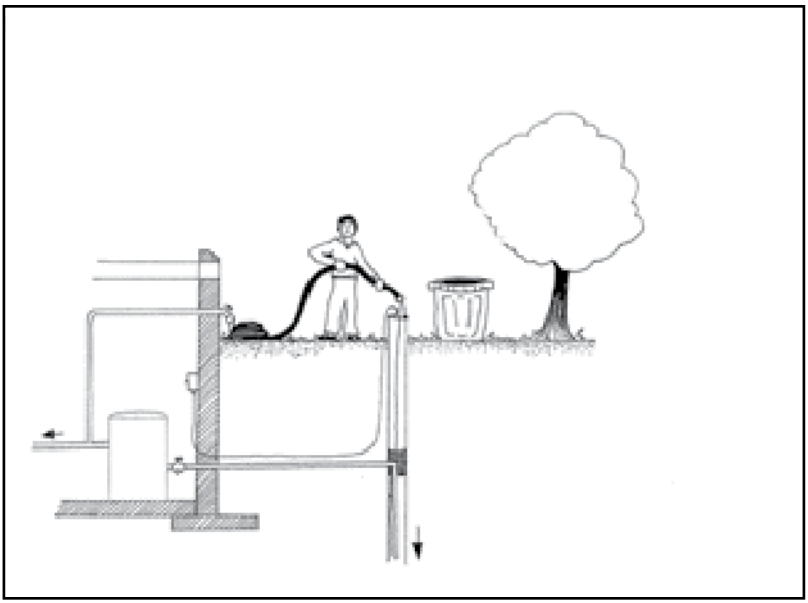
Bacteria and Water Wells



American Ground Water Trust

Consumer Awareness Information Pamphlet # 10

CONTENTS

© 2006 American Ground Water Trust

1 Introduction: What Is The Issue?

Bacteria may cause sickness. *Bacteria and Water Wells* provides the public with information and guidance about what steps should be taken if bacteria are present in a water well. This pamphlet is principally aimed at consumers using private wells as a water source. Homeowners have the responsibility to check the water quality of their private wells. This publication gives background information about bacteria, treatment techniques and aquifer and water well protection strategies. For many people, the word bacteria brings immediate images of disease and sickness. The good news is that not all bacteria are harmful. There are bacteria everywhere; in the air, in the soil, in your mouth, millions in a spoonful of yogurt!

The occurrence of bacteria in water is common, treatable, and in most cases, preventable. The ideal situation is to have no bacteria in drinking water, although most bacteria in water wells are harmless and pose little health risk. Ground water from the majority of properly constructed drilled wells is bacteria free. To ensure protection from any health risk, it is important for the public to understand something about microorganisms and how they may impact health. The information in this pamphlet is a first step to help in the education process.

2 Importance of Well Water

Ground Water Use in the United States

Over 150 million Americans use ground water for drinking every day. About 43 million people obtain ground water from 15 million private wells. Every day in the U.S., about 2,000 new wells are constructed for water supply. Most town and community water supply systems are checked by professional staff who are required by law to ensure that the water supplied to homes is safe for drinking. It is the responsibility of homeowners to keep self-supplied well water free from health risk.

There is a difference between well contamination and aquifer contamination. If a bacterial water quality problem is detected, it could be occurring in the water system, the well or (less likely), the aquifer. You need to find out where the problem is located. There is no point in investing money to permanently treat symptoms if it is possible to eliminate the cause.

Value of Ground Water

In the 1950's and 1960's, most U.S. communities gave greater attention to more visible services, such as fire protection, than to the less dramatic issue of aquifer protection. However, by the 1980's and 1990's, increased suburban population densities, competing economic and environmental demands for water resources, increased environmental awareness, and concern with health related issues, made the public far more aware of the importance of safe drinking water. Safe water cannot be taken for granted. While there has been a change in awareness, many people are still prepared to pay more for cable TV than they are prepared to pay for safe drinking water!

