors (WQMs) are assigned a site on the Willamette or one of its tributaries to monitor once a month. Sampling is conducted by lowering a bucket off a bridge or taking samples from a dock.

Each volunteer in the Water Quality Program is trained to test for temperature, pH, dissolved oxygen, conductivity, and turbidity.

## **Time Commitment**

Volunteers typically spend between 2-3 hours each month sampling. Time spent may vary depending on your level of experience with the tests and the amount of time you need to drive to pick up the kit and to your sampling site.

## **Volunteer Responsibilities**

1. Commit to at least one year of sampling.
2. Attend a Willamette Riverkeeper Water Quality Monitoring training.
3. Maintain skills and good technique through annual refresher trainings.
4. Perform water quality testing at your assigned site once a month between the 10<sup>th</sup> and the 20<sup>th</sup>.
5. Always follow the Riverkeeper Water Quality Monitoring protocol given in this book and in the monitoring kit.
6. Let the Water Quality Coordinator know ASAP if you cannot sample for the month (preferably by the first of the month), or intend to leave the program (a few months' notice would be much appreciated).
7. Complete required quality control measures (e.g. take duplicate samples regularly).
8. Submit data to Willamette Riverkeeper within a week of sampling.



# About Riverkeeper and the Monitoring Program

## ***Willamette Riverkeeper's Mission***

*To make the Willamette River Watershed healthy for fish and wildlife, and safe for fishing and swimming, forever and for all.*

## ***The History of WRK's Monitoring Program***

Willamette Riverkeeper's water quality monitoring program has evolved and expanded through the years. Our organization began monitoring water quality in 2001 on the Lower Willamette River, mainly in the Portland area. In 2005, when WRK gained their first AmeriCorps member, the program really took hold, and data quality was improved.

Previously, samples had been taken from a boat, and the exact sample location was hard to replicate. Sites were subsequently designated at bridges and docks to maintain consistency. Each site was selected based on the following considerations: ease of sampling regardless of flow volume, representativeness of conditions in a specific area, proximity to industrial discharges, and proximity to the mouths of tributaries. In addition to monthly monitoring of physical parameters, WRK volunteers also monitor bacteria levels at popular recreation sites in the summer.

The program expanded in 2006 to include sites in and near Wilsonville, Salem, Albany, Corvallis, and Eugene. Currently, the monthly monitoring program consists of 37 sites and approximately 90 volunteers. The program is supported by the Oregon DEQ (Department of Environmental Quality), which provides training, equipment, and long-term data management and analysis. Volunteers provide WRK and DEQ with quality data.

Volunteer monitors play a key role in helping us to fulfill our mission, to make sure the Willamette River is clean and healthy for all its beneficial uses.

## ***Why Monitor Water Quality?***

Sometimes it is hard to see how Water Quality Monitoring is directly related to helping our environment and community. When we are out in the field following protocols and writing down a bunch of numbers, we can feel removed from the task of actually cleaning up the river.

It is important to remember that our water resources have environmental, social, and economic value and that by measuring a few key parameters we are tracking the degradation or enhancement of this resource. Once we have collected our measurements we can utilize the data to significantly protect human and habitat health. Each parameter provides us with different information about the quality of the water. By combining and comparing the data from different parameters, we can assess the overall quality of the water. Often, we cannot single out specific sources or pollutants based on the parameters that we monitor alone. However, the information we collect *can* indicate where there may be larger issues that should be researched in greater detail. For example, the data we gather sometimes indicates that state or federal water quality standards are not being met – something that we need to know in order to improve the effectiveness of these protections. By collecting continuous and consistent data, we can also describe trends in water quality. The data could also be used as a starting point to ask or answer specific



questions, such as “what are the fluctuations in and causes of high turbidity at the mouth of the Molalla River?”

Public agencies don’t have the resources to monitor everywhere, and volunteer monitoring is a way to fill those data gaps. Volunteer monitoring is a very effective tool for keeping track of our surrounding environment, and studies have shown that volunteer-collected data can be of comparable quality to professionally-collected data.

Once collected, our data will be made available to the community so that the public has an opportunity to become more aware of water quality issues. Water Quality Monitoring is one step in the process of encouraging community growth that is compatible with the surrounding environment.

Water quality monitoring is popular with watershed councils, Riverkeeper organizations, and other stewardship groups. Due to its positive results, monitoring has been embraced as a great method for education, surveillance, and research.

### ***Water Quality Program Contact***

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Water Quality Program Coordinator

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Webpage: <http://www.willamette-riverkeeper.org/WRK/waterquality.html>

### **Thank You!**

Whatever your level of participation in water quality monitoring, Willamette Riverkeeper greatly appreciates your help. Volunteer Water Quality Monitors help to broaden our knowledge 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! Thanks so much!!!



## Monitoring Procedures

Currently, our monthly monitoring program examines five commonly used indicators (or parameters) of water quality: dissolved oxygen (DO), temperature, conductivity, turbidity, and pH.

### *Timing of Sampling Sessions*

WQMs are asked to sample their site once a month between **the 10<sup>th</sup> and the 20<sup>th</sup> of each month** and **during daylight hours**.

The parameters we measure naturally vary widely by time of day and by season. These natural variations present a challenge when we compare data from different times of day and different seasons.

WQMs can help improve the usefulness of our data by consistently choosing dates and times each month that are similar. Keeping a relatively consistent amount of time between sampling events (e.g. always sampling between the 15<sup>th</sup> and 17<sup>th</sup>) gives us a more gradual demonstration of seasonal changes in parameters. Sampling at the same time each month makes it easier to aggregate and compare monthly results. Collecting more frequent data is one way to reduce variability, but without sampling more than once a month, the best way to reduce variability is to be consistent with the timing of sampling. That said, we understand that your schedules are also variable – so all data is accepted and used (aside from data collected in the dark!)

