WATER

Bacteria in Water Wells

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by R. Waskom[1]

Quick Facts...

Bacterial contamination of drinking water can cause serious human illness.

Bacterial slimes in irrigation wells may clog pumps and pipes.

Bacterial contamination can be controlled by well chlorination, proper septic system and well maintenance, and good sanitation practices.

Coliforms are a broad class of bacteria that live in the digestive tracts of humans and many animals.

A properly cased and sealed well protects water quality.

Bacteria are microscopic organisms that are found just about everywhere. Most bacteria are harmless, but certain types can cause disease, sickness or other problems. Wells used for drinking water should be tested for the presence of coliform every one to two years, in addition to other water quality parameters. Non-disease causing iron bacteria can affect household and irrigation wells. Iron bacteria causes plumbing fittings and laundry to stain and, in severe cases, clogs well screens. Chlorination is the most common method for disinfecting contaminated wells. In some cases, replacing the well cap, casing and seal may be necessary to keep the well clean after it is disinfected. Repairing the household septic system may also be necessary.

Bacteria in Household Wells

Public drinking water supplies are required, by law, to be free from microbial pathogens. However, private water systems, while also vulnerable to contamination from bacteria, usually have no governmental oversight. If you rely on a private well, it is your responsibility to ensure the water is safe to drink. You should inspect the condition of your well regularly and test a water sample every one to two years. More frequent testing is recommended when well condition is poor, the well has been inundated with floodwater, the septic system has malfunctioned, abandoned wells or feed yards are located nearby, or visitors have complained of stomach or intestinal distress. Bacteria in your water may indicate that your well has become contaminated with fecal matter, possibly introducing harmful viruses and protozoa such as Cryptosporidium or Giardia.

Protecting Your Water Supply

- Periodically inspect exposed parts of the well for problems such as:
  - a cracked, corroded, or damaged well casing.
  - a broken or missing well cap.
  - settling and cracking of surface seals.
- Slope the area around the well to drain surface runoff away from it.
- Keep accurate records of well maintenance and water quality analysis.

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- Hire a licensed water well contractor for new well construction, modification, or abandonment and closure.
- Avoid mixing or using pesticides, fertilizers, weed killers, fuels degreasers, and other pollutants near the well.
- Do not dispose of wastes in dry wells, abandoned wells or sinkholes.
- Do not cut off the well casing below the ground's surface.
- Pump and inspect septic systems as often as recommended by your local health department.
- Never dispose of hazardous materials in a septic system.
- Have the well tested once a year for coliform bacteria, nitrate and other particles of concern.

Testing Well Water for Bacteria

Laboratories that test for coliform bacteria usually have specific times and days where they accept these water samples. It is critical that you contact the local health department, or private lab, prior to collecting the sample. Most labs give you a sterile sample bottle and instructions for collecting the sample.

If you have not sampled your well for bacteria recently, collect a water sample at a bathroom faucet with the aerator removed. If you are retesting a well that has previously tested positive for bacteria or after a disinfection treatment, sample as close to the well as possible. If you have a holding tank or in-house water treatment system, you may want to collect separate samples at the well and at the bathroom faucet. Kitchen faucets with swivel arms are not recommended locations for sampling.


Sampling at the tap for bacteria in well water.

Before filling the sample bottle, run cold water though the faucet at full flow for three minutes, then reduce the flow to a trickle and let run for one additional minute. Wash your hands with soap and warm water before opening the sterile sample bottle (do not touch the inside of the bottle or lid). Do not rinse the sample bottle before filling to the level indicated on the bottle. Cap the bottle tightly and label it with your name, address, date and time of sampling. Keep the sample cool and deliver it to the lab within 24 hours.

Interpretation of Lab Results

There are a variety of bacteria, parasites and viruses that cause health problems when humans ingest them in drinking water. Testing water for each of these germs is difficult and expensive. Instead, water quality and public health workers measure coliform levels. The presence of coliforms in drinking water suggest there may be disease-causing agents in the water.

Coliforms are a broad class of bacteria that live in the digestive tracts of humans and many animals. Labs may test for total coliforms, fecal coliforms, or *E. coli*, any of which indicate microbial contamination. Results are generally reported as no coliforms present, the actual number of organisms detected per 100 ml of water, or as too numerous to count. Some labs may simply report results as bacteriologically safe or unsafe. If your drinking water contains more than 1 total coliform org/100 ml or is reported as unsafe bacteriologically, the well should be disinfected and retested in one to two weeks. If subsequent tests indicate bacteria are still present, the source of the contamination must be identified and eliminated before the water is safe to drink.