3 Microorganisms in Ground Water

Bacteria Background

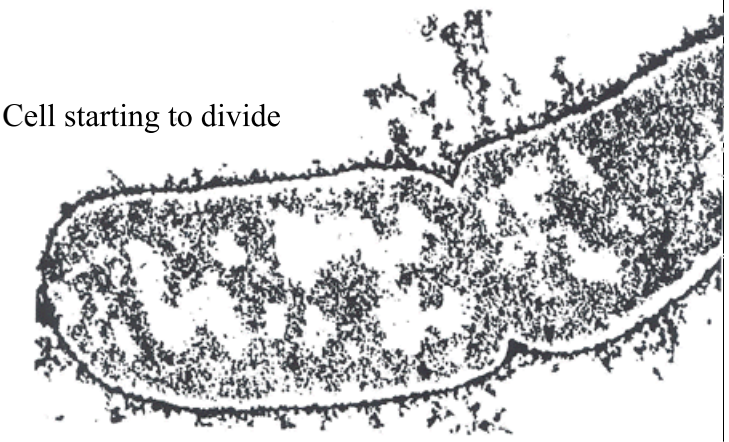
Bacteria are microscopic organisms. They are so tiny that about 25,000 lined up would take up about two inches. [Just one, is correctly called a bacterium, but they are usually referred to in the plural, bacteria.] Bacteria have existed for a very long time. There are micro-fossils in the geologic record that show bacteria were in existence 3.2 billion years ago. Some researchers believe that the first oxygen that appeared on Earth, 2 billion years ago, was created by bacteria.

Antony van Leeuwenhoek is credited with discovering bacteria in 1676. The big question then was, where did they come from? Two hundred years later, in 1876, Robert Koch concluded that bacteria can cause disease. Louis Pasteur's work with bacteria

showed that vaccination was a way to acquire immunity from some diseases.

Bacteria have great diversity. Some grow and multiply by using energy obtained from sulfur, ammonia, hydrogen or iron, and they obtain carbon for cell synthesis from carbon dioxide. Some

Escherichia Coli bacterium (greatly magnified)



bacteria thrive in oxygen rich environments (aerobic) and others in oxygen deficient (anaerobic) conditions. Most bacteria reproduce by binary fission (split into two). If conditions are suitable, bacteria can reproduce very quickly. They are very resilient, remaining dormant when conditions are not ideal. Dried, but living bacteria can even be carried in the air. Bacteria can excrete toxins or carry them inside their cell wall until they die and disintegrate. Some bacteria may invade a specific organ of the body, for example the brain, throat or bone. Bacteria may produce enzymes that are responsible for illness.

Not all bacteria cause disease and harm living creatures; some can be very beneficial. Bacteria are the beginning of the world's food chain, and as decomposers, bacteria play a critical role in recycling organic materials essential to plants and animals. Great numbers of bacteria live on human skin surfaces; there are millions

in one drop of saliva. Bacteria are an essential part of the digestive process of animals and insects. Laboratory grown bacteria "superbugs" have proved to be useful in cleaning up environmental contamination. Septic systems and most waste water treatment facilities are designed to allow the work of bacteria to naturally break down harmful components.

Microorganisms

Many types of microbes live naturally in soil and rock environments and are part of the sub-surface ecosystem. Sub-surface dwelling organisms are usually attached to the rock particles in soils and aquifers. During periods of high water table, for example after prolonged rainfall, ground water has greater contact with soil organisms and nutrients. The result can be an increase in organisms found in water from wells.

All natural surface water (rivers, lakes, wetlands) contain micro-organisms. Ground water usually has many fewer microorganisms than surface water because of its long travel time in the sub-surface environment. However, ground water can become contaminated by domestic sewage, feedlots and surface runoff, as well as other pollution sources. Where the subsurface geology permits rapid downward movement of water from the surface, or where the ground water sources are tapped near the surface, aquifers may be vulnerable. Shallow dug wells, or drilled wells in which the well casing is not properly grouted (sealed), are particularly susceptible to contamination. Some types of bacteria can cause a nasty taste and odor, or cause cloudiness in water.