### *Reserving an Equipment Kit*

Google Calendar, accessed by the internet, is the preferred method for reserving a kit. The calendar is easy to use and the WQC is happy to walk you through it!

- Please reserve the kit as soon as you know the date that you'll be going out in the field, but at least 48 hours in advance. This will give your Lead Volunteer (or LV, the "keeper of the kit") time to prepare the kit for sampling and ensure that you have access to it. If you need to make a reservation less than 48 hours in advance, please contact your LV directly to make sure the kit will be available. Tip: Scheduling earlier in the monitoring window helps to avoid a "crunch" at the end.
- Make one reservation for the entire time that the kit will be in your possession (for example, make a separate reservation on both days if you will be picking up the kit at night to sample the next day). This will prevent scheduling conflicts!
- Double check to make sure that all the information is correct and that **your reservation appears on the WRK monitoring calendar (This is very important! If you accidentally reserve on your personal calendar, the LV won't be able to see your reservation and you may find the kit unavailable when you go to pick it up – so double-check).**



## Accessing Google Calendar

1. If you do not have a Google account, you will need to create one:
  - Go to [www.google.com](http://www.google.com) and click on "sign in" in the upper right hand corner of this page.
  - This will bring you to the Google Accounts page. Click on "Create an account now" in the bottom right hand corner.
  - Fill out the required fields for current e-mail address and name. Then, click on "Create account" at the bottom of page. You should get a confirmation screen.
  - Wait a couple minutes and check your email with the address you used to access your Google account. You should receive a confirmation email to activate your account. You must verify this information by clicking on the link in this email. After you confirm using the link, log back into your account.
2. Phone or email the WQC to confirm that you have successfully set up your Google account. The WQC will give you access to the monitoring calendar.
3. Go to <http://www.google.com/calendar> sign in to your account, and find the monitoring calendar.
  - In the bottom left hand corner of the page you should see one calendar under the "My Calendars" list – this is your own personal calendar. You should see another calendar under the "Other Calendars" list – this is the "<your city's name here> Monitors" calendar. You can turn each calendar's display on and off by clicking on the name – highlighted calendars are currently on.
  - **If you don't see the monitoring calendar, call or email the WQC.**

## Making a Kit Reservation

1. Go to <http://www.google.com/calendar> and sign in to your account.
2. Turn on (highlight) the "<your city's name here> monitors" calendar.
3. Make sure the kit is not already reserved during the time you'd like to use it.
4. Click on the down arrow to the right of the "<city> monitors" calendar. From the menu that appears, choose "create event on this calendar".
5. Enter your name and site name into the box that currently says "Click to Add Title".
6. Make adjustments to the date and time as necessary by clicking on the boxes and selecting from the drop down menus that appear.
7. Click "Save".
8. Make sure your event appears on the correct calendar. It is important to create events on the monitoring calendar rather than your personal calendar. You can check this by clicking on your event and looking at the box labeled "Calendar". It should say "<your city's name here> Monitors". If it doesn't, use the drop-down menu to select it. **This is the only calendar that your LV and other monitors in your region will be able to see.**
9. To edit or delete an event, click directly on the event and you will see a link to each option in blue. Be sure to click SAVE if you have adjusted the reservation.



## ***If You Can't Sample***

It happens. If you are unable to sample please contact the WQC or your Lead Volunteer as soon as possible so that they can arrange for site coverage.

## ***Site Access***

All of our sites are located at a bridge or a dock. These are points of public access which allow us to sample from mid-stream or at least part way into the river in almost any season.

If your site is located at a State Park or somewhere which requires a vehicle pass, the fee will normally be waived for water quality monitors. Let them know what you are doing and that we are a non-profit organization. If they insist on payment, contact the WQC and we will reimburse you.

When sampling from a bridge, a metal weighted bucket is lowered over the side of a bridge and the parameters are tested from the sample water. Please use extreme caution when testing at a bridge and never tie the rope to yourself.

## ***Quality Control***

Our data is only meaningful if it is of "known quality". This means that each result is accompanied by information about the accuracy of our equipment and consistency of our technique. We measure data quality using three general categories: **representation**, **accuracy**, and **precision**.

The Oregon Department of Environmental Quality (DEQ) lends us our water quality monitoring equipment with the expectation that we will provide data of known quality. Every 6 months, a batch containing all data collected during that time is submitted to the DEQ LASAR water quality database, and each result is assigned a grade based on its level of **accuracy** and **precision**. Quality control is vital because the quality level of our data helps determine what purposes DEQ and other agencies can use it for. High quality, or "A-level" data, for example, can be used to influence regulations and for inclusion in technical reports. So when removing fingerprints from a sample cell or making sure there is no air in the DO bottle, remember that proper technique gives us confidence in the quality of our results.

### **Representation**

Representation means that our sites have been selected so that our results reflect the overall condition of the waters we would like to test. For example, we don't test from the riverbank because our results wouldn't represent the quality of most of the water in the stream. If you ever have to sample from a different spot than usual, always note the change on your datasheet.

### **Accuracy**

Accuracy is a measurement of how close our results are the actual value of the sample we've taken. It essentially means that all of our meters are giving correct readings. To ensure this, our LVs perform regular accuracy checks and calibrations on all of the computerized equipment that we use.



## **Precision (Duplicate and Split Samples)**

Precision measures the variation in our sampling technique or variation in conditions at a site. WQMs are largely responsible for ensuring the precision of our data by performing “duplicate samples” and “split samples.”

### **Duplicate Samples**

To take a duplicate sample, simply take a second sample from the stream (or a whole new bucketload if sampling from a bridge) and perform the test or tests a second time, in exactly the same way as you did for the first sample. By comparing the regular sample results with duplicate sample results, DEQ assigns precision “grades” to each WQM’s data. For example, if you measure pH twice and obtain a 7.53 reading and a 7.83 reading, your precision grade for pH would be an “A”. However, if you obtained a 7.53 and a 7.84, you would have a “B” grade (see the charts on the next page for the grade assignments, an example, and an explanation of what the grades mean).

