

Water Quality Index

In an effort to develop a system to compare water quality in various parts of the country, over 100 water quality experts were called upon to help create a standard Water Quality Index (WQI). The index is basically a mathematical means of calculating a single value from multiple test results. The index result represents the level of water quality in a given water basin, such as a lake, river, or stream.

The WQI, which was developed in the early 1970s, can be used to monitor water quality changes in a particular water supply over time, or it can be used to compare a water supply's quality with other water supplies in the region or from around the world. The results can also be used to determine if a particular stretch of water is considered to be "healthy."

To determine the WQI, the following nine water quality parameters are measured:

- **Biochemical Oxygen Demand**
The Biochemical Oxygen Demand (or BOD) is a measure of the amount of food for bacteria that is found in water. Bacteria utilize organic matter in their respiration and remove oxygen from the water. The BOD test provides a rough idea of how much biodegradable waste is present in the water. (Biodegradable waste is usually composed of organic wastes, including leaves, grass clippings, and manure).
- **Dissolved Oxygen**
The dissolved oxygen test measures the amount of life-sustaining oxygen dissolved in the water. This is the oxygen that is available to fish, invertebrates, and all other animals living in the water. Most aquatic plants and animals need oxygen to survive; in fact, fish will drown in water when the dissolved oxygen levels get too low. Low levels of dissolved oxygen in water are a sign of possible pollution.
- **Fecal Coliform**
Fecal coliform is a form of bacteria found in human and animal waste.
- **Nitrates**
Nitrates are a measure of the oxidized form of nitrogen and are an essential macronutrient in aquatic environments. Nitrates can be harmful to humans, because our intestines can break nitrates down into nitrites, which affects the ability of red blood cells to carry oxygen. Nitrites can also cause serious illnesses in fish.
- **pH**
The pH level is a measure of the acid content of the water. Most forms of aquatic life tend to be very sensitive to pH. Water containing a great deal of organic pollution will normally tend to be somewhat acidic. Water with a pH of 7 is considered neutral. If the pH is below 7, it is classified as acidic, while water with a pH greater than 7 is said to be alkaline. The pH of tap water in the U.S. is usually between 6.5 and 8.5.

- **Temperature Change**

The water temperature of a river is very important, as many of the physical, biological, and chemical characteristics of a river are directly affected by temperature. Most waterborne animal and plant life survives within a certain range of water temperatures, and few of them can tolerate extreme changes in this parameter. Using the same thermometer, the water temperature should be checked at the test site and at a similar site one mile upstream. Care should be taken when taking the temperature upstream to ensure that the amount of sunlight and the depth of the river are similar to the original test site.

- **Total Dissolved Solids**

This is a measure of the solid materials dissolved in the river water. This includes salts, some organic materials, and a wide range of other things from nutrients to toxic materials. A constant level of minerals in the water is necessary for aquatic life. Concentrations of total dissolved solids that are too high or too low may limit growth and lead to the death of many aquatic life forms.

- **Total Phosphate**

Phosphates are chemical compounds made from the elements phosphorous and oxygen; they are necessary for plant and animal growth. Phosphates can be present in water in many forms, so total phosphate gives an estimate of the total amount of phosphate potentially available in a given water supply.

- **Turbidity**

Turbidity is a measure of the dispersion of light in a column of water due to suspended matter. The higher the turbidity, the cloudier the water appears. If water becomes too turbid, it loses the ability to support a wide variety of plants and other aquatic organisms.

After the nine water quality tests are completed and the results recorded, a "Q" value is calculated for each parameter, and the overall WQI for the sampling site is then calculated. To learn more about the calculation process, see Calculating the Overall WQI.

It is important to monitor water quality over a period of time in order to detect changes in the water's ecosystem. The Water Quality Index can give an indication of the health of the watershed at various points and can be used to keep track of and analyze changes over time.

What Does the WQI Mean?

The Water Quality Index uses a scale from 0 to 100 to rate the quality of the water, with 100 being the highest possible score. Once the overall WQI score is known, it can be compared against the following scale to determine how healthy the water is on a given day.

Table I - WQI Quality Scale	
91-100:	Excellent water quality
71-90:	Good water quality
51-70:	Medium or average water quality
26-50:	Fair water quality
0-25:	Poor water quality

Water supplies with ratings falling in the good or excellent range would be able to support a high diversity of aquatic life. In addition, the water would also be suitable for all forms of recreation, including those involving direct contact with the water. Water supplies achieving only an average rating generally have less diversity of aquatic organisms and frequently have increased algae growth.

Water supplies falling into the fair range are only able to support a low diversity of aquatic life and are probably experiencing problems with pollution. Water supplies that fall into the poor category may only be able to support a limited number of aquatic life forms, and it is expected that these waters have abundant quality problems. A water supply with a poor quality rating would not normally be considered acceptable for activities involving direct contact with the water, such as swimming.

