

WELL WATER TESTING AND UNDERSTANDING THE RESULTS

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As a private well owner, you are responsible for making sure your well water is safe to drink. Private drinking water wells are not required to be tested on a routine basis like public water supplies. Many substances that can be found in well water and can affect drinking water quality have no taste, color, or smell. The only way to know if they are or could be present is to have your well water fully tested before purchasing the property and regularly thereafter for common contaminants.

What's the difference between public and private water supplies?

If your water comes from a regulated public water system (PWS), it is tested regularly for contaminants regulated by federal and state standards. The Environmental Protection Agency (EPA) defines a regulated PWS as "any water system that makes water available for drinking to 15 or more connections, or regularly serves an average of 25 individuals daily at least 60 days out of the year." At a minimum, a small PWS checks for bacteria, nitrates, and nitrites. A large community PWS will test for many more constituents including pathogens, radioactive elements, and certain toxic chemicals. Any PWS that is designated as a "community water system" is required to provide a Consumer Confidence Report or Drinking Water Quality Report.

Private water supplies can include wells, springs, and cisterns. You, the home owner/well owner, are responsible for assuring the water is safe for potable use. Routine testing for common contaminants is highly recommended. Even if you have a safe water supply, regular testing can be valuable as it establishes a record of water quality. If your water quality changes, you can address it; and if someone damages your water supply, your records can demonstrate the historical water quality, which may help you in your efforts to correct the impaired water supply.

Why should you test your well water?

No one else will test your water for you. Regular testing helps to protect you and your family's health and protects the financial investment you have in your home. The only reliable way to detect contaminants in your water is to test it. Laboratory testing provides you with information on the quality of your well water.

When should you test your well water?

In addition to yearly testing, as a private well owner you should have your drinking water tested whenever:

- You notice a change in the taste, odor, or color of your water
- Before buying or selling a home with a private well (this may be a requirement in some areas, check with your real estate agent or county health department)
- Before and after installing any type of water treatment system

Because of differences in groundwater quality throughout Arizona, it is best to check with your drinking water agency or local health department for information to help you determine what to test for, as there may be local pollution issues that influence your drinking water quality. The most common times to test your well water quality are when you are buying a home or are experiencing problems. See Table 1.

How do you collect a water sample for testing?

Well owners should analyze their water both at the wellhead (if possible), after a water treatment device (to make sure that it is removing the constituents it is supposed to remove), and at the tap that has received no water treatment (choose an inside cold water line). Water analyses at the wellhead and at a tap that doesn't receive treated water should be the same. If not, you will want to find out why any parameters are different (could be because of a cracked pipe, leak, or contaminated storage tank/distribution system). Below are steps to take for collecting water samples both in the house and at the wellhead.

Steps to Take for Collecting Water Samples in Your House

Water samples for bacterial analyses must be collected in a sterile container under sterile conditions. The best option is to obtain a container from the laboratory that will be analyzing your water.

1. The sample collector should either wash his/her hands before sampling or wear latex/nitrile gloves.

Table 1. Recommended drinking water tests for various conditions of (or nearby activities to) the source. (Source: EPA)

Conditions or Nearby Activities	Recommended Test
Recurrent gastro-intestinal illness	Coliform bacteria (total and fecal) ¹
Household plumbing contains lead	Copper, lead, pH ²
Radon in indoor air or region is radon rich	Radon
Scaly residues, soaps don't lather	Hardness
Water softener needed to treat hardness	Alkalinity, calcium, magnesium
Stained plumbing fixtures, laundry	Copper, iron, manganese
Objectionable taste or odor (rotten eggs)	Corrosion, hydrogen sulfide, metals
Water appears cloudy, frothy, or colored	Color, detergents, suspended solids
Corrosion of pipes, plumbing	Corrosion, lead, pH ²
Rapid wear of water treatment equipment	Corrosion, pH ²
Nearby areas of intensive agriculture, septic systems	Coliform bacteria ¹ , nitrate, pesticides (herbicides, insecticides, fungicides)
Coal or other mining nearby	Corrosion, metals, pH ²
Gas drilling operation nearby	Barium, chloride, sodium, strontium
Odor of gasoline or fuel oil, and near gas station or buried fuel tanks	Volatile organic compounds (VOC's)
Dump, junkyard, landfill, factory or dry-cleaning operation nearby	Chloride, metals, pH ² , sulfate, total dissolved solids (TDS) ⁴ , VOC's
Salty taste and seawater, or a heavily salted roadway nearby	Chloride, sodium, TDS ⁴