You don’t need to duplicate every parameter every time you sample. However, you do need to duplicate each parameter at least once every 6 months. Duplicating all parameters during the same sampling session is best – it helps WRK and DEQ to gauge data quality and makes tracking duplicate samples easier. However, if you don’t have time to duplicate all samples at once, it is acceptable to duplicate parameters during different sampling sessions.

Precision grades are assigned to each individual – however, if you sample with a partner or partners, then any duplicates you perform together will be counted for both of you. If you typically sample alone, you should complete duplicates for all parameters individually (even if you have a partner at your site).

**If you receive below a “B” grade for any duplicate, you should redo the duplicate next time you sample to raise your grade. If you receive a “B” grade and want to try for an “A” grade, you may also redo the duplicate next time you sample. The WQC will update you halfway through the six-month period to let you know which duplicates you need to perform.**

### **Split Samples**

“Split samples” (performed once each year) are similar to duplicate samples, but they measure variation between two monitors rather than variation in the technique of a single monitor. Two monitors do a split sample by performing tests side by side, using water from a single bucket draw. The WQC or a Lead Volunteer will schedule your split sample and join you in the field. This split sample session will double as an annual “recertification” training, giving us a chance to see that everyone is performing tests in the same way and giving you a chance to ask questions and receive feedback about your work. You don’t need to wait a year – feel free to request a split sample session at any time you feel like you could benefit from one.



## Data Quality Grades for Precision (Duplicate Samples)

Grade	Difference Between Result and Duplicate Result				
	Temperature	pH	Dissolved Oxygen	Conductivity	Turbidity*
<b>A</b>	≤ ± 0.5°C	≤ ± 0.3	≤ ± 0.3	≤ ± 10%	≤ ± 5%
<b>B</b>	≤ ± 2.0°C	≤ ± 0.5	≤ ± 1	≤ ± 15%	≤ ± 30%
<b>C</b>	> ± 2.0°C	> ± 0.5	> ± 2	> ± 15%	> ± 30%
<b>D</b>	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data
<b>E</b>	No Precision Checks	No Precision Checks	No Precision Checks	No Precision Checks	No Precision Checks

\*There is an exception to the 5% rule for turbidity: if results are < 20 NTUs, a difference ≤ ± 1.0 NTU results in an A grade.

### An Example:

Parameter	Result	Duplicate	Difference	Outcome
pH	7.5 SU	7.8 SU	.3 SU	"A" Grade: good job!
DO	10.7 mg/L	10.2 mg/L	.5 mg/L	"B" grade: consider doing another DO duplicate next month to get your data up to "A" level
Conductivity	110.6 μS	110.0 μS	.54%	"A" Grade: good job!
Turbidity	7.4 NTU	5.4 NTU	31.25%	"C" Grade: unacceptable by DEQ -- definitely redo this duplicate next month!

To calculate the "% difference" for conductivity and turbidity, use this formula:

$$\% \text{ difference} = ((\text{Result}-\text{Duplicate})/(\text{Result}+\text{Duplicate}/2))*100$$

### What the Grades Mean

- A:** Data is of known high quality and can be used for all purposes, including regulatory
- B:** Data is of known but lesser quality; it may be used for some purposes but not others
- C:** Data is known to be of unacceptable quality and is considered unusable for most purposes
- E:** Data quality is unknown or known to be poor; data is unusable except for educational purposes (this grade is assigned when accuracy checks haven't been done at all)



## ***Safety Considerations***

### **Develop a safety plan**

- Find out the location and telephone number of the nearest telephone. Locate the nearest medical center and write down directions from it to your site(s) so that you can direct emergency personnel.

### **At the site**

- 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 and animals.
- Try to monitor with at least one partner.
- Always let someone 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.
- Confirm that you are at the proper site location by checking maps, site descriptions, or directions.
- Watch for 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 soap.
- Do not monitor if the stream is posted as unsafe for body contact. If the water appears to be severely polluted, contact the WQC.
- Do not walk on unstable stream banks.
- If you are sampling from a bridge, be wary of passing traffic. Never lean over bridge rails.
- Wear the orange safety vest if you are on or near a road.

**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**

These optional items aren't strictly required but may enhance your safety and effectiveness. Everything else you will need will be provided in the monitoring kit.

- Watch (a watch or cellphone with a stopwatch feature is strongly recommended)
- Notebook
- Camera and film, to document particular conditions
- Walking stick of known length for balance, probing, and measuring
- Brightly-colored clothes; long sleeves and pants are best
- Insect repellent/sunscreen
- Small first aid kit, flashlight, and extra batteries
- Whistle to summon help in emergencies
- Refreshments and drinking water



## **Data Recording**

During testing, record your results on a printed copy of the Water Quality Sampling Field Data Sheet (available on the last page of this manual, or download a copy at [http://www.willamette-riverkeeper.org/WRK/documents/WQ\\_Field\\_Data\\_Sheet.pdf](http://www.willamette-riverkeeper.org/WRK/documents/WQ_Field_Data_Sheet.pdf)).

- Please remember to include the ID number of the kit for each parameter. This allows us to easily match the data collected to accuracy and calibration records for the equipment used.
- Use the “Acceptable Ranges for Beneficial Use” table on page 31 to get an idea of expected values for each parameter. **If in the course of your testing, you record values that are outside of the “Normal ranges observed by WRK” always duplicate the test to verify your results.** 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. Any problems, concerns, or relevant factors can also be reported in the “comments” section next to the parameter.
- Do your best to answer the weather related questions on the form. Weather can have a significant effect on all parameters.
- Include the names of all who helped to perform sampling so we can track volunteer hours from the data sheet and record duplicates accurately.
- Finally, **double-check your sheet** to make sure it is complete and values are accurate and reasonable, then sign and date your form to make it official.