Disinfecting Contaminated Wells

There are several options for private water supply disinfection. These include continuous chlorination, shock chlorination, ultraviolet radiation (UV), ozonation, boiling and pasteurization. Each of these methods has advantages and limitations, but they are all intended for use on clean, clear water. Water

Other disinfection methods for household water systems:

***Ultraviolet radiation** (UV)*

• uses UV light to kill microorganisms
• lamp has 9- to 12-month lifetime
• needs UV sensor to determine germicidal dose
• effective for bacterial contaminants (viruses more difficult, cysts and worms unaffected)
• advantage is that no chemicals are added to the water
• disadvantage is that there is no residual disinfection; cloudy or turbid water decreases effectiveness

Ozonation

• ozone more powerful disfectant than chlorine
• disadvantage is ozone cannot be purchased, must be generated on site
• machinery to generate ozone can be complicated and difficult to maintain
• spa ozonators can easily be placed in cisterns or storage tanks
• effects of ozonation by-products not fully understood

Boiling

• two minutes vigorous boiling assures biological safety
• kills most organisms (chlorination reduces them to safe levels)
• practical as an emergency measure only
• once boiled, cooled water must be protected from recontamination

Pasteurization

• uses heat to disinfect but does not boil water
• flash pasteurization uses high temperature for short time (160° F, 15 seconds)
• low-temperature pasteurization uses lower temperature for longer time (140° F, 10 minutes)

Note: Always wear protective clothes, gloves and goggles when handling chlorine, and work in a well ventilated area. If chlorine comes into contact with the skin, and especially the eyes, stop immediately and wash thoroughly with clean water.

supplies must be sealed and protected from sources of bacterial contamination for disinfection methods to function properly.

Chlorination is the standard method for disinfecting wells because it is highly effective against bacteria. However, the drawbacks include: safety issues in handling concentrated chlorine; the taste it gives the water; the required contact time; its variable effectiveness against other microorganisms; and chlorine's reaction with organic matter to form trihalomethanes, THM (THMs are known carcinogens).

Continuous chlorination is accomplished with a chemical feed pump that dispenses chlorine directly into the well or into a baffled tank. The contact time required to kill microbes varies depending on the chlorine concentration, water temperature and pH. **Simple chlorination** maintains a low level of chlorine at a concentration of 0.2 to 0.5 ppm for at least 30 minutes of contact time. **Super chlorination** produces a chlorine residue of 3 to 5 ppm for approximately 5 minutes of contact time. Chlorine odor and taste can be removed with an activated carbon filter at the point of use. **Shock chlorination** is recommended for newly installed wells, whenever a well is serviced or flooded, or when a well test shows the presence of coliform bacteria.

Shock Chlorination Treatment

Unlike continuous chlorination, shock chlorination is a one time treatment designed to kill bacteria in the well and water system. Shock chlorination is the preferred disinfection treatment for private well systems because it is simple, cheap and effective for most situations. The amount of chlorine used in well treatment is determined by the well's diameter and depth of water. A 200 ppm solution of chlorine in the well and plumbing system for a period of at least 2 hours is desired – preferably overnight. While it is common for public water supply providers to use chlorine gas for disinfection, gaseous chlorine is considered too dangerous for private use. Private systems most often use liquid chlorine (sodium hypochlorite) or dry chlorine (calcium hypochlorine). Unless you are confident about safely performing shock chlorination yourself, contact a licensed water well contractor to perform the procedure.

Step 1. **Clean exterior and accessible interior surfaces.** Scrub the outside of the well cap and casing with a stiff brush and a strong chlorine solution (1/2 gallon of chlorine laundry bleach per 5 gallons water) prior to removing the cap. Remove the well cap and scrub the accessible interior surfaces with the chlorine solution. If possible, storage tanks and cisterns should be emptied and sanitized by hand to avoid disposal of large quantities of highly chlorinated water.

Step 2. Calculate the amount of chlorine needed. Determine the volume in the well and holding tank or cistern using Tables 1 and 2. Add 100 gallons for the water stored in the plumbing, pressure tank and water heater. Use Table 3 to determine how much chlorine is needed per 100 gallons of water in your well and plumbing system. For most homeowners, the cheapest and simplest method is to dilute common liquid bleach with water in a clean trash can or bucket. Add the required amount of bleach for your system capacity and dilute approximately 10-to-1 with water (a typical small trash can holds about 25 gallons).

