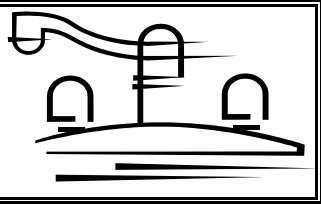
Homeowner's Package
Interpreting Drinking Water Quality Results
Identifying Problems and Solutions



This fact sheet is intended to help you interpret the results of commonly recommended analyses for drinking water from private wells in Wisconsin. Some of these tests are important because they deal with health related contaminants; the other tests will tell you about important characteristics of your well water, such as how hard or corrosive it is.

BACTERIA-COLIFORM

Coliform bacteria are microorganisms that are found in surface water and soil. Because coliform bacteria are also found in the feces of humans and animals, they are used as an indicator of the sanitary conditions of your well. A sanitary well should not contain any coliform bacteria. While coliform bacteria do not usually cause disease, their presence in a water sample indicates a potential pathway for fecal wastes and other pathogenic (disease causing) organisms to enter your well. If human or animal wastes are contaminating the water, gastrointestinal diseases, hepatitis, or other diseases may result. If coliform bacteria is present, many laboratories will also test for *E.coli,* a type of fecal coliform. The presence of *E. coli* in a water sample is more conclusive evidence of fecal contamination which represents an even greater health risk than the presence of coliform bacteria.

***ABSENT** = No coliform bacteria are present and the water supply is bacteriologically safe.*
PRESENT** = Coliform bacteria are present; water supply is considered bacteriologically **unsafe

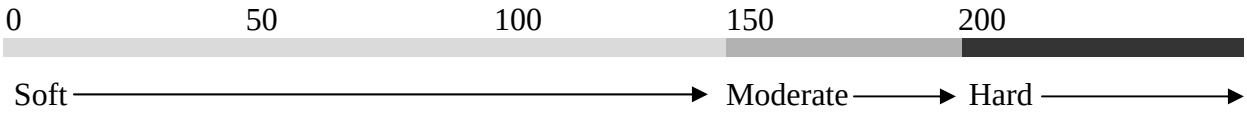
What should you do if coliform bacteria are present?
If coliform bacteria are present in a water sample we recommend resampling, using careful technique. *Until the source of the problem is identified and corrected, we recommend using an alternative source of drinking water or boiling water for 5 minutes before using for drinking or cooking.* If a second test confirms the original test, take corrective action outlined below:

1. Check well for sanitary defects. Some common examples include:
   - Well cap is loose or missing (well cap should be a vermin proof cap).
   - Casing is cracked or rusted through, or casing does not extend 12 inches above grade.
   - Inadequate grout (seal or fill around well casing).
   - Pitless adapter poorly welded.
2. After correcting any visible defects, disinfect with a dilute bleach solution using the procedure outlined by the Department of Natural Resources brochure entitled "Bacteriological Contamination of Drinking Water Wells".
3. Test again after all traces of bleach have dissipated to ensure that the procedure was effective.

Comments: In areas where fractured bedrock aquifers are overlain by thin soils (called karst regions) bacteria in a well may be the result of geologic conditions which don't allow for adequate filtration of water before reaching a well. You may suspect this if water suddenly changes color or odor shortly following large rain events. For wells that are consistently contaminated with bacteria, disinfection may not solve the problem. In this case, the best solution may be to drill a new well.

HARDNESS - TOTAL

The hardness test measures the amount of calcium and magnesium in water. Hardness is primarily caused by water slowly dissolving rocks that contain calcium and magnesium. While there are no health concerns associated with drinking hard water, it can cause lime buildup (scaling) in pipes and water heaters. Hard water reacts with soap which can decrease its cleaning ability. In addition, hard water causes build-up of soap scum and/or graying of white laundry over time. Some people that use hard water for showering may notice problems with dry skin. Calcium and magnesium are essential nutrients. Drinking hard water generally contributes a small amount towards total calcium and magnesium dietary needs. If hardness levels are very high this could represent a significant contribution of calcium and magnesium to the diet. Water naturally low in total hardness (referred to as soft water) may be corrosive. *Note: The water softening industry measures hardness in grains per gallon. 1 grain/gallon = 17.1 mg/L $CaCO_3$.*



Acceptable results: The total hardness is a test for overall water quality; there are no health concerns related to total hardness. Values near 150 mg/L are generally ideal from an aesthetic viewpoint. Generally, values less than 150 mg/L are considered soft water while values greater than 200 mg/L are considered hard water.

