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Water Testing

Interpreting Water Tests: What Do The Numbers Mean?

Current laboratory techniques can detect impurities at very low concentrations in water. Consequently, water that we once considered pure really contains numerous contaminants, very often from natural sources and usually below harmful levels. Since water can dissolve thousands of substances, we cannot expect pure water, but we want to be sure of safe drinking water.

To protect family members and livestock, private water supplies should be checked to see if they meet the minimum criteria for bacterial and chemical content. Three general types of water testing are applicable to residential water:

- Bacteriological analysis to determine if the water supply is contaminated by human or animal waste.
- Chemical analysis to check for contamination by hazardous chemicals.
- Mineral and pH analysis to determine the quality of the water and its desirability for a domestic water supply.

Bacteriological Tests

It is not possible to test for every water-borne disease-causing bacteria and virus. If such tests were possible, they would be very costly. Instead, only a test for total coliform bacteria is usually performed.

Coliform bacteria are found in the digestive system and pass through in the waste of human beings and warm-blooded animals. Coliform bacteria are not general pathogens but serve as indicators to show that disease bacteria may be present and that treatment or corrective measures should be taken. Coliform tests have become the basis for bacteriological evaluation of water in the United States. If these bacteria are present in a water supply, sewage or manure may be contaminating the water.

Tests for coliform may be carried out using either the multiple-tube fermentation technique or the membrane filter technique. The **multi-tube fermentation procedure** involves three test phases called the pre-

sumptive, the confirmed, and the completed test. The presumptive test is based on the ability of coliform bacteria to ferment lactose sugar broth, producing gas. The confirmed test consists of growing cultures of bacteria from the presumptive medium that suppresses the growth of other organisms. The completed test is then based on the ability of the cultures to again ferment lactose broth. This test is very specific for coliform.

The **membrane-filter technique** is faster than the fermentation procedure and is becoming the coliform test standard in most laboratories. It has the advantage of giving a direct count of the number of coliforms, but it is not as specific for coliform as the fermentation technique. The number of coliform bacteria present is determined by passing a known volume of water through a membrane filter that has a very small pore size. The coliform bacteria are trapped on the filter. A sterilized growth medium is then poured over the filter, and the bacteria are left to grow. After incubation, the coliform colonies are counted, and the concentration in the original water sample determined.

Coliform tests alone will not distinguish whether bacteriological contamination is from humans or other animals. Therefore, some labs are beginning to analyze for fecal streptococci as well as fecal coliform. The quantities of fecal coliforms and fecal streptococci discharged by human beings are significantly different from the quantities discharged by other animals. Thus, the ratio of fecal coliform (FC) count to the fecal streptococci (FS) count (**the FC:FS ratio**) can be used to show whether the suspected contamination derives from human or from animal wastes.

Interpreting Bacteriological Tests

A general bacteriological report from the laboratory will indicate that the water is either coliform negative or coliform positive. A positive coliform test means that coliform bacteria do exist in the water. If this is the case, then you should take immediate steps to eliminate the source of contamination and to disin-

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fect the water before use. It is not unusual for private water supplies to have bacterial contamination. Therefore, it is important that all new wells and private water sources be tested before being used and retested at some prescribed interval. If your lab uses the fermentation technique, the report will come back with a number designated as MPN which is an abbreviation for “most probable number” per 100 ml. This is not an absolute concentration of organisms present but a statistical estimate of that concentration.

If the lab uses the membrane-filter technique, the report will come back with a concentration of coliform colonies. For example, if 100 ml (about 3.4 ounces) of water were filtered and 1 colony grew on the plate, the reported concentration would be 1 per 100 ml. Sometimes samples come back designated TNC which is an abbreviation for “too numerous to count.”

The ratio of fecal coliform (FC) count to the fecal streptococci (FS) count (FC:FS ratio) can be used to determine the source of pollution in rural areas where septic tanks are used and animal wastes are common.

Typical ratios of FC to FS for human beings and various animals are presented in Table 1. The FC:FS ratio for domestic animals is less than 1.0 whereas the ratio for human beings is more than 4.0. If ratios are obtained in the range of 1 to 2, the most likely interpretation is that the pollution is derived equally from human and animal sources.

Table 1. Estimated Fecal Coliform To Fecal Streptococci Ratio From Feces Of Human Beings And Some Animals.

Animal	Fecal Coliform To Fecal Streptococci (FC:FS) Ratio
Chicken	0.40
Cow	0.20
Duck	0.60
Human Being	4.40
Pig	0.04
Sheep	0.40
Turkey	0.10

Source: Mara 1974.