¹Microorganisms – microorganisms in your water can cause a range of gastrointestinal illnesses including dysentery and cholera. Typically, total coliform, fecal coliform, or Escheria coli are the bacterial tests that indicate the microbiological quality of water.

²pH – although pH is not a primary drinking water standard (those that cause health problems), it can impact color, taste, and odor and thus is known as a secondary drinking water standard (contributes to the aesthetics of the water). On a scale of 1 to 14, the pH number measures acidity (1-6), neutrality (7), or alkalinity (8-14). A standard range is 6.5-8.5, and beyond that, the water is considered corrosive.

³Nitrate – high levels of nitrate can cause a potentially fatal condition in infants called methemoglobinemia, or blue baby syndrome.

⁴Total dissolved solids (TDS) – TDS is also a secondary drinking water contaminant (see footnote 2), and its standard is 500 ppm. High levels of TDS can make water taste bad, cause hard water deposits, and reduce the effectiveness of soaps and detergents. Total dissolved solids may include organic matter, filterable residue of dissolved materials, and organic salts. Principal salts include sodium, potassium, calcium, magnesium, bicarbonate, chloride, and sulfate, with traces of iron, manganese, and many other substances.

- Choose a location to sample your water. If you don't have any water treatment devices, such as a water softener or a reverse osmosis filter, take the sample from a cold water tap where you get your drinking water. If possible, choose a non-leaking, non-swivel, non-mixing faucet. If you do have treatment devices on your water system, you need to decide what you want to test. Do you want to know about your source water quality or the water you are actually drinking? A properly functioning water softener will change the quality of your water since it replaces most of the calcium and magnesium in your water with sodium and/or potassium. A working reverse osmosis system will reduce the levels of salts and other contaminants from your source water. If you want to sample what you are using, simply get the sample from the tap you get your drinking water from. If you want to sample your source water, locate a faucet, which is attached to the water line before the treatment system. Remove any aerators, flow restrictors, or screens. HINT: The bathtub cold water faucet is a good spot to obtain your sample if you want to sample your source water.
- Sterilize the faucet by using alcohol wipes or bleach. An alternate method is to flame the end of the tap with a butane lighter. However, if you have plastic in your faucet, use a different sterilization method. NOTE: extreme care should be used when using an open flame to accomplish this procedure. Keep in mind that by sterilizing the faucet, you could be removing a source of bacterial contamination.
- Allow the water to run for 2-5 minutes. This clears the lines of stagnant water and brings in fresh water for a more accurate test sample.
- Fill the sterile container to the overflowing limit or "fill line" indicated on the collection bottle. Be careful not to touch the inside of the container, sample container lid or top, or the faucet with your fingers.
- Refrigerate samples promptly. NOTE: Do not freeze samples. It is best if the samples arrive at the laboratory within 6 hours of collection, but some laboratories allow for up to 12 hours. Remember to put the samples in an ice chest with ice when transporting them to the laboratory.

Many labs will not accept samples on Friday, so confirm the schedule with the laboratory before taking the sample. Water tests for contaminants other than coliform bacteria may allow for a longer delivery time to the laboratory. Mailing water samples that are to be tested for bacteria is not recommended, as the results are not reliable because the time delay gives any bacteria present time to grow and multiply.

7. Write down the collection date, time, and location for each sample so that you can provide this information to the testing laboratory.

Steps to Take for Collecting Water Samples at the Wellhead



GREGORY FRECH

Water samples for bacterial analyses must be collected in a sterile container under sterile conditions. The best option is to obtain a container from the laboratory that will be analyzing your water.