## **Data Reporting**

The preferred method for data reporting upon returning from the field is through the online data entry form:

- Point your browser directly to <http://www.willamette-riverkeeper.org/WRK/waterqualityforms.html>, and set a bookmark for the future.
- From here, you will be asked to log-in. The WQC will assign you a log-in name and password when you receive your site assignment.
- Once you’re logged in, enter the data from your datasheet.
- You can use the “USGS Gauges” link on the data entry page to find out if your site has a USGS gauge nearby and if so, to access the most recent flow data for entry into the form.
- **Be sure to keep your original field datasheet in a safe place. We will ask for you to return them to us every 6 months via snail mail or fax for quality control purposes.**



# Testing Protocol

## **Testing Triage – Grabbing Samples and Order of Testing**

### **Before Grabbing the Samples**

1. Set out equipment, leaving meters in cases
2. Rinse the following, first with distilled water and then with river water:
  - DO sampling bottle and stopper.
  - Turbidity sample cell and lid.
  - pH sample container (150 mL plastic beaker)
  - Conductivity sample container, if you are using it (250 mL plastic beaker)
3. Rinse the sampling bucket (if you are using one) with river water.
4. Set the pH probe in river water and allow it to acclimate for 5-10 minutes (see page 22, steps 1-5).

### **Grabbing the Samples**

1. Write down the time (in 24-hour time) on your datasheet.
2. Grab your samples.

**Note: when grabbing a turbidity sample, choose the cleanest vial in the kit. If you can see scratches on a cell, do not use it! Avoid fingerprints on the glass by handling the cell from the neck or by the lid.**

- **If you are using a bucket**, take your DO and turbidity samples from it:
  - i. Dissolved Oxygen: The best way to grab a DO sample if using a bucket is to place the sampling bottle directly in the bucket before you lower it. Place the bottle in the bucket with one of the tubes on the bucket lid inserted into the bottle, secure the bucket clasps, and lower to fill. The container will fill with water but no air. Cap the DO sampling jar under water to avoid introducing air bubbles.
  - ii. Turbidity: Grab the turbidity sample from the bucket immediately after bringing it up. It's important to **fill the sample cell immediately after collection** (before sediment has a chance to settle). Check to see that the sample cell is filled to the white line or the middle of the white diamond (dump out any excess). The sample cell can be capped and set aside to measure later.
- **If you are not using a bucket**, take your DO and turbidity samples from the stream:
  - i. Dissolved Oxygen: Avoid sealing air bubbles in the jar. Slowly submerge the bottle by hand, sideways at first, then tilt to finish. Avoid bubbles "glugging" through the neck of the bottle. Fill completely and cap under water to avoid air bubbles. Tilt bottle to pour off the excess water above the stopper. Inspect for air bubbles.
  - ii. Turbidity: Grab a sample for turbidity directly in the cell vial. Do this by submerging your arm to your elbow, or use a bucket to collect water and sample from the lower half of the bucket. Fill the sample cell is to the white line or the



middle of the white diamond. The sample cell can be capped and set aside to measure later.

### **Analysis Order**

1. Follow instructions on page 15 to perform conductivity and temperature tests.
2. Follow instructions on pages 17-18 to perform steps 1-6 of the DO test (Sample Preparation portion).
3. Follow instructions on pages 16 and 22-23 and to perform the turbidity and pH tests (in any order).
4. Follow instructions on pages 19-20 to perform steps 7-21 the DO test (Titration portion)

### **Performing Duplicate Samples**

1. For quality control purposes, each monitor must perform at least one duplicate sample of each parameter every six months. Duplicates help us ensure that we are collecting data consistently and that we are aware of any wide variations in results at your site.
2. **If using a bucket, all duplicate samples must be taken from a different bucket load.**
3. Write down the time of the duplicate sample was taken on your datasheet with a note indicating that the time is for the duplicate.
4. Lower the bucket or collect the samples from the stream and perform the test or tests exactly as you did for the initial sample.

### **After Sampling**

1. Rinse all glassware, containers, delivery tubes, and probes with distilled water before storing.



## ***Conductivity and Temperature***

### **Equipment List**

Things you will need from the sampling box:

- 1 YSI-30 Conductivity/Temperature meter with probe
- Distilled water

### **Considerations**

- **Make sure that you are measuring specific conductance (blinking °C mode).**
- Use the conductivity meter to obtain a value for the temperature parameter (not the pH meter).
- 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.**
- Water can warm up quickly in the sampling bucket – take your temperature and conductivity readings directly from the stream or from the bucket immediately after pulling it up.

### **Sample Measurement**

1. Turn on the meter.
2. Rinse the probe with river water.
3. Put the probe directly in the bucket or water body. **Make sure the probe is fully submerged.** If you cannot fully submerge the probe, pour into a clean plastic beaker and immerse the probe.
4. The meter should already be in *specific conductance* mode (the °C should be **blinking** and conductivity units should be  $\mu\text{S}/\text{cm}$ ). If it is not, press the mode button until the °C sign is blinking.
5. Agitate/swirl the probe in the sample.
6. Do not allow probe to contact the walls of the container.
7. When the reading is stable, record the temperature and conductivity value on the data sheet.
8. Rinse the probe with distilled water, then dry and place in the storage cavity on the meter.



## ***Turbidity***

### **Equipment List**

1 Turbidity Kit containing:

- Hach 2100P Turbidity meter
- Box containing empty vials
- Silicone Oil
- Cotton cloth (to remove moisture)
- Black cloth (to use with oil)

### **Sample Measurement**

Begin with a sample cell full to the white line or diamond with river water (see page 13 for sample grabbing protocol).

