d. pH

i. Why is this test important?

Scientists use this measurement to determine if a solution is either an acid, neutral or basic (alkaline). Most life does well around the number seven on the pH scale. Since the scale goes from one to fourteen, the further the water is in either direction from seven, the greater stress is upon living things. Normal fresh water lakes and streams will show a pH around the 6-8 range.

Strong acids, like “battery acid”, would have pH around one while a strong base like “Draino” would have a pH near fourteen. Low pH (acidic) could be caused from acid rain or industrial pollution. High pH values (basic) could be caused industrial dumping or natural minerals leaching into the water, soaps and detergents.

PH is a logarithmic scale, which means something with a pH of 6 is ten times as acidic as a liquid with a pH of 7. A liquid with a pH of 5 is one hundred times as acidic as a liquid with a pH of 7.

ii. Water Quality Standards

The general range of pH for US surface waters is about 6.5 to 8.5. The pH depends on many factors such as stream vegetation, bed geology and the presence of water pollutants. In Texas, for example, the pH ranges from 5 to 9. Michigan soils tend to be high in calcium, which buffers lakes and streams from rapid changes in pH. Most Michigan water permits limit the discharge pH to 6.5 to 9 to protect aquatic life. The current drinking water standard for pH is between 6.5-8.5

iii. How to conduct the test

The test method is very simple and can be performed in about one minute.

After taking the water sample from the river or stream, put 5 mL of the sample into a test tube.

Add 10 drops of an indicator solution.

Cap the sample and mix for a few seconds, by inverting the sample. The color of the water sample will change to a blue color that is proportional to the pH of the water sample.

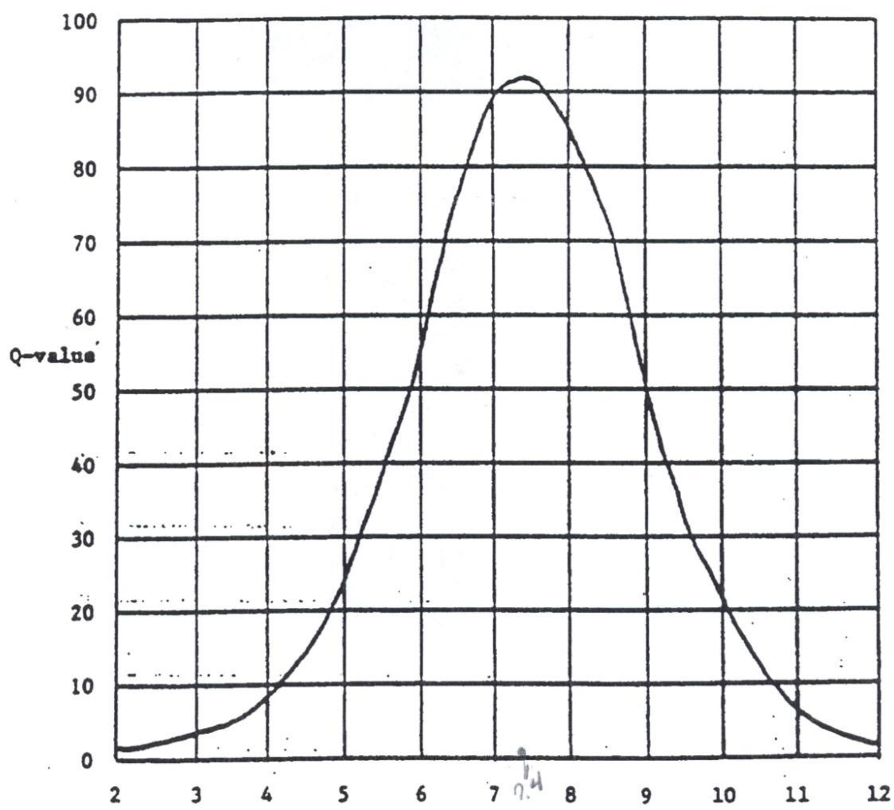
The pH is then determined by matching the color of the water sampled to a standardized color chart provided by the test kit. Read the pH to the nearest 0.5 units. Make sure you have light behind the sample, and a white paper behind the sample can be helpful to reduce error caused by colors in the area.