Step 3. Add the chlorine solution to the well and circulate. Remove the well cap and pour the diluted chlorine solution into the well. Next, use a hose that is connected as near to the well as possible and run water back down the well for at least 15 to 20 minutes to recirculate the chlorinated water. Thoroughly rinse the sides of the well casing and the pitless adapter during recirculation. Wash every component of the system that may have contact with the water supply.

Step 4. Disinfect the household plumbing. Before disinfecting the household plumbing system, disconnect or bypass any carbon filters or reverse

Table 1. Storage capacity of well casing or pipe.

Well diameter (inches)	Storage per foot of water depth (gallons per foot)
2	0.16
3	0.37
4	0.65
5	1.02
6	1.47
8	2.61
10	4.08
12	5.87

Example:
You have a 6-inch diameter well casing that is 150 feet deep and it is 50 feet to the static water level (the water level when not pumping). From Table 1 you estimate that you have approximately 150 gallons of water stored in the well casing (100 feet of water x 1.47 gal per foot of 6" pipe = 147 gallons). Add an additional 100 gallons for the plumbing system (150 + 100 = 250 gallons of water needing treatment). From Table 3, you determine that 3 pints of household bleach are needed per 100 gallons of system capacity.

$$250\ gallons\ capacity\ X\ \frac{3\ p\ \ bleach}{100\ gallons\ capacity} = 7.5\ p\ \ bleach$$

Table 2. Capacity of storage tanks or cisterns.

Depth (feet)	Diameter of round cistern or length of side of square cistern (in feet)				
	6	7	8	9	10
Round type	Cistern capacity, gallons				
5	1,055	1,440	1,880	2,380	2,935
6	1,266	1,728	2,256	2,856	3,522
7	1,477	2,016	2,632	3,332	4,109
8	1,688	2,304	3,008	3,808	4,696
9	1,899	2,592	3,384	4,284	5,283
10	2,110	2,880	3,760	4,760	5,870
Per foot of depth	211	288	376	476	587
Square type					
5	1,345	1,835	2,395	3,030	3,740
6	1,614	2,202	2,874	3,636	4,488
7	1,883	2,569	3,353	4,242	5,236
8	2,152	2,936	3,832	4,848	5,984
9	2,421	3,303	4,311	5,454	6,732
10	2,690	3,670	4,790	6,060	7,480
Per foot of depth	269	367	479	606	748

osmosis equipment. Next, open the cold and hot water faucets, one at a time, and let the water run until a strong chlorine odor is detected from each faucet. Flush toilets until chlorine odor is apparent. Don't forget to also run the washing machine and dishwasher. Once the chlorine has reached all points in the system, allow it to stand undisturbed overnight. Turn off the hot water heater during this time and be sure the house is well-ventilated.

Step 5. Flush the system. The next morning, flush the chlorinated water out of the system onto a safe area where desirable vegetation will not be harmed, such as a gravel driveway far away from any surface water or stream. Chlorine will evaporate to harmless levels within one to two days. Do not allow more than 100 gallons of chlorine-treated water to enter the septic system. After the chlorine is drained from the system, run water through the taps until the strong chlorine odor is gone. A slight residual chlorine taste and odor will likely remain in the water for a couple days. The water should now be safe for human consumption; however, it is advisable to retest the water for bacteria after one week to ensure the problem is resolved.

Table 3. Chlorine mix ratio for a 200 ppm solution.

Chlorine Product	% Active Chlorine	Amount needed for 200 ppm solution
Liquid laundry bleach	5.25%	3 pt/100 gallon
Concentrated chlorine bleach	12-17%	1 pt/100 gallon
Chlorine powder	25-30%	11 oz/100 gallon (2/3 lb/100 gallon)
Chlorine tablets	65-75%	4 oz/100 gallon (1/4 lb/100 gallon)

8 pt = 1 gallon; 16 oz = 1 pound; ppm = parts per million

Iron Bacteria in Wells

Bacterial growths are common in many irrigation and household wells in Colorado, especially in deeper aquifers. These bacteria most often are iron bacteria and they do not cause any known human health concerns. However, the bacteria can be detrimental in three ways:

1. These bacteria form a slimy coating up to 1/2-inch thick inside pipes and pump columns. This increases friction losses and pumping costs.
2. Iron bacteria causes well water to be foul tasting and smelling, discolored and undesirable for drinking.
3. Iron bacteria may plug the well screen or perforated well casing.

Useful Web sites:

• The Colorado Department of Public Health and Environment: www.cdphe.state.co.us/wq/Drinking_Water/Private_wells.htm.