1. Gently invert the sample container to re-suspend the sediment before a measurement is taken.
  - Invert but do not shake the vial -- shaking creates NTU-altering air bubbles. You may need to gently move the bottle around to remove air bubbles.
2. If the vial is wet, wipe it with something cotton (like your t-shirt or the rag provided).
3. Use the black polishing cloth provided in the kit to remove water spots and fingerprints (but not moisture) and to apply the silicone gel.
  - Put a drop of the silicone gel on the polishing cloth before wiping. The gel will fill in scratches that are too small to see.
4. Holding the sample cell by the lid, place it in the cell compartment of the meter with the white diamond on the cell aligning with the orientation mark facing the front of the meter.
5. Close the lid.
6. Press power. **Be sure the display shows "AUTO RNG."** If not, press the "RANGE" key until it is displayed.
7. Press "READ" and wait for the display to show a NTU value. Record.
8. Perform a turbidity "blank" sample. To do this, fill a clean sample cell with distilled water exactly as you would with river water, and repeat steps 1-7. It may help to uncap the bottle and pour the distilled water rather than squeezing it from the bottle – this will prevent air bubbles. Record this value on your datasheet.
9. Dump out and rinse the sample cell with distilled water.



## ***Dissolved Oxygen (DO)***

### **Equipment List**

The Hach OX-DT Dissolved Oxygen Kit contains:

- Glass sample bottles with stoppers
- Plastic volumetric flask (round bottom and thin neck)
- Glass Erlenmeyer flask (flat bottom with triangular shape)
- Plastic 100 mL graduated cylinder (for repeat titrations only)
- Plastic powder pillow packets of 3 reagents
  - #1. Manganous Sulfate (long and skinny)
  - #2. Alkaline Iodide-Azide (small)
  - #3. Sulfamic Acid (short & stout)
- Starch indicator solution
- Digital titrator
- Delivery tube
- Sodium thiosulfate cartridge
- Scissors

Items you will need from the sampling box:

- Distilled water
- Waste jar
- Goggles & gloves

### **Considerations**

- The Sample Preparation portion of the DO protocol should be performed immediately after grabbing the sample in the field; however, the Titration portion of the protocol may be done up to two hours later (the sample may be transported and kept at ambient temperature).
- Once you begin adding titrant (sodium thiosulfate) to the sample don't stop the process until you are done. If left to sit these reactions will go in reverse and impact your final result.

### **Protocol**

#### ***DO Sample Preparation***

Begin with an air-bubble free sample jar of river water (see page 13 for sample grabbing protocol).

**Note: Performing steps 1 and 2 quickly will help dissolve the precipitate and ensure that you get a complete chemical reaction!**

1. In quick succession, add the contents of 1 powder pillow of Manganous Sulfate (long and skinny packet) and 1 powder pillow of Alkaline Iodide-Azide (small packet).
  - a. Tap pillow on one end to settle the contents on the bottom.
  - b. Use scissors to cut pillow open. Hold finger over plastic end.
  - c. Be careful not to let the plastic fly into the water.
  - d. Put plastic trash in the garbage located in the kit tub.



- e. Try to avoid getting reagent on the neck of the bottle. If you do, use the stopper to push any reagent into the sample.
2. Immediately, replace the glass stopper and shake vigorously for 20-30 seconds (wear goggles).
  - a. Avoid sealing any air bubbles in the sample.
  - b. Pour off excess water above stopper into waste jar.
  - c. Hold the bottle and stopper tightly.
  - d. Shake like you mean it! Try to get all of the powdered reagents into solution.
  - e. Some of the reagents may not completely dissolve – this is normal and cold weather may contribute to this.
3. A flocculent precipitate (a cloudy substance) will form in the sample. If oxygen is absent the sample will be white. If oxygen is present, the sample will be brownish-orange, as in normal river samples. Allow the sample to stand until either 1.) the “floc” has settled approximately one-third of the way to the bottom of the bottle **or** 2.) three minutes have passed, whichever is shortest.
  - A floc which does not settle may be due to cold temperatures.
4. Repeat the vigorous mixing for 20-30 seconds. Again, allow the sample to stand until the floc settles approximately one-third of the way to the bottom, **or** three minutes have passed – whichever comes first.
5. Remove the glass stopper and add 1 powder pillow of Sulfamic Acid (short and stout packet).
6. **Immediately** replace the glass stopper and shake vigorously for 20-30 seconds (wear goggles). The sample should turn a clear amber color.
  - a. Again, push any reagents off the neck of the bottle and into the sample using the stopper.
  - b. Avoid sealing any air bubbles in the sample.
  - c. Pour off excess displaced water into the waste bucket.
  - d. Shake vigorously. Try to get all of the reagents into solution. If crystals remain at the bottom of the bottle wait a few minutes and shake the bottle again. (All the reagents should dissolve at this stage. If you are unsuccessful at dissolving the reagents make a note on the field sheet).



## **DO Titration**

(These steps may be done up to 2 hours after steps 1-6 above)