1. The sample collector should either wash his/her hands before sampling or wear latex/nitrile gloves.
2. Choose a location in the immediate downstream piping from the pump. ADEQ recommends that source samples be taken within a few feet of the wellhead. NOTE: ADEQ requires a non-threaded sample tap to be installed just after the check valve on all new drinking water well installations.
3. Avoid sampling in windy conditions. If it is windy where you are sampling, the sample can become contaminated.
4. Sterilize the sample tap by using alcohol wipes or bleach. An alternate method is to flame the end of the tap with a butane lighter. However, if you have plastic in your tap, use a different sterilization method. NOTE: extreme care should be used when using an open flame to accomplish this procedure. Keep in mind that by sterilizing the tap, you could be removing a source of bacterial contamination.

5. Before collecting the sample, open the tap and allow the water to run full flow until the pump starts and runs for several minutes. This allows the sample to be drawn directly from the groundwater supply rather than water that has been in storage for a period of time. Before collecting the sample, adjust the flow of water to a stream approximately the size of a pencil.
6. Fill the sterile container to the overflowing limit or “fill line” indicated on the collection bottle. Be careful not to touch the inside of the container, sample container lid or top, or the faucet with your fingers.
7. Refrigerate samples promptly. NOTE: Do not freeze samples. It is best if the samples arrive at the laboratory within 6 hours of collection, but some laboratories allow for up to 12 hours. Remember to put the samples in an ice chest with ice when transporting them to the laboratory. Many labs will not accept samples on Friday, so confirm the schedule with the laboratory before taking the sample. Water tests for contaminants other than coliform bacteria may allow for a longer delivery time to the laboratory. Mailing water samples that are to be tested for bacteria is not recommended, as the results are not reliable because the time delay gives any bacteria present time to grow and multiply.
8. Write down the collection date, time, and location for each sample so that you can provide this information to the testing laboratory.

ADEQ-certified Water Distribution Operators

If you do not feel comfortable taking a sample at your well, you can locate an ADEQ Certified Water Distribution Operator to draw the sample for you. An ADEQ Certified Water Distribution System Operator would be useful if you are checking for bacteria in the well. It is very easy to contaminate samples being analyzed for bacteria which will give you a false positive. Contamination can be caused by dust in the wind as well as poor sampling techniques. ADEQ Certified Operators are experienced at how to avoid these problems. A database of ADEQ Certified Operators can be found on the following link: <http://www.azdeq.gov/databases/opcertsearch.html>.

You may still need to locate a laboratory and use their sample bottles. Check with your chosen ADEQ certified operator, or call the lab directly. Labs usually supply the correct sample containers for free.

What are my choices for well water testing?

State-approved laboratories

Private well owners should have their water tested each year at a certified laboratory that has been “approved” by the State of Arizona. It is important that you have your water tested at a state approved lab, as these labs are following accepted procedures for testing your water. The Arizona Department of Health Services, Bureau of State Laboratory Services, is responsible for certifying water-testing facilities in Arizona [contact information: 3443 N. Central Avenue, Suite 810, Phoenix, AZ 85012-2208; (602)

255-3454; FAX (602) 255-3463; <http://azdhs.gov/lab/index.htm>]. There is more information on water testing labs described in the Arizona Cooperative Extension fact sheet *Laboratories Conducting Soil, Plant, Feed, or Water Testing* (AZ1111).

Test kits

Private well owners can purchase numerous types of water testing kits for basic water quality analysis. Most of these kits rely on color changes in either paper strips or liquid solutions. When a water contaminant is exposed to a specific chemical reagent, a characteristic color develops. Most testing kits provide complete instructions and easy-to-follow steps. It is important to follow the directions exactly to avoid erroneous readings from the test kits. Some kits provide only “presence/absence” or “positive/negative” results. These results are not useful unless you can determine the contaminant level that determines either the positive/negative or presence/absence result.