Sources: Primarily dissolved carbonate minerals from soil and rock materials. When carbonate minerals dissolve, they increase the amount of calcium and magnesium ions in water.

ALKALINITY

Alkalinity is a measure of water's ability to neutralize acids, and so is related to pH. It results primarily from dissolving limestone or dolomite minerals in the aquifer. Alkalinity and total hardness are usually nearly equal in concentration (when they are both reported in mg/L $CaCO_3$ (calcium carbonate), because they form from the same minerals. If alkalinity is much higher than total hardness in an unsoftened sample, consider testing for sodium. If alkalinity is much lower than total hardness, test for chloride, nitrate, and sulfate.

The lower the alkalinity, the more likely water is to be corrosive. High alkalinity water (greater than 150 mg/L) may contribute to scale (lime) buildup in plumbing.

Acceptable results: This is a test for overall water quality, there are no health concerns associated with alkalinity. When expressed as mg/L $CaCO_3$, the value should be near that of hardness (from 75% to 100% of the hardness value).

Sources: Primarily dissolved carbonate from soil and rock materials.

Water Testing Units of Measure

Many minerals and contaminants in water are reported as a concentration:
one milligram per liter (mg/L) is equal to one part per million (ppm)
When comparing test results to water quality standards and other guidelines it is important to check that you are comparing values with the same unit of measure.

CONDUCTIVITY

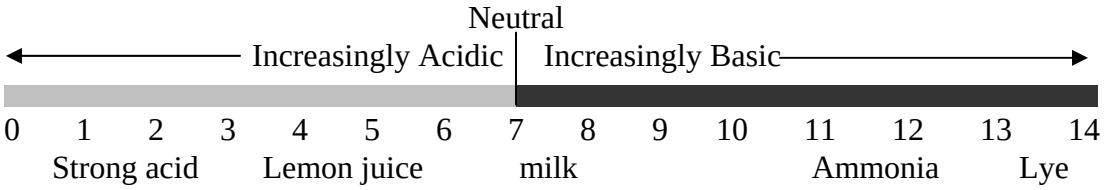
Conductivity (specific conductance) is a measure of the ability of water to conduct an electrical current. It is related to the amount of dissolved substances (or ions) in water, but it does not give an indication of which minerals are present. Conductivity (measured in μmhos/cm at 25^{o} C) is about twice the hardness (mg/L $CaCO_3$) in most uncontaminated waters in Wisconsin. If it is much greater than two times the hardness, it may indicate the presence of other ions such as sodium, chloride, nitrate, or sulfate, which may be human-influenced or naturally occurring. Changes in conductivity over time may indicate changing water quality.

Acceptable results: This is a test for overall water quality, there is no health standard associated with conductivity. A normal conductivity value is roughly twice the hardness in unsoftened water.

Sources: Natural and human-made dissolved substances in the water.

pH

Chemists use a pH test that measures the concentration of hydrogen ions in a solution. The concentration of hydrogen ions determines whether a solution is acidic or basic. The pH test rates your water's acid/base level on a scale from 0 to 14. A pH value of 1 is very acidic (like battery acid), while a pH value of 14 is very basic (like lye). A pH value of 7 is neutral. A change of 1 pH unit is a 10-fold change in acid level. Acidic water (pH less than 7) is often corrosive. pH values are often slightly higher in the laboratory than at your well, because carbon dioxide gas (CO_2) leaves water when it is exposed to air.



Acceptable results: This is a test for overall water quality; there is no health standard associated with pH. However corrosive water is more likely to contain elevated levels of copper or lead, if these materials are in your household plumbing (see Saturation Index). Typical groundwater pH values in Wisconsin range from about 6.5 to 8.5. Values from 7.5 to 8.3 are ideal. The lower the pH, the more corrosive the water will be.

Sources: Low values are most often caused by lack of carbonate minerals in the aquifer.