• The Water Well Construction Rules: *http://water.state.co.us/boe/*

Iron bacterial slime on metal pipe joints.

Detecting Iron Bacteria

Iron bacteria are most often detected in well water by a foul taste and putrid odor. Check the end plugs in the pipelines for slime particles or catch them in a white cloth held in the pump stream to gather further evidence of bacterial growth.

Iron bacteria usually are yellowish-green in color and greasy to the touch. Particles of bacteria can be dislodged by brisk surging of the well but are most noticeable in well discharge after the well has been idle for awhile. Some wells are so severely infested that the water has a greenish tint to it. This water will smell of decaying matter. If there is any doubt about the safety of well water for human or livestock consumption, send a sample to a certified laboratory for analysis.

Iron bacteria live in ground water aquifers and can spread from well to well by the use of contaminated tools during well servicing. These bacteria usually appear in irrigation wells with oil-lubricated turbine pumps, especially where excess oil drips and accumulates on the water surface in the well. Bacteria grow and survive in moving water as well as still water. They seem to grow best in pump columns. Bacteria survive above static water levels and progress into underground pipelines.

The disinfection standard in the Colorado Water Well Construction Rules does not differentiate between domestic, municipal, irrigation or industrial wells, nor does it differentiate between wells constructed or pumps installed by contractors or private drillers/pump installers. Therefore, a variance is required from the Colorado Division of Water Resources to disinfect a well using chemicals other than chlorine or chlorine compounds. Requests for variance should include the type and amount of disinfection proposed, reason for its use (as opposed to chlorine solutions), and a factsheet from the manufacturer that describes the substance and its uses, including any health cautions.

In most cases, chlorine is the best method of disinfecting irrigation, livestock and commercial wells. However, slime forming bacteria, such as the Pseudomonads, can form thick layers of slime within the well that bind with chlorine and inactivate it, essentially protecting the lower layers of organisms. In these cases, oxidation with lye, ozone, hydrogen peroxide, steam treatment and physical removal are the only effective means of eliminating the thick biofilm of slime bacteria. *E. coli* and *Salmonella* bacteria do not form biofilms, but will live inside them and may be protected from chlorination. If you suspect slime forming bacteria, contact your licensed water well contractor or pump installer for assistance.

Treating Irrigation Wells

To disinfect irrigation wells, determine the amount of chlorine product needed for the well's capacity (discussed earlier). Ideally, pour half the mixture between the pump column and well casing and the other half into the column. Well access holes vary in size and, occasionally, are placed directly over the concrete base. On some pumps, there are no access holes. If this is the case, pour the chlorine solution into the pump column through the discharge pipe. Use a hose and funnel to feed the chlorine into the column.

After the chlorine is poured into the well, pour about 50 gallons of clean water into the same access hole so the metal parts are washed off to prevent corrosion. Wash tools and exposed skin parts, such as arms and face. Allow the chlorine solution to remain undisturbed for two to four hours. Start the pump and surge the well briskly by pumping the water up to the discharge pipe, shutting down the power unit, and allowing the water to fall back into the well. Surge the well in this manner three to four times at 4- to 6-hour intervals. After 18 to 24 hours, the water in the well can be purged.

For further information, contact your local health department or Colorado State University Cooperative Extension county office.

CSU Cooperative Extension publication XCM-197 and the following fact sheets may also be useful.

- *6.700,* Private Wells for Home Use
- *0.513,* Domestic Water Quality Criteria
- *0.520,* Selecting an Analytical Laboratory
- *9.307,* Drinking Water Quality and Health

Pump the treated water to a waste area away from streams, livestock or cropland. While pumping to waste, surge the well intermittently and pump until the water is clear. After at least one hour of pumping clear water, the well is ready for irrigation use.

If any concentrated chlorine comes into contact with the skin, and especially the eyes, stop immediately and wash the area thoroughly with clean water. Do not handle dry chlorine in windy conditions and **always** wear protective clothes, gloves and goggles when handling chlorine or any caustic materials.

Preventing Iron Bacteria

The best prevention against bacterial slimes is to disinfect tools, equipment, or devices used during well drilling or pump servicing. Another good method of prevention is to chlorinate the well once a year or anytime it has been opened or serviced. Oil appears to provide an ideal environment for these bacteria. Use turbine oil only in the amount required for proper pump operation. Where chlorination is impractical, reduce bacterial growths by using turbine-pump oil that contains additives inhibiting bacterial growth.

[1]Colorado State University Cooperative Extension water resource specialist.