According to Artiola & Uhlman (2009), testing kits have several limitations when compared to many U.S. Environmental Protection Agency (USEPA) approved methods used in laboratories, and these include:

- high contaminant detection limits (may or may not detect contaminants at or below drinking water standards);
- limited or narrow contaminant detection range;
- testing method and/or shortcuts used may or may not be USEPA approved;
- poor or insufficient precision and/or accuracy;
- results may be influenced by the presence of other water contaminants; and
- user error.

They go on to report that these kits can serve private well owners well when:

- using kits to routinely monitor your well and to highlight when a more accurate analysis may be required; and
- using kits from reputable companies that offer a certification or approval for use from the USEPA.

There are several companies that provide water-testing kits with varying degrees of sophistication. These vary from simple paper strips to portable colorimeters that also require multiple reagent mixing steps. You should use kits that are USEPA certified. Avoid testing kits from companies that also sell water treatment devices.

What is the cost of well-water analysis?

State-approved laboratories

Laboratory fees for water quality analysis vary greatly from one parameter to another. According to Janick and Uhlman (2009), testing for hardness, TDS, and pH may cost about \$50, while testing for lead or nitrate may cost about \$30. However, testing for all possible individual pollutants can cost more than \$3,500 per sample. Contact the Arizona Department of Health Services to obtain a list of certified labs. From the list that they give you, you can call several labs to establish current prices. Refer to fact sheet *Laboratories Conducting Soil, Plant, Feed, or Water Testing* (AZ1111) for more information on laboratories.

Test kits

The price of these kits ranges from a few dollars to thousands depending on the number of tests and the amount of sophistication, precision, and automation that the test kit can provide. Test kits using color strips will cost less than test kits using a machine (colorimeter) to read the color and convert it to amount of contaminant. Colorimeters, although more costly than test strips, are generally more accurate, and if you plan to take many tests, may be worth the initial cost.

How do you interpret your test results?

After your water has been tested at a state licensed laboratory, you will receive the test results in the mail. Each laboratory report looks different. However, for each substance that was tested, the amount of that substance found in the water sample should be reported. You can compare the amount detected in your water sample with the drinking water standard that is set by the USEPA for public water supplies. A drinking water standard is the maximum contamination level (usually expressed as a concentration) in a public drinking-water supply, designed to protect human health. Often times, the lab report will list the standard for each substance tested on the report. For more information on water quality standards, see the Arizona Cooperative Extension fact sheet, *Drinking Water Standards* (AZ1009), or visit USEPA's website <http://www.epa.gov/safewater/standards.html>.

Most substances in water are measured and reported as a concentration. Depending on the substance, the results may be reported as:

Part per million (ppm) = milligram per liter of water = mg/L

Part per billion (ppb) = microgram per liter of water = µg/L

CFU/100 mL = colony-forming unit per 100 mL of water

Upon receiving the laboratory report, you should obtain a copy of the National Primary Drinking water Standards (NPDWS) (see USEPA site link in the web resources at the end of this publication) or in Appendix A of the *Arizona Well Owner's Guide to Water Supply* (AZ1485)) and locate the following information for each parameter tested:

- The laboratory minimum detection limit (MDL) for each substance tested from laboratory report.
- The NPDWS maximum concentration limit (MCL) for each substance tested from USEPA table.
- Level of contaminant measured for each substance tested from laboratory report.

How to compare water quality values using example for arsenic in water

Assume that the laboratory report that you received after submitting your samples to the lab included a maximum detection level (MDL) of 5 ppb for arsenic. The USEPA maximum contaminant level (MCL) for arsenic in water is currently 10 ppb. Assume that your water sample tested at 20 ppb. Conclusion: your well water has arsenic levels above the National Primary Drinking Water Standard for arsenic (which means that your water is unsafe to drink), and the laboratory used an acceptable

Table 2. Suggested water testing & visual inspection schedule (source: *Arizona Well Owner's Guide to Water Supply* (AZ1485)).