Groundwater

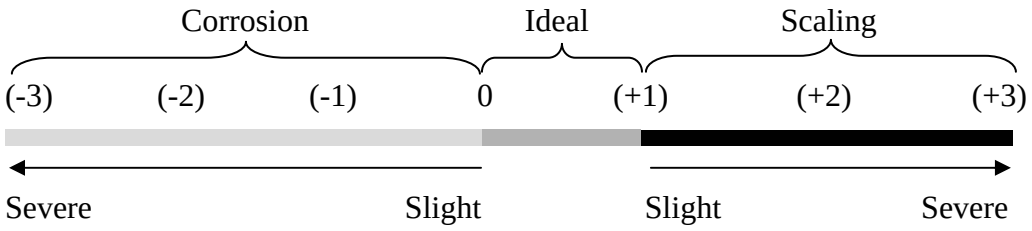
Did you know that your well water is actually groundwater? Groundwater is water that occupies void spaces between soil particles or cracks in the rock below the land surface. It originates as precipitation that infiltrated into the ground. The type of soil and bedrock that your well is drilled into often determines water's pH, saturation index, or the amount of hardness or alkalinity in water. The type of soil and bedrock in a region also determines how quickly contaminants can reach groundwater. Human activities are often responsible for elevated levels of contaminants such as nitrate and chloride.

SATURATION INDEX

The saturation index is a measure of water's ability to corrode or form scale. It is calculated using values from pH, alkalinity, total hardness and conductivity tests. A negative value indicates that water is likely to be corrosive, while a positive value indicates a tendency for lime scale (calcium carbonate) to precipitate (form a solid and settle out) from water.

Water is a good solvent, and will attack unprotected metal plumbing. Corrosive water can sometimes have health implications if it causes elements like lead, copper and zinc from pipes and solder joints to dissolve into drinking water. Symptoms of corrosive water may include pinhole leaks in copper pipes or green stains in sinks. A value of (-3) indicates that water is more corrosive than a value of (-1).

Lime precipitate (scale) is a natural protection against corrosion. Too much scale, however, will plug pipes and water heaters, decreasing their efficiency. Water softeners are an effective form of treatment to prevent scale buildup, but also decrease any protection from corrosion the natural water may have provided. A value of (+1) indicates less scaling potential than a value of (+3).



Acceptable results: This is a test for overall water quality, there is no health standard associated with the saturation index. Values between 0 and 1 units are considered the most desirable. However, the relationship between the saturation index and corrosivity/scaling is imperfect. Because copper and lead are health related concerns, you may still need to test your water to determine whether corrosion of these metals is occurring.

Sources: Low values may be caused by lack of natural carbonate minerals in the aquifer. Low values also occur when hardness is removed with a water softener. High values normally relate to high water hardness and alkalinity.

Corrective Action for Hard or Corrosive Water

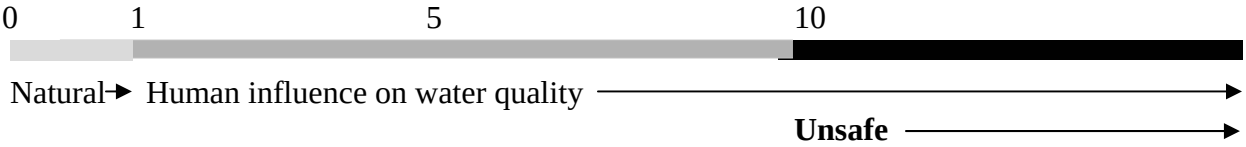
If you are experiencing problems with scaling or other issues associated with hard water:

- Soften water using a water softener. Softened water removes calcium and magnesium from the water and replaces it with another cation (usually sodium). Many people choose not to soften the cold water tap used for drinking and cooking.

If you are experiencing problems with corrosion of household plumbing:

- Install a water treatment device designed to make water less corrosive.
- Install plastic plumbing which will not develop pinhole leaks or leach metals.
- If you have a shallow well, drilling a deeper well may be helpful.
- Water allowed to contact unprotected metal plumbing for extended periods can dissolve unsafe levels of copper and/or lead. If levels of copper or lead in drinking water are a concern, run water for a few minutes before collecting for drinking or cooking. Or use a water treatment device designed to remove copper/lead.

Nitrate is a chemical commonly found in lawn and agricultural fertilizer. It is also formed when waste materials such as manure or septic system effluent decompose. Infants less than six months of age should not drink water (or formula made with water) that contains more than 10 mg/L nitrate-nitrogen. This is because of concerns related to methemoglobinemia (also called blue baby syndrome), a condition *in infants* which inhibits the blood's ability to carry oxygen. If not caught early and treated, this condition can be fatal. Some studies also suggest that high nitrate water may be linked to birth defects and miscarriages, so pregnant women should also avoid drinking water over 10 mg/L. The natural level of nitrate in Wisconsin's groundwater is less than 1 mg/L. Elevated nitrate levels can be an indicator of other potential contaminants. If nitrate levels are elevated you may want to consider testing for pesticides if you know they are used nearby.