Calculating the Overall Water Quality Index

After the nine water quality tests are completed and the results recorded, you can calculate the Water Quality Index (WQI) for the section of the water supply you monitored.

To calculate the overall WQI, you must first compute what are known as Q-values for the results you obtained for each of the nine tests and record them on the WQI Worksheet. This section outlines the procedures for computing these values:

1. Locate the chart for the appropriate test parameter (see links below).
2. Locate and mark your test result on the bottom, or horizontal axis, of the chart.
3. Beginning at your mark, draw a vertical line up until it intersects the curve on the chart.
4. From the point where your line intersected with the curve, draw a horizontal line to the left until you reach the vertical axis of the chart.
5. Record the value where this horizontal line intersects the vertical axis of the chart on the form. This would be the Q-value for the test.
6. Repeat each of these steps to find the Q-value for each of the remaining tests results.

You can select each of the following test parameters to view (or print) a copy of the Q-value chart for that parameter.

- Biochemical Oxygen Demand (BOD)
- Dissolved Oxygen
- Fecal Coliform
- Nitrate
- pH
- Temperature Change
- Total Dissolved Solids
- Total Phosphate
- Turbidity

Make sure you record the correct Q-value in the appropriate column next to each test parameter on the WQI Worksheet before you proceed to the next step.

Completing the WQI Calculation

The Q-value for each test should then be multiplied by the weighting factor shown on the Worksheet for each test, and the answer should be recorded in the "Total" column. The weighting factor indicates the importance of each test to overall water quality. For example, the weighting factor for fecal coliform is 0.16, so it is considered more important in evaluating the overall water quality than nitrates, which only has a 0.10 weighting factor.

Finally, add the numbers shown in the Total column to determine the overall Water Quality Index (WQI) for the water source tested. Compare your Index result to the scale shown in Table I to determine the water quality rating for the water supply tested.

Water Quality Index Worksheet

Date/Time of Test _____

Location Sampled _____

Tester's Name _____

Test Parameter	Test Results	Q- Value	Weighing Factor	Total
BOD	(mg/L)		0.11	
Dissolved Oxygen	(% saturation)		0.17	
Fecal Coliform	(colonies/100 mL)		0.16	
Nitrates	(mg/L)		0.10	
PH	(Units)		0.11	
Temperature			0.10	
Total Dissolved Solids	(mg/L)		0.07	
Total Phosphate	(mg/L)		0.10	
Turbidity	(NTU)		0.08	