Viruses and Protozoa

In addition to bacteria, two other types of pathogenic organisms can affect water quality, viruses and protozoa. The disease causing organisms usually leave an infected person via feces. They may cause illness in anyone drinking the contaminated water, although many people do not experience any adverse effects. Bacteriologic and protozoic pathogens are known to cause typhoid, dysentery, cholera, and some types of gastroenteritis.

Giardia lamblia and Cryptosporidium are protozoal parasites that can cause health problems. Fortunately, occurrences of these are rare in ground water because the relatively large size of the protozoa cysts allows them to be filtered out as water soaks through the soil to the water table. Viruses account for more than 100 human diseases including polio, infectious hepatitis and some forms of gastroenteritis.

Coliform Bacteria

Coliform bacteria are the bacteria most commonly associated with water quality. The Environmental Protection Agency standard for acceptable drinking water is a total coliform count of zero. Coliform bacteria are a large group of various species of bacteria. The group includes bacteria that occur naturally in the intestines of warm-blooded animals (fecal coliform) and non-fecal coliform bacteria. Fecal coliforms can include disease causing and non-disease causing species.

Escherichia coli (E. coli), often listed in water quality analyses, is one species of fecal coliform bacteria. They occur in the digestive system of healthy warm-blooded animals. E. coli are present in large numbers in human sewage. E. coli can be easily cultured in a laboratory and therefore, they are a good indicator species. Their presence in a water sample indicates that the water may have been in contact with wastewater. If so, then more harmful disease causing organisms may also be present.

Iron Bacteria

Some bacteria that occur in wells, while not themselves harmful, can cause problems. Iron bacteria can cause staining of plumbing fittings and laundry, can provide a place in wells for other bacteria to live, can increase corrosion and can cause encrustation of well screens and pumps. Iron and sulfur bacteria cause a build up of a bio-film in wells. By providing an environment for other more harmful bacteria to live, the slime reduces the ability of chlorine to kill bacteria. Another negative effect of iron bacteria is that they can cause electrons from ferrous iron (Fe2) to be converted to ferric

iron (Fe3). This results in increased oxidation (corrosion) of pipes and pumps. An additional problem is that the free ferric iron ion can bind with other chemicals to cause clogging of pump intakes, well screens and water filters. A reduction in the inflow spaces to a well will cause an increase in speed of water flow in the remaining spaces; this turbulent flow causes the release of even more minerals to clog the well and water system.

4 Well Protection Strategies

How Can Bacteria Get into a Well?

A properly constructed and adequately cased (lined) and grouted (sealed) water well usually obtains its water at a depth at which few bacteria present. Bacteria are usually filtered out, or they die off, as water infiltrates and slowly moves in the sub-surface ground water environment. However, large numbers of bacteria can occur when there is insufficient filtration or travel time between the land surface and the ground water.

Bacteria are found in upper soil layers and in streams, lakes and ponds; in addition, there can be concentrated bacteria sources such as inefficient septic systems, farm animals and storm runoff. There are several ways in which bacteria actually get into a well:

- ⇨ Any shallow or dug well that is constructed from boards, bricks, stone or tile is vulnerable to surface water contamination. Dug wells, with their water in contact with saturated soil layers, are particularly at risk because bacteria affected water can seep straight into the well. Insect infestation is very difficult to prevent in large diameter wells.

- ⇨ If a drilled or bored well has casing (liner) that has not been properly sealed, bacteria from the upper soil layers may "leak" down into the well. In such cases, surface water or contaminated ground water may move vertically downward contaminating high quality aquifers.

- ⇨ In the event of a flood or storm runoff, surface water could enter the top of the well if the casing does not extend far enough above the ground or if there is no watertight seal on the well casing. Wells that are in pits below ground level, in driveways or lawns, may be especially vulnerable to such ponding.

- ⇨ Over time, old well casings may rust through, leaving holes near the ground surface where water can seep in and contaminate deeper ground water. This problem can be made worse if a water well is used as an earth contact for electricity. Earthing causes well casing corrosion. Although convenient for electricians, well casing should not be used as an electrical ground.