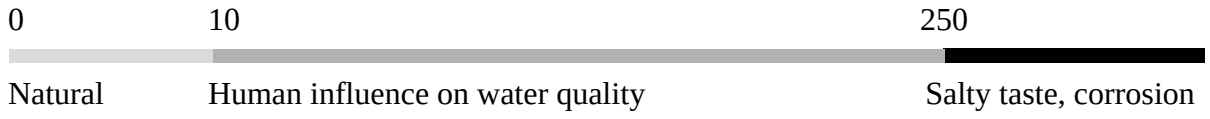


Acceptable results: The drinking water standard for nitrate-nitrogen is 10 mg/L. *Above 10 mg/L is considered unsafe for infants less than 6 months old and women who are pregnant.* Less than 10 mg/L is considered acceptable. Less than 2 mg/L is preferred. If feed is also high in nitrate, problems for livestock may begin to occur if the concentration of nitrate in well water is between 20-40 mg/L.

Sources: Fertilizers, septic system effluent, and animal waste.

CHLORIDE

In most areas of Wisconsin, chloride in groundwater is naturally less than 10 mg/L. Higher concentrations usually indicate contamination by septic systems, road salt, fertilizer, animal waste or other wastes. Some higher naturally occurring concentrations occur in carbonate and sandstone aquifers in eastern Wisconsin . Chloride is not toxic, but some people can detect a salty taste at 250 mg/L. Water with high chloride may also have elevated sodium content. High chloride may also speed up corrosion in plumbing (just as road salt does to your car).



Acceptable results: Chloride has no health standard. Levels less than 10 mg/L are desirable. Levels more than 250 mg/L may cause a salty taste or corrosion of some metals. Sodium (which may be found with chloride) has a health advisory level of 20 mg/L for individuals on physician prescribed "no salt diets".

Sources: Septic systems, road salt, fertilizer, animal waste, landfills, other wastes, or naturally occurring mineral deposits.

Corrective Action for Nitrate

If possible, eliminating the contamination source is the ideal solution. Unfortunately it may take years or even decades to observe any reduction in nitrate levels. As a result an alternative solution is usually necessary. Below are some additional actions that may reduce nitrate levels:

- Extending the casing depth, lowering the depth of the existing well, or drilling a new well *may* result in water with lower nitrate concentrations.
- Use bottled water for drinking and cooking.
- Connect to a public water supply if possible.
- Use a water treatment device designed to reduce nitrate levels.*
    - The following devices can be effective at reducing nitrate levels in drinking water:
        - Reverse osmosis (RO), distillation, or anion exchange

* *When purchasing a water treatment device to remove a health related contaminant, choose a device that has been approved by the WI Dept. of Commerce. If you are unsure request a product approval letter from the manufacturer.*

ADDITIONAL INFORMATION

The following website has more information on private wells and water testing:
http://www.uwsp.edu/cnr/gndwater/privatewells/index.htm

Useful Publications

- **Answers to Your Questions about Groundwater**. DNR. PUB DG-049 2003
- **Bacteriological Contamination of Drinking Water**. DNR. PUB-DG-003-2005
- **Better Homes and Groundwater**. DNR. PUB-DG-070 2004
- **Choosing a Water Treatment Device**. UWEX. G3558-5
- **Do Deeper Wells Mean Better Water?** UWEX. G3652
- **Improving Your Private Well Water Quality**. UWEX. G3826
- **Tests for Drinking Water from Private Wells**. DNR. PUBL-DG-023-04REV
- **You and Your Well**. DNR. PUB-DG-002 2003

For copies of **WI Department of Natural Resources (DNR)** publications please call (**608)266-0821** or visit http://www.dnr.state.wi.us/org/water/dwg/pubbro.htm.

For copies of **UW-Extension (UWEX)** publications visit http://learningstore.uwex.edu/ or call (**877)947-7827.**

The **Wisconsin Geological and Natural History Survey (WGNHS)** has many excellent geology and groundwater resources including maps available from their office. If interested call (**608)263-7389** or for a complete listing visit their website at http://www.uwex.edu/wgnhs/pubs.htm.

Original Authors: Byron Shaw, Christine Mechenich, and Jim Peterson
Revised March 2007 by Kevin Masarik, Groundwater Education Specialist
Center for Watershed Science and Education, UW-Stevens Point/UW-Extension