7. Rinse a 200 mL (plastic) volumetric flask and a 500 mL Erlenmeyer flask with distilled water.
8. Remove the glass stopper on your sample bottle and fill the volumetric flask to the 200 mL line.
  - The bottom of the meniscus-curve of the water line should touch the measurement line.
9. Transfer this 200 mL portion to the 500 mL Erlenmeyer flask.
10. Clean a delivery tube inside and out with distilled water. Insert clean delivery tube into the Sodium Thiosulfate (a.k.a. "titrant") delivery cartridge.
11. Insert the Sodium Thiosulfate cartridge into the titrator.
12. Lower the titrator plunger gently until it contacts the Sodium Thiosulfate cartridge.
13. Turn the delivery knob (slender knob) in the direction of the arrow to push the Sodium Thiosulfate through to the end of the delivery tube. Check for air bubbles in the cartridge and delivery tube.
14. Reset the counter to zero by turning the thicker knob facing the delivery tube counter-clockwise.
15. Place the delivery tube tip into the sample. Turn the delivery knob (the slender knob) in the direction of the arrow to add titrant to the sample. When the sample is a pale yellow color, move on to the next step.
  - For the entire titration, swirl the flask while adding titrant to make sure the titrant mixes with the sample. Swirl constantly and fairly vigorously, but without spilling. This takes practice and a good grip – ask for help or a demonstration if you're unsure of this step.
  - The titration will take several hundred "titrator digits" (equivalent to one number on the counter) – anywhere from 400 to more than 1300. Generally, values range from 700-1100.
  - At first, you can add fifty to one hundred digits at a time.
  - As you continue to add titrant, lessen the amount added between swirls to twenty or thirty digits at a time. The sample will gradually turn a pale yellow color.
16. Once the sample is pale yellow, the endpoint of the titration is approaching. Add two mL of Starch Indicator Solution and swirl to mix thoroughly. A dark blue color will develop.
17. Continue to swirl and add titrant at about five to ten digits at a time. As the sample approaches a lighter blue, you are nearing the endpoint. Add just one or two digits at a time now. Stop when the sample is clear, with no visible blue tint. Be careful to



not overshoot the endpoint!

- Hold a white piece of paper behind the flask for comparison to determine the absence of any blue color.
18. Look at the value on the Digital Titrator's counter, and multiply it by 0.01 (move decimal to the left 2 places). The result is the sample DO in mg/L. Record this reading on the data sheet.
  19. Disassemble the titrator.
  20. Dump your extra sample and titrated sample into the waste jar.
  21. Rinse sample bottles, flasks, and delivery tube well with distilled water.

### ***Repeating titrations***

If a titration needs to be rechecked, measure the volume remaining in the glass DO sample bottle using a 100 mL graduated cylinder and pour into an Erlenmeyer flask. Titrate to the endpoint as described above in steps 14 – 17 (Your final digit count should be somewhere around half your original count).

Calculate the DO in your rechecked sample as follows:

$$\text{DO (mg/L)} = \text{digits} \times 0.01 \times 200 \div \# \text{ mL measured}$$



## ***pH: Denver pH Meter***

### **Equipment List**

The pH case contains:

- Denver UP-5 pH meter with temperature and pH probes
- pHisa ionic strength buffer
- 1 mL syringe
- electrode storage solution
- 9 V battery

You will need from the kit:

- 150 mL sample container
- distilled water squirt bottle

### **Considerations**

- **Do not** set down probe or allow the bulb to touch any surfaces; it is very fragile. Only place the probe in solution or its storage container.
- Always use the black plastic guard provided to keep the probe bulb from touching the bottom of the container. Slide it onto the end of the probe, avoiding scraping the ceramic junction (the small beige dot on the end of the probe).
- When measuring pH, the level of the sample water should reach no higher than about 1" from the bottom of the probe.
- Never submerge the vent hole. If this occurs, notify the Lead Volunteer.
- The inside of the pH probe should be free of crystal build-up and filled to within one inch of the vent with Electrode Filling Solution. The storage bottle should be half-full with Electrode Storage Solution. If it is low, you can refill the storage bottle with Electrode Storage Solution
- Report any probe maintenance issues to your Lead Volunteer or the WQC.
- It is best to read pH immediately in the field. However, you may take a pH reading up to 2 hours later if necessary. To do so:
  1. Rinse one of the shallow, wide empty containers with distilled water and three times with sample water.
  2. Take a sample in this container.
  3. Keep container sealed and in a cooler with ice until you are ready to take the measurement

### **Notes on pH Stability**

- Be patient. pH is not a simple measurement, it is a process!
- The pH is reported to the tenth, example 7.4. The pH will rarely be stable in the hundredths of a unit using these meters in the field.
- Cold temperatures will lengthen the time it takes to get the correct reading. If possible, store the kit inside before taking measurements in the field.
- The "stability" of the pH reading for a particular sample is determined by the sampler based on how much the result changes between quiescent readings (i.e. "still" readings, taken at intervals between stirrings of the probe). Changes may be described as "drift" or "noise".
  - "Drift" describes a continuous increase or decrease in the reading. Drift may be the result of equipment or sample conditions.
  - "Noise" describes changes in readings that do not move consistently up or



down but seemingly randomly. Excessive noise likely indicates a problem with the pH meter or probe.

- Some guidelines for determining stability:
  - If your quiescent sample readings are within 0.02 units, your reading is stable.
  - If your quiescent water readings are greater than 0.02 units off and the difference is consistent with the direction the pH has been drifting, then the pH may not have equilibrated and a one minute interval of stirring should be repeated (up to three total 1-minute stirrings).
  - Occasionally, the reading will continue to drift and gentle stirring will bring the reading back to the true pH. If stirring brings the reading back to a similar, steady value each time, this can be considered the stable reading.
  - Do not continue stirring the sample indefinitely. Eventually environmental conditions can change the actual pH of a sample. Avoid total testing times of more than ~8 minutes (the first 3-minute stirring and 3 more 1-minute stirrings, with readings in between).
  - If you aren't sure of the stability of your pH reading after following the above steps, note this on your datasheet. We may need to replace the probe or meter.

## **Protocol**

### ***Acclimating the Probe***

The following 5 steps are not strictly required for an accurate reading, but letting the probe acclimate will make reading stabilize sooner, especially if it is cold out! A pH probe absorbs ions by design. Acclimating the probe to your sample eliminates the false effect of absorbed ions on your sample.

1. Take a 100mL **preliminary** water sample in a small 150mL sample cup.
2. **Fully unscrew** the O-ring lid and **carefully** remove the probe from its storage solution bottle.
  - Be careful not to spill the storage solution.
  - Expose the vent hole and protect the bulb in a guard or by suspending from probe holder.
3. **Rinse** both probes with distilled water.
4. Place the temperature and pH probes gently in the **preliminary** water sample.
5. **Let sit for 5-10 min** to let the probe acclimate to its surroundings.