- ⇨ Well casing can become cracked. Once there is a direct connection to the surface layers, bacterial infection may result. Earthquakes, subsidence and settling around the well, or impact damage from farm implements or snow plows, can make a well susceptible to contamination.

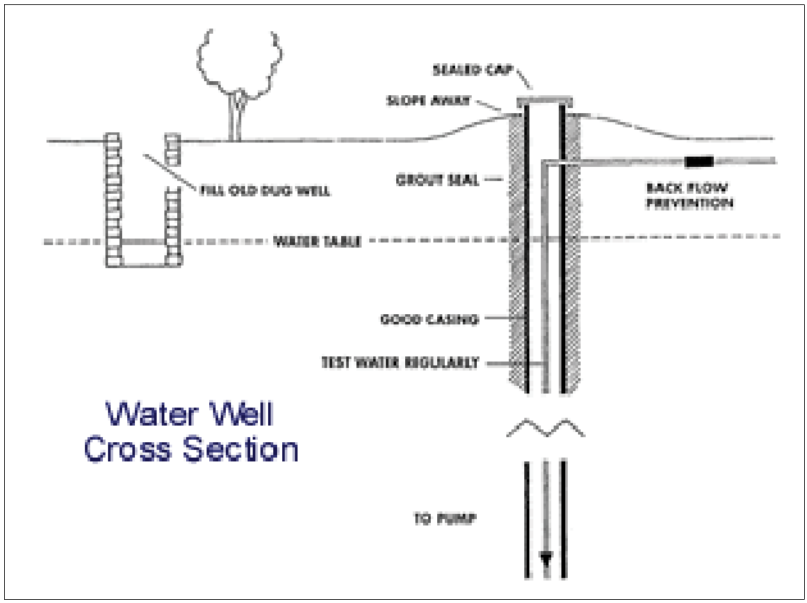
- ⇨ Well bacteria may be introduced into a well when it is drilled, or when a pump is installed or serviced. Contractors must ensure that their equipment is decontaminated between jobs to prevent transporting infection from well to well. Pump installers often lay the pump, pipe and cable out on the ground before installation in the well. This practice is unwise because it can allow bacteria from the ground surface to adhere to the well equipment and enter the well. Water wells should be sanitized after any service or installation work.

- ⇨ Wells may become infected when ground water levels rise above normal and extend up to soil levels where bacteria are present. This can occur:

(1) in times of exceptional rainfall,

(2) if major long-term water use by a nearby irrigation or municipal well ceases [ground water levels then begin to rise much higher than at the time of original well construction], or

(3) when road construction, mining operations or dam construction lead to water level changes in wells.



⇨ A common bacteria-causing problem is a faulty (or non-existent!) well cap that allows insects, especially earwig beetles, to take up residence in well casing. Their droppings and dead bodies can cause bacterial contamination of wells.

- ⇨ Unsealed abandoned water wells and geotechnical investigation drill holes (typically used in engineering investigations for highways and major building development) can be conduits for bacteriologically affected surface water to reach aquifers. All landowners should be aware of the potential risks of old unused wells. Natural surface outcrops of fractured rock and areas of mining or quarrying can also provide rapid access of contaminated surface water to aquifers.

- ⇨ Backflow prevention devices are essential to prevent any risk of bacteria being siphoned back in the well. An example of this problem could occur if a power failure stopped a pump while a garden hose was filling a fish pond. Without a backflow device, or an adequate foot valve on the pump, water from the fish pond could be siphoned back down the well. Back flow prevention devices are easily fitted and are not expensive.

How to Test for Bacteria

All new water wells should be tested for the presence of bacteria. All wells used for drinking should be rechecked annually or after any maintenance or replacement work that has involved well equipment. It is particularly important to test a well if at any time, change in taste, odor or appearance of the water is noticed.