Chemical And Mineral Tests

Many synthetic chemicals can contaminate a water supply, impair its usability, and create a health hazard. Examples include petroleum products, agricultural pesticides, and industrial chemicals.

Unless a specific chemical or type of chemical is suspected to be in the water, special chemical tests are not routinely performed. Fees are relatively expensive for **chemical analyses** particularly if the lab is asked

to screen the water sample for the presence of some unknown chemical. However, if a particular chemical is suspected, a test can usually be performed at a nominal fee (less than \$50.00). Fees for testing the levels of certain chemicals may be very high (from \$200 to more than \$1,000).

A **mineral analysis** indicates the extent of mineral impurities in the water. Large amounts of minerals and other impurities may not only affect the appearance of the water, they can also pose a health hazard.

For minerals which are generally found in high concentrations, **colorimetric and titrametric testing** methods are commonly used. The results are compared to representative standards in field test kits.

For trace elements and organic contaminants which are found in much lower concentrations, other analytical techniques are used. These techniques include **atomic absorption spectroscopy, activation analysis, chromatography, mass spectroscopy, and emission spectroscopy**. These techniques are usually expensive and require sophisticated laboratory equipment and well-trained personnel. Procedures are described in standard methods of chemical analyses handbooks.

Interpreting Chemical, Mineral, And pH Tests

Most analyses for contaminants—both chemical and mineral—provide results in terms of concentration. (See previous articles on drinking water standards.) These results are usually expressed in units of either parts per million (ppm) or milligrams per liter (mg/L). These units are used interchangeably by most people. Concentrations of some contaminants are even expressed in quantities as small as parts per billion (ppb). Concentrations greater than 10,000 milligrams per liter are commonly expressed in percentages by weight.

While one part per billion is very small (like 1 teaspoonful in two Olympic-sized swimming pools or one aspirin in 96,000 gallons of water), it may take only a small amount of some contaminants to cause adverse health effects. The Environmental Protection Agency (EPA) has determined the Maximum Contaminant Level (MCL) of health-affecting minerals and chemicals. Most of these levels are based on milligrams per liter (parts per million) or micrograms per liter (parts per billion.) The EPA also regulates nuisance contaminants. These are also measured in milligrams per liter or parts per million.

A typical mineral analysis will give the content in parts per million of mineral elements such as calcium, magnesium, manganese, iron, copper, and zinc. It will also determine the acidity or pH of the water and the hardness, expressed in parts per million or grains per

gallon (usually as calcium carbonate equivalent). It may also give the concentration of nitrate, sulfate, and other chemical compounds.

It is good practice to have a mineral analysis to determine the quality of a new water supply and to retest after 6 months of use. After that, repeated testing may be unnecessary unless there is an obvious change in the color, taste, odor, or staining potential of the water.

Water hardness (total dissolved solids, commonly referred to as TDS) is often reported as a concentration (mg/L) of calcium carbonate equivalent. Hardness may also be expressed as grains per gallon (gpg). Soft water has 0 to 75 mg/L of calcium carbonate (0 to 5 gpg); very hard water, more than 300 mg/L (more than 18 gpg). One grain per gallon is approximately equivalent to 17.1 mg/L.

When hardness exceeds 180 mg/L, it generally causes problems, and a water softener should be considered. Water softened to zero hardness is corrosive. A blend of non-softened water and extremely soft water is desirable.

Acidity of water is expressed in pH units. This is a numerical expression that indicates the degree to which water is acidic or basic. The pH can range from 0 to 14, but most potable water will range from 6.5 to 8.5. Any solution with a pH below 7 is acidic; any solution with a pH above 7 is basic or alkaline.

High pH levels are undesirable since they may impart a bitter taste, cause buildup of mineral deposits on water pipes and appliances, and decrease the effectiveness of chlorination.

Summary

If you have your water tested, do not be surprised if many substances are found and reported. Before becoming concerned, compare results with Primary and Secondary Drinking Water Standards.

If there is a problem with your water or if you are confused about the test results, consult a water quality treatment expert. If a drinking water standard is exceeded, notify your local health department or the Alabama Department of Environmental Management (ADEM). These agencies as well as private water treatment companies can be contacted for specific treatment recommendations.

Finally, have your water retested to be certain that you really do have a problem. The second test should be done by a different laboratory to confirm results.

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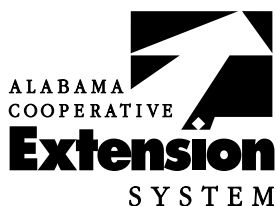
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The following articles in the Water Quality series may be helpful:

Drinking Water Standards

Protecting Your Health: Primary Standards

Regulating Nuisance Contaminants: Secondary Standards



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