### ***Sample Measurement***

1. **Dump out the preliminary sample and take a second 100mL sample** from the stream or the bucket. If you didn't do a preliminary sample, rinse the sample container with river water before grabbing the sample.
2. Place the temperature and pH probes gently in the sample.
3. Add 1.0 mL of pHisa solution to the sample (this decreases the stabilization time). Stir to mix in pHisa. Avoid hitting the probe against the walls of the container.
4. **Turn on pH meter.** The meter should be in "measure" mode, showing a curved line graph in the top left corner. Values for pH (large numbers) and temperature (°C) will



be displayed. If this isn't the case, press the MODE button until the display is correct.

5. **Swirl/stir** the probes in the **sample for about 3 minutes**, avoiding probe contact with the walls of the container.
6. **Stop swirling.** Hold the probe in the quiescent (still) water sample. When the screen displays an "S" at the left side (S for "stable"), take note of the pH reading, either on paper or in your head.
7. **Then, stir the sample for one minute. Stop and again make a note of the reading** when the screen displays an S.
8. **Repeat step 7 until** the reading is relatively stable (see pH considerations on stability on pages 21-22) **OR** you have performed 3 one minute stirrings. Then record the pH value and the sample temperature. If you feel that the reading is still not stable, make a note stating this in the comments section.
9. Turn off the meter (press the power button).
10. Cover the vent hole on the pH probe and remove the probe guard (if you have one).
11. Rinse the probe with distilled water.
12. Unscrew the storage bottle cap **completely** and place the pH probe back in the storage solution bottle. Rescrew the lid securely. Store the probe and storage solution bottle upright in the case (top of probe facing the handle of the case) to prevent solution from spilling.
13. Store the pH case in the kit with the handle facing upright to prevent storage solution from spilling.



## Focused Studies

If you have a specific question that cannot 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 WQC 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?



# Parameter Descriptions and Standards

## *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 water at a higher temperature has a lower capacity to hold dissolved oxygen. Dissolved oxygen is measured on a weight per volume basis in milligrams per liter (mg/L). Milligrams per liter is a unit of concentration that applies to dissolved material in solution; with DO it refers to the amount of oxygen in a liter.

### **Natural Influences**

Dissolved oxygen levels are affected by natural and foreign influences. Aquatic plant photosynthesis, which releases oxygen into the water as a by-product, is one contributor of dissolved oxygen. Photosynthesis occurs only during daylight hours. Respiration and decomposition, which consume oxygen rather than produce it, occur 24 hours a day. At night, when photosynthesis stops but respiration and decomposition continue, DO concentrations decline. DO is lowest just before dawn and highest in the afternoon. DO levels are also affected by the seasons. The cooler months of winter allow for higher levels of DO. In autumn, large quantities of decomposing plant material result in lower levels of DO.

Turbulence (waterfalls, rapids, etc.) increases dissolved oxygen. More oxygen dissolves into water when more surface area of the water is exposed to air (through turbulence) and more diffusion can occur. Just like stirring sugar into coffee, stirring makes it dissolve faster.

### **Pollution Influences**

Human actions can also affect DO levels. For example, artificial heating of water through industrial discharges or loss of streamside vegetation creates warmer water that cannot hold as much oxygen.

Pollution can also lead to an oxygen-deficient environment through "eutrophication." Eutrophic waterbodies receive excessive amounts of nutrients, particularly phosphates and nitrates. These nutrients are commonly the result of agricultural runoff, and they greatly accelerate algae growth. The algae grow in layers, and eventually the algae on the bottom die from lack of sunlight. As they decompose, they consume more oxygen than is replaced by the photosynthesizing algae.

### **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. Fish kills occur when dissolved oxygen levels remain below 1-2 mg/L for a few hours. Conversely, 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) minimum standard 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 by using specific conductance, which corrects for temperature. If the meter is in specific conductance mode, 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 ( $\mu\text{S}/\text{cm}$ ).

## **Natural 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 volumes of rain can also dilute the amount of TDS and lower conductivity. In a dry spell, water evaporates and TDS are left behind resulting in higher conductivity.

## **Pollution Influences**

Human impacts on conductivity 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, but we use conductivity mostly as a indicator of other problems. Significant changes in conductivity can indicate a discharge or some other form of pollution that has entered the stream. Although extreme readings of conductivity may signify the presence of other toxic substances, we do not have the means to identify the source. Once we have identified that there may be a problem, further research is necessary.

## **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. Past measurements of Willamette Valley and Coast Range conductivities were 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  $\mu\text{S}/\text{cm}$ .



## ***Temperature***

### **Description**

Temperature is probably the most easily measured parameter, but it is also a critical factor influencing several biological and chemical variables within the water. Temperature is measured in degrees Celsius ( $^{\circ}\text{C}$ ).

### **Influences**

The most obvious natural cause for temperature change is the seasons. In the summer the water will obviously be warmer than in the winter. Turbidity (suspended particulate in the water column) can also increase temperature as particles absorb sunlight and heat.

Human disturbance has a great impact on temperature. One direct source of human impact is thermal pollution. Thermal pollution is caused by 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.

Loss of streamside vegetation is a major issue affecting the temperature of the Willamette and its tributaries. With the removal of riparian forests, the water is exposed to intense sunlight resulting in increased water temperature.

### **Biological Consequences**

Temperature has an effect on both chemical and biological activities in water. The rate of chemical reactions generally increases at higher temperatures. 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 in native species, and can make an ecosystem more susceptible to disease and invasive species.