Reliable do-it-yourself bacteria testing kits are now on the market for about $15. It is important to follow directions. A bacteriological analysis by a certified laboratory usually costs between $30 and $40. Sample bottles (and instructions) are available from virtually all certified water quality labs. If a technician visits your home to collect the sample, the testing fee is likely to be higher. Testing services may also be available from county health departments or from state agencies (See listing of state phone numbers on page 18.)

How to Sample Well Water for a Bacteria Test

This is a general guide only; carefully follow laboratory instructions or the directions on a store-bought test kit.

- obtain sterile bottle
- remove aeration devices from the cold water tap/spigot/faucet
- run cold water for three minutes at full flow
- reduce flow to a trickle and run for another minute
- open the sterile sample bottle (do NOT touch the inside of the bottle or lid)
- do NOT rinse the bottle
- fill the bottle as directed, (about 200ml or 1/4 pint)
- put cap on bottle, seal tightly
- put your name, address, date and time of sampling in the bottle
- keep bottle cool
- deliver immediately to lab, as required for their schedule, best within 24 hours (some labs don't take samples on Fridays).

Sample as close to the well as possible; there may be a tap in the basement. Most quality analyses are done to test the well water. It is possible that the well is clear of the bacteria, and that an inadequately maintained treatment system (especially point of use systems) may be harboring bacteria. A test on a sample from the kitchen tap may be needed. To test for bacteria in a point of use filter, take a sample first thing in the morning - do not run the water before sampling.

What Do the Test Results Mean?

A bacteriological test shows that coliform bacteria were (or were not) in the water sample delivered to the lab. A sample that

is reported "safe bacteriologically," means that coliform were not found in the sample. If the sample was taken according to directions, you can be reasonably sure that the water is suitable for drinking and general domestic use. When a sample is reported "unsafe bacteriologically," it means that coliform bacteria were found. The chances are that the well has been affected by surface water or near-surface waters. To be on the safe side, consider the water supply to be a health risk and until you have found out where the problem originates, you should not consume the water unless it is boiled first.

The first thing to do with an "unsafe" result is to re-sample. If the second sample results show presence of coliform bacteria, you need to immediately investigate sources of contamination and disinfect your water system. Unless you feel confident about doing this yourself, the well should be disinfected by a qualified sanitarian, or ground water contractor. Guidelines for well disinfection procedure are given below.

Description of Water Well Disinfection Procedure

This is a general description only; state and county codes may vary.

1) Use common household bleach as the chlorine source for disinfection.
   - Bleach products usually contain 5 to 6 percent chlorine
2) Find the total depth of water in the well.
   - For example, if the well is drilled to 200 feet and the water level is 50 feet down from the top then there is a 150 feet depth of water in the well
3) Determine how many gallons of water are stored in the vertical column of the well. Once you know depth you can work out the gallons.

Well diameter	Gallons per foot of well	Gallons in 100 feet
4-inch	0.65	65
6-inch	1.47	147
8-inch	2.61	261

- Disinfection is not feasible for large-diameter dug wells

4) Work out how much bleach will be needed: For every 50 gallons of water in the well use one quart of laundry bleach (4 quarts in a gallon).
   - In most cases, one gallon of bleach will disinfect 200 gallons of well water at a chlorine concentration of about 200 to 300 ppm (parts per million)
   - Bleach loses strength in its container over time. Check the "sell by date" and use bleach that is less than three months old.
   - Do not use excessive amounts of bleach - more is not more effective.
5) For best results the bleach should be combined with water before adding it to the well.
   - By reducing the concentration there is less chance of corrosion of the cables and pipes in the well. The greater volume of water helps get the chlorine mixed in the well column.
6) Make the Chlorine-Water Mixture by filling a five gallon bucket with water and adding about one quart of bleach. Pour the mixture into the well and repeat until the right amount of bleach has been added to the well (see #4 above).
7) Remove the well cap and pour the mixture directly down inside the well casing.
   - Wear rubber gloves and safety glasses to protect skin and eyes from splashes. Spills contacting the body should be rinsed immediately and thoroughly with fresh water.
8) Recirculate the water in the well by running water with a hose back into the well for 30 minutes.
   - This will help draw the Chlorine-Water Mixture down the well and will wash the "dry" portion of the well casing or drilled hole above the water table more thoroughly.
9) To disinfect the household plumbing first turn off the electric or gas supply to the hot water heater. Turn on all the faucets, shower heads, clothes washers, dish washers and outside faucets, etc. until there is a chlorine smell at each location.
   - If you have water conditioning equipment check the owners manual to see if it is sensitive to chlorination. All equipment in the water system should be disinfected because it may serve as a safe haven from which the bacteria may reinfect the system.
10) Leave the Chlorine-Water Mixture in the plumbing system