Overall Water Quality Index _____

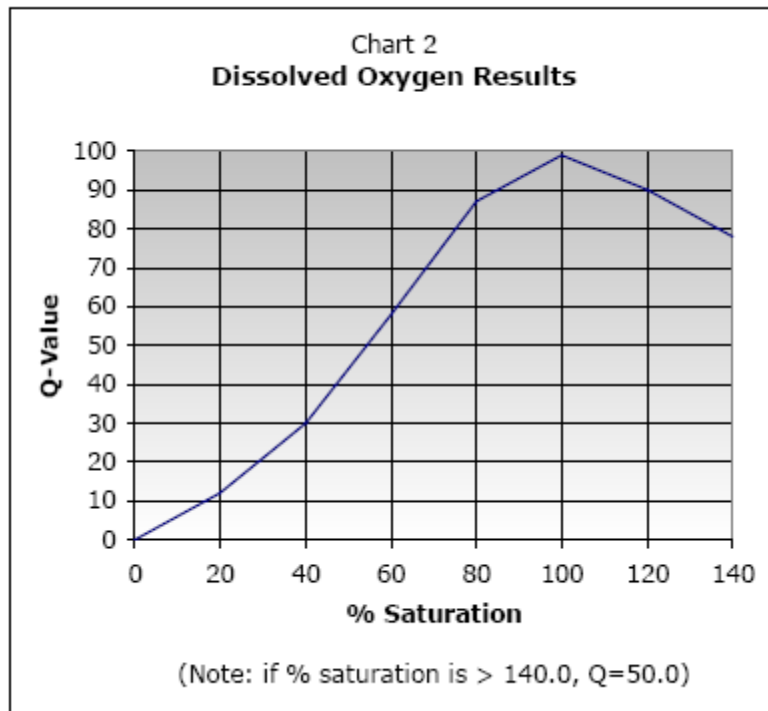
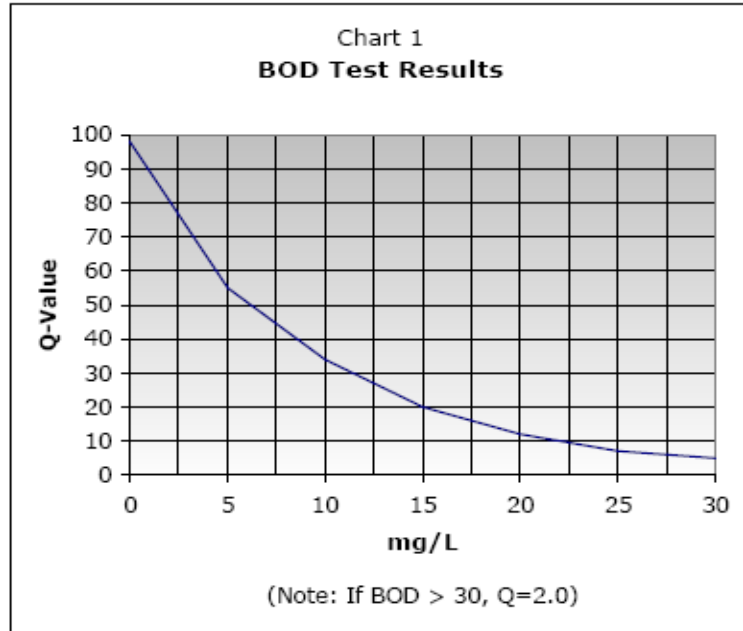
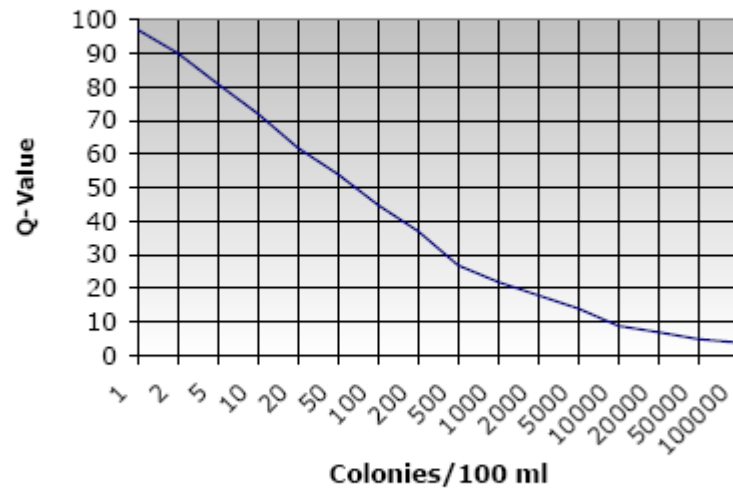
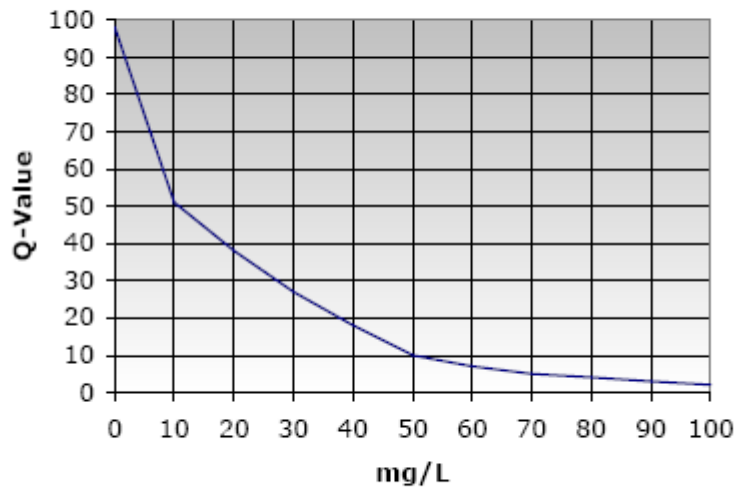


Chart 3
Fecal Coliform Results



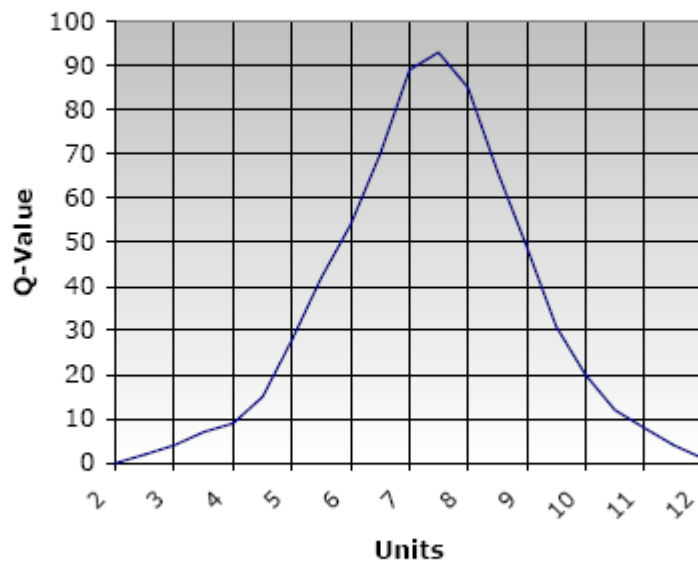
(Note: if Fecal Coliform > 100000, Q=2.0)

Chart 4
Nitrate Results



(If Nitrates > 100.0, Q=1.0)

Chart 5
pH Results



(Note: If pH is < 2.0 or > 12.0, Q=0)