iv. Determining the Q-Value

Once the pH is determined from the test method, the Q-value is determined directly by reading from a graph. The graph gives the highest Q-values for pH readings in the 7 to 8 range. The Q-value is lower as the pH decreases from 7 or increases from 8. For example, at a pH of 6 or 9 the Q-value is only 50. Interestingly, the highest Q-value is about 92 at a pH of 7.4. Based on the chart from Earthforce, a Q-value of 100 cannot be achieved even with a pH level of 7.4 which is considered "perfect."

FIELD MANUAL FOR WATER QUALITY MONITORING

Chart 3: pH Test Results



pH: units

Note: if pH<2.0, Q=0.0
if pH>12.0, Q=0.0

v. What to watch for: Common Mistakes

The most common error in this test is when adding 10 drops of the indicator solution. It is easy to add more or less than 10 drops if the student is not paying close attention. Adding more than 10 drops provides erroneous results, and may not produce repeatable data. Another common error is in the location of the sampling site or the actual sampling. Sampling too close to the storm outfall presents challenges and in such cases the teacher or mentor should be consulted. Finally, sampling of the water should be performed carefully so that the bottom of the stream or river is not impacted, nor just a surface sample of water taken by the student. The student must be aware that the sample collected must represent the overall condition of the water body. The best place to take a sample is from the middle of a stream, not at the surface, not at the bottom, or not to close to the stream banks. This may be difficult depending on the site.

vi. Consistency when doing multiple tests

Generally, three tests or more if time permits should be performed by the student. Test results should be plus or minus 0.5 pH units. The goal is to obtain data that is accurate and precise. Any result that is extreme should be questioned and with your classroom mentor or FRWC staff. The sample mode, which is the most common pH value should be reported, not the average or mean. For example, assume test pH values are determined to be 7.5, 7.5, 8.0, 7.5 and 8.0. The value of 7.5 should be used to assess the Q-Value, rather than 7.7 which is the mean.

vii. How to analyze why the results are good or bad

There are two key questions to answer to determine if the results are results are good or bad. First, is there confidence in the reported test results? From a statistical standpoint, we are asking if the data has precision and confidence. This first question is independent of the numerical value for pH and deals with having enough test data that is fairly consistent. This results in statistical confidence of the measured value of pH. The above example of pH data shows both precision and confidence. A range of plus or minus 0.5 pH units is good.

For another example, consider the data set of 7, 8 and 9. In this scenario, there is no precision and no data mode. Additionally, the data ranges 2 pH units which is extreme. A difference of 2 pH units is a difference of 100 times! Reporting the average of pH=8 is not correct. At this point there are two options: consider the results as “not available” or continue with more testing. If two more tests revealed a pH=9, then the value of 9 is the mode and is the field sampling result.

The second question addresses if the reported test result is accurate or either an extreme value or a significant change from established norms for the test site. In the first above example, the reported test result was 7.5. If this value is within the normal historical range and what is reasonable for the specific site, then the value of 7.5 can be reported and can be assessed as “good.” In the second example above with a pH=9, the result must be questioned if it is indeed extreme or an outlier based on historical or long term data. The value of pH=9 maybe reported and still considered “good” provided this assessment is made to validate the data.

It should also be noted that extreme pH results of below 7 or above 9 can indicate sampling or testing error, unique problems or changing conditions with the stream, river or creek flow. In this case, the teacher or mentor should be contacted about this issue. Sampling downstream of the major storm water outfall (discharge pipe) during or after rainfall can produce such unique pH results. As such, the presence of storm water outfalls should be determined by the teacher or mentor prior to the field exercise. Also, a review of historical data in the classroom prior to the field sampling may show the existence of a highly variable pH under unique environmental conditions.

It is extremely important that the reported data be as statistically valid as possible. Some of the GREEN data is being used to satisfy NPDES storm water requirements for the Genesee Drain Commission and other decision makers in the waters. These are important considerations to keep in mind as the GREEN data is compiled.