Type of Test	What to Analyze
Initial Test	Arsenic, chloride, fluoride, hardness, iron, lead, manganese, mercury, nitrate, pH, radionuclides (particularly radon), sodium, sulfate, total coliform bacteria, total dissolved solids. Test for selenium if the well is near both the San Simon and Colorado rivers as well as the Gila River in Yuma County) and test for hexavalent chromium if the well is near Kingman.
Annual Test	Nitrate, pH, total coliform bacteria, total dissolved solids. Spring and summer testing is preferred, after rainy season. USEPA recommends that you test more frequently and for more potential contaminants if you suspect a problem.
Immediate Test <i>Health changes</i> – reoccurring gastrointestinal problems in children or guests	Total coliform bacteria
<i>New baby expected</i> – test immediately and every 6 months until child is 1 year old	Nitrate
Monthly Visual Inspection (look for and note changes)	Color, odor, taste, turbidity (cloudiness, particulates)
Changes in your water supply system (after repairing or replacing well or pipes or installing a new pump or system components)	Test for the same parameters listed in <i>Initial Test</i>

testing method since its reported MDL of 5 ppb, which is less than the USEPA MCL of 10 ppb.

Remember, whatever tests are done, the analyses should be at or below the National Primary Drinking Water Standards. If any of the test results are above the NPDWS, then you have a problem that needs to be addressed immediately. A list of national standards for drinking water health symptoms is available in the *Arizona Well Owner's Guide to Water Supply* (AZ1485) and at the USEPA Safe Drinking Water website <http://www.epa.gov/safewater/>.

How frequently should you get your water tested?

Test your water after replacing or repairing any part of the well system (piping, pump, or the well itself). Also test if you notice a change in your water's look, taste, or smell. Testing frequencies in Table 2 are general guidelines. If you suspect there is a problem with water quality, test it immediately. If any of the tests produce positive results (water test results above the national drinking water standards), contact your county health department or call the Safe Drinking Water Hotline for more information (800-426-4791) and determine and fix the source of the contamination.

Summary

The important part about interpreting your test results is whether the substance is considered a health threat at the

particular concentration found in your water sample. Compare your water test results to USEPA's standards and consult the fact sheets mentioned above. For additional help interpreting your test results, contact your state or local drinking water agency, or County Cooperative Extension Office.

Reference

Environmental Protection Agency. *Drinking Water from Household Wells*. http://www.epa.gov/safewater/privatewells/pdfs/household_wells.pdf. Accessed 15 July 2009.

Environmental Protection Agency. Tribal Compliance Assistance Center, Drinking Water Management. <http://www.epa.gov/tribalcompliance/drinkwater/dwdrinkdrill.html>. Accessed 20 October 2009.

Web Resources

Arizona Department of Water Resources: <http://www.azwater.gov/dwr/default.htm>

Arizona Department of Water Resources Well Owner's Guide: http://www.water.az.gov/adwr/Content/Publications/files/well_owners-guide.pdf

University of Arizona, Well Owners Help: <http://wellownerhelp.org/>

University of Rhode Island, Home*A*Syst Program: <http://www.uri.edu/ce/wq/has/PDFs/Drinking.pdf>

USDA-NIFA National Water Program: <http://www.uri.edu/ce/wq/has/Private%20Wells/PRIVATE.HTM>

U.S. Environmental Protection Agency, Groundwater & Drinking Water: <http://www.epa.gov/safewater>

Water Systems Council: <http://www.watersystemscouncil.org/>

For Additional Information

Arizona Cooperative Extension (ACE) bulletins contain a variety of information about water, water quality, safe drinking water, and private wells. They are available through your county Extension office or from CALSmart Distribution Center, located in Tucson, at 4101 N. Campbell Avenue; (877) 763-531; (520) 795-8508 FAX; or visit <http://ag.arizona.edu/pubs/>

Sources

Artiola, J. and K. Uhlman. 2009. *Arizona Well Owner's Guide to Water Supply*. University of Arizona Extension publication, az1485.

Blue Baby Syndrome at Environmental Health Perspectives. Available at <http://www.encyclopedia.com/doc/1G1-65640291.html>. Accessed 27 June 2008.

Home Water Testing, Office of Water, EPA, WH-550A, EPA 570/9-91-500, June 1991



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This information has been reviewed by University faculty.
cals.arizona.edu/pubs/water/az1486f.pdf

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