Testing:
Onsite, Laboratory or Both?

Deciding when, where and how to test well water

By Marianne Metzger

When a new drinking water well is drilled, it is important to conduct tests in order to ensure the water will be safe and potable. There are usually local or state regulatory requirements that call for bacteria testing, and there may be a few additional contaminants that could pose health concerns. Many well drillers and water treatment professionals will do a quick onsite analysis to get a feel for the quality of the water, testing for pH, conductivity/TDS, chlorine/ORP or other specific ions. There are thousands of testing methods available, all of which can differ based on the contaminant being tested, the detection level or results you would like to achieve and the sample matrix.

When testing to meet regulatory requirements, you must test according to an approved method, which can become complicated. There are methods that have been written and approved by the U.S. Environmental Protection Agency that are acceptable to state requirements. There are also testing methods referred to as Standard Methods, which have been written by the American Public Health Association, American Water Works Association and the Water Environment Federation. These methods are usually acceptable to the state's requirements, but not all methods are acceptable to all of the different state requirements; therefore, you need to be sure the method you are running is acceptable to the regulatory agency requiring the testing.

Bacteria Testing

Bacteria testing is the most common parameter tested in new wells. There are too many bacteria to feasibly test for, so when we refer to bacteria in drinking water we are commonly looking for coliform, fecal or *E. coli* bacteria. These are indicator bacteria, meaning their presence indicates a possible presence of other infectious disease-causing bacteria.

There are a couple of testing methods that can be used, including membrane filtration, multiple tube fermentation and MMO-MUG methods. These methods are commonly run in a laboratory, but there are variations available for field-testing as well.

It is important to properly collect samples for bacteria analysis because improper collection can lead to false positives or negatives.

For drinking water, you must collect a minimum of 100 mL of sample in a sterilized collection bottle. If the water is chlorinated, the sample must be preserved with a dechlorinating agent, most commonly sodium thiosulfate. This will prevent further bactericidal action from occurring while the sample is in transit, giving a true result of microbial content of the water sample. The sample bottle is usually sealed to indicate it is sterilized, and it is important to keep the bottle closed until you are ready to collect your sample.

When collecting a sample, it is important not to touch the inside of the bottle, which can lead to a false positive. When collecting a sample from a tap, remove any aerator or filter equipment and sterilize the tap using a disinfectant such as alcohol, hydrogen peroxide, sodium hypochlorite or a flame.

Membrane Filtration

The membrane filtration method is a Standard Method 9222, and is designed to give a quantitative result of bacteria present in water. To simplify, the water sample is filtered using a membrane filter, which will retain all coliform bacteria on the filter. This filter is placed in a sterilized dish containing a growth medium and is incubated for 22 to 24 hours at 35°C, ±5°C.

The sample will be viewed using a microscope to visually examine and count the bacteria colonies. A typical coliform colony will be pink to dark red in color with a metallic sheen on the surface. One of the biggest drawbacks to this method is the presence of noncoliform bacteria, which can appear as red, pink, white or colorless. These bacteria lack the metallic sheen found in coliform bacteria, and a large number of noncoliform bacteria in a sample

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can overtake the plate and mask the fact that coliform may be present, thus invalidating the results. While this method can give you an idea of the amount of bacteria present, you may also get an invalid result.

Multiple Tube & MMO-MUG

The multiple tube formation and the MMO-MUG methods are similar in that they both utilize a chromogenic substrate that will trigger a color change if coliform is present and will fluoresce if *E. coli* is present. The multiple tube fermentation is also called most probable number and will utilize five to 10 tubes in which the sample is split.

The samples will then be incubated at 35°C, ±5°C for 24 hours. If there is a question as to the color change, the sample can be incubated for an additional four hours to see if there is a more distinct color change.

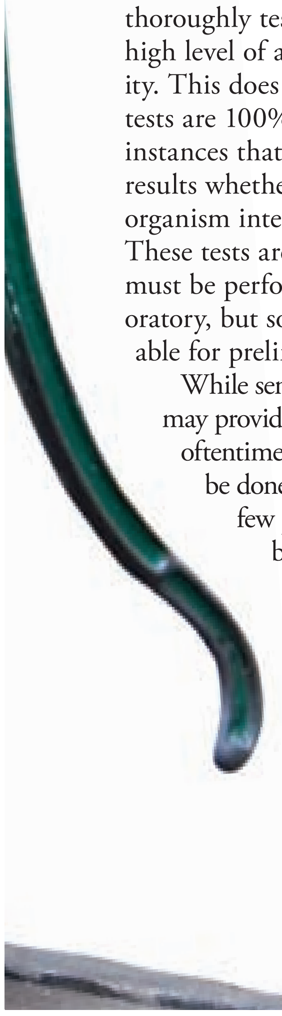
Using Standard Methods 9221C, you can estimate the most probable number of bacteria based on the number of tubes, the sample size in each tube and how many of these changed color, indicating a presence of coliform.

The MMO-MUG method also uses chromogenic substrate, but it is a single analysis in which the substrate is added directly to the sample collection bottle and incubated at 35°C, ±5°C for 24 hours. This will tell you if coliform is present or absent in that particular sample.

Public Water Supplies

The bacteria methods described above are methods approved for running public water supply samples. This means these methods have been thoroughly tested and demonstrate a high level of accuracy and repeatability. This does not mean that these tests are 100% accurate; there are instances that can produce inaccurate results whether it is another microorganism interfering or human error. These tests are usually regulated and must be performed by a certified laboratory, but some field kits are available for preliminary testing.