### **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. The more suspended material exists in a sample, the more light-scattering (i.e. turbid) it is and hence, the less transparent. We use turbidity to estimate the amount of sediment, or Total Suspended Solids (TSS) being transported in the water column. The higher the 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. 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 beneficial processes in the life of a river. Habitat that supports foraging, shelter, and breeding for native aquatic 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 suffocated. Spaces between rocks that are ideal for macroinvertebrate 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, disrupting processes at the bottom of the aquatic food chain. Instead of transmitting sunlight, turbid water absorbs it as heat and increases the water temperature.

Sediment also 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, or inside organisms such as insects, fish, and (eventually) 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 device similar to a light meter 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.



# **pH**

## **Description**

pH is a 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 higher the number of hydrogen ions, the lower the pH, the lower the number of hydrogen ions, the higher the pH.

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. Because respiration occurs day and night, but photosynthesis only occurs during the day, 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. pH levels of 6 and lower have been demonstrated to have a direct toxic effect on fish. Indirectly, high inputs of fertilizers like phosphorus can increase pH. Phosphorous will increase plant growth and thus photosynthesis. Increased photosynthesis will remove a greater amount of  $CO_2$  from the water and increase pH. Important nutrients, as well as oxygen, can become insoluble at higher pHs.

## **Biological Consequences**

pH is important because it determines the solubility of nutrients and chemicals in the water. Acidic water (low pH, high amount of hydrogen ions) 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 medium 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 other words, nutrients can be *too* available, and low pH will also make pollutants more bio-available. 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. Because 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 values for pH in the Willamette River are between 6.5 and 8.5.



## **Flow**

### **Description**

“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 streamflow. 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, causing additional stress for aquatic life.

### **Methods and Standards**

Generally, there are no water quality standards for flow and environmental flow requirements are site-specific. Flow can be measured with meters or gauges. Because gauges don't exist at all of our sites, we simply visually monitor the flow and depth of the stream by taking note of the water level and water current. To do this define a stable marker at your site (bridge pillar, pilings, stream bank) which you can use estimate depth (low, moderate, high) throughout your monitoring months. Has flow gone up or down since last month and how much? Also note if the stream is moving -- and if so, how fast? This will become a lot easier when you are more familiar with your monitoring site.

Many sites have USGS gauges located nearby. If yours does, you can go on-line (<http://or.water.usgs.gov/>) and record the streamflow for the day that you sampled.



## Acceptable Ranges for Beneficial Use

Use	DO (mg/L)	Cond.(µS/cm)	Turb. (NTU)	Temp. (°C)	pH	E.coli (MPN per 100 mL)
Salmon migration	7.0-11.0	No set standards for conductivity; values should be compared to a reference for that particular stream reach.	<10 NTU difference from natural conditions**	20*	6.5-8.5	
Salmon rearing	6.0-11.0			18*		
Salmon spawning	>11*			13*		
Aquatic life -- cold water	>8*					
Aquatic life -- cool water	>6.5*					
Aquatic life -- warm water	>5.5*					
Swimming						<235***
Recreation (not swimming)						<406*
Normal ranges observed by WRK	6.0-13.0	20-400	.5-150	0-30	6-9	0 - >2420

\* Oregon State (DEQ) Standard

\*\* State Standard; measured as compared to a control point upstream of turbidity-causing activity. The effect of turbidity on fish depends strongly on duration of exposure (hours, days, weeks).

\*\*\* EPA Standard

## Water Quality Impacts Associated with Land Uses

<u>Source</u>	<u>Common Pollutants/Impacts</u>
Cropland	Turbidity, total solids, nutrients, thermal impacts, pesticides
Grazing land	Fecal bacteria, turbidity, nutrients, thermal impacts
Forestry	Turbidity, total solids, thermal impacts
Mining	Alkalinity, pH total dissolved solids
Industrial/commercial discharge	Turbidity, total solids, conductivity, pH, toxics
Sewage treatment plants	Dissolved oxygen/biochemical oxygen demand, turbidity, total solids conductivity, nutrients, fecal bacteria, thermal impacts, pH
Construction	Turbidity total solids, thermal impacts, dissolved oxygen/biochemical oxygen demand, toxics
Suburban/Urban runoff	Turbidity, total solids, thermal impacts, dissolved oxygen/biochemical oxygen demand, bacteria, metals, petroleum hydrocarbons
Lawns/golf courses	Nutrients, turbidity, total solids, bacteria, toxics
Septic systems	Fecal bacteria, nutrients, dissolved oxygen/biochemical oxygen demand, conductivity, thermal impacts
Marinas/boat usage	Nutrients, bacteria, toxics



## Background Information

### ***On the Web***

USGS daily stream flow data, technical publications, and more information than you can handle: <http://or.water.usgs.gov/>

Oregon Water Quality Index:  
<http://www.deq.state.or.us/lab/wqm/wqimain.htm>

Oregon Department of Environmental Quality LASAR monitoring database:  
<http://deq12.deq.state.or.us/lasar2/>

Oregon Department of Environmental Quality - Willamette TMDL  
<http://www.deq.state.or.us/WQ/willamette/willamette.htm>

Scorecard, the Pollution Information Site: <http://www.scorecard.org>

NCAP: Northwest Coalition for Alternatives to Pesticides:  
<http://www.pesticide.org>

Water on the Web: good intro to some of the water quality parameters we monitor: <http://waterontheweb.org/under/waterquality/index.html>

Willamette Riverkeeper: Become a member, sign up for a paddle trip, look for pictures of yourself, and learn more about the Willamette: <http://www.willamette-riverkeeper.org>. Visit our Water Quality Monitoring page for resources, articles, and more: <http://www.willamette-riverkeeper.org/WRK/waterquality.html>





# WATER QUALITY SAMPLING FIELD DATA SHEET



## Willamette Riverkeeper

Please submit forms to WRK within **7 days** of sampling.

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

### -----RESULTS-----

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

**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 or conditions, anything worth noting. Use the back of sheet if needed):

Monitor Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Reviewer Name: \_\_\_\_\_ Signature: \_\_\_\_\_ Date \_\_\_\_\_