While sending samples into a lab may provide highly accurate results, oftentimes testing can and should be done in the field. There are a few parameters that can easily be run in the field to get an immediate idea of water quality. A simple conductivity reading using a meter, for example, will give you an idea of the amount of solids dissolved in the water.



There are also parameters that should be run in the field because they can easily change over time. A pH test, for example, should be done onsite to yield the most accurate analysis. Onsite testing can yield accurate results if conducted properly, but many onsite testing methods can have interferences that will skew results.

Testing pH Levels

The most common item to test onsite is pH because it affects so many aspects of water quality and its treatment. To simplify, pH is a measurement of the activity of hydrogen ions. A pH level below 7 will indicate the water is acidic, while a pH level above 7 indicates the water is alkaline.

A pH test should be done as soon as possible after collection because it has a tendency to change when exposed to the atmosphere, as it can absorb carbon dioxide and form carbonic acid, which will lower the pH level. The pH can be determined using colorimetric or electrochemical methods.

Colorimetric tests produce a color change based on the pH level of the sample. Colorimetric tests can be test strips or titration-based where the pH indicator is a liquid added to the sample. Indicators are usually weak acids, which produce a color change at definitive pH values. There are many indicators and each has a narrow pH range, so in order to get a full pH range, a variety of indicators are used.

Indicators can be contained on test strips—litmus paper being the most well known. These can also be in liquid form, in which case you add a specified amount of indicator to the sample and visually compare the color change to a chart or color wheel. These tests are commonly used because they are inexpensive and easy to use, however, results may not be the most accurate. Because it is a comparison of color, the results are subjective to the person reading the result, and most charts give you a range of the pH value rather than a definitive result. There are colorimetric tests in which the result can be read by a spectrophotometer, which allows more consistent results because the color change is read electronically.

The pH can also be read using a meter, which can yield a much more accurate result if the meter is properly maintained and calibrated. A pH meter consists of a measuring electrode, reference electrode, meter and sometimes an automatic temperature compensator. The measuring and is made of a special glass that senses the hydrogen ions and generates a millivoltage, which is picked up by the filling solution and passed onto the silver wire that then passes the signal on to the measuring meter.

A reference electrode provides a constant known voltage. The voltage being measured and the reference are delivered to the meter, which transmits the results in pH units. Many meters have a temperature sensor to automatically correct the difference in temperature.

A pH meter does require some care and maintenance. When not in use, the probe should be stored wet using an electrode storage solution as suggested by the manufacturer. If storage solution is not available, you can temporarily store in water that has been saturated with salt (not containing any iodine) or the pH 4 buffer. Never store the probe in distilled or DI water; this can drastically reduce the life of the probe.

In order to ensure the pH probe is reading accurately, it is important to calibrate on a regular basis. To calibrate use pH buffers, which are solutions of known pH levels—the most common being 4, 7 and 10.

Meters should be calibrated using a minimum of two buffers, but three is optimum. Begin by immersing the probe into the 7 buffer (zero point); the meter should read at or around 7. If the meter does not read at 7, you can adjust up or down until it does. Repeat the process using the other two buffers.

It is important to rinse the probe with DI water before using another buffer in order to ensure accuracy. The life of a pH probe is dependent on how well it is cared for and the environment in which it is being used. A pH probe should typically be replaced once every six months to a year, depending on use.

Conductivity Analysis

Conductivity is another analysis that can easily be done onsite and is a good indicator of water quality. Conductivity is the measurement of ions that conduct electricity and is often used to estimate dissolved solids in the water. Conductivity is typically measured using a conductivity meter.

Meters that utilize an amperiometric method have two electrodes to which an AC voltage is applied, and the electrodes measure the current. This method is based on Ohm's law, meaning the higher the current being measured, the higher the conductivity will be.

Meters that utilize a potentiometric method have four rings, and the two outer rings apply an AC voltage to induce a current loop in the solutions being measured. The two inner rings measure the drop in voltage induced by the current loop. The advantage to the potentiometric method is that it will cover a wide range of conductivities.

Chlorine Tests

Chlorine is another test commonly done onsite. Chlorine should be tested immediately after a sample has been collected because it is a reactive chemical that will readily combine with other elements already in the water to form other compounds referred to as disinfection byproducts.

Many water treatment professionals or well drillers test the chlorine levels onsite to make sure they have added the appropriate amount of chlorine to fully disinfect the water. The most widely used method is Standard Method 4500Cl-G, which utilizes a color reagent commonly referred to as DPD. The DPD stands for N,N-Diethyl-P-Phenylenediamine and produces a pink-to-red color based on how much chlorine is in the sample. Testing kits will then either compare the sample to a color chart or wheel. Some colorimetric tests will use a meter to measure the color change, which improves the accuracy. Chlorine can also be measured using an amperiometric method that utilizes a probe; however, this type of test is typically used for inline testing.

There are many tests you can run for drinking water, some of which should be performed by a laboratory while some can be done onsite. Decide what tests you would like to run onsite and then perform testing to see how accurately you can test. Onsite testing kits can differ depending on the manufacturer, which can affect the level of accuracy you or your technicians can achieve, so you may want to look at a variety of manufacturer's kits.

It is important that whoever is running the analysis is confident in the results they are achieving. When performing tests for health-based contaminants like nitrates or arsenic, consider consulting a laboratory to assure you are getting the most reliable results. *wqp*

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