and well for 12 to 24 hours before removing the chlorinated water.

- During the disinfection process, the well water should not be used so make plans for essential water needs before you begin the disinfection process!

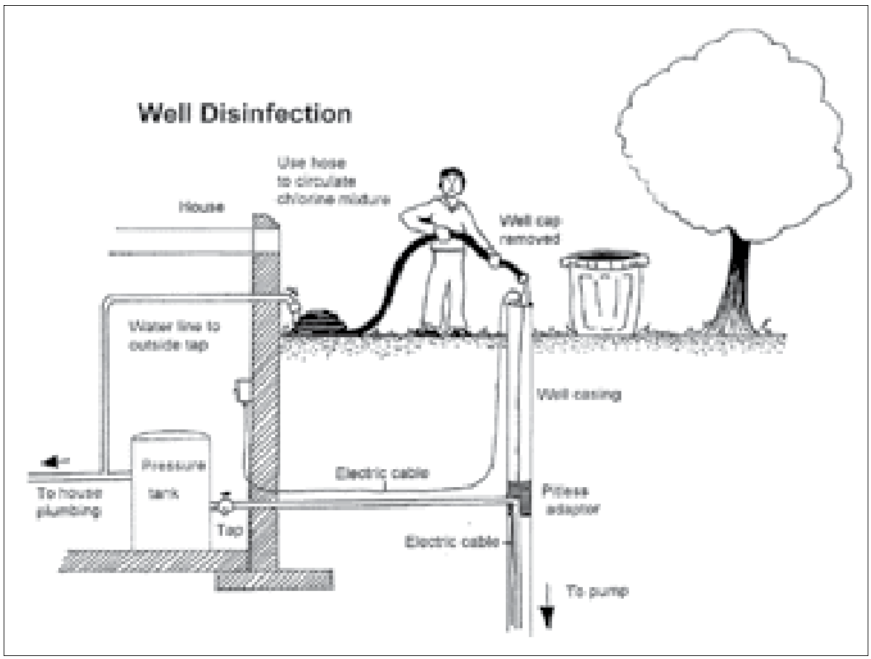
11) Remove the chlorinated water from the well by running the pump and leading the hose to a safe area.
    - Don't put the chlorine solution into a septic system or in a creek or pond where it may kill fish. Flowers and vegetables may be affected by chlorinated water.
12) When the chlorine odor has gone the well flushing is complete.
    - If you have difficulty smelling the chlorine odor, a swimming pool chlorine test kit can indicate whether or not there is chlorine remaining in the well water.
13) Once the chlorine has been removed from the well water, the indoor plumbing may be flushed out to the septic or sewer system to remove the chlorinated water.
    - Re-connect the hot water heater. The water supply should now be bacteria free.
14) Wait about 5 to 10 days before re-sampling the water supply and testing for bacteria.
    - If bacteria are still present, repeat the process. It may take several treatments to remove long-established bacteria colonies. If the problem persists, contact a professional familiar with microbiological contamination in wells.
15) Repeat testing in three months to confirm treatment success, and then test annually.

Dry granulated chlorine can be dangerous and is NOT recommended for home owner use.

If the bacterial contamination is just in the well or water system, it should be removed by the disinfection process. It can sometimes take two or three disinfection attempts before the

bacteria are eliminated.

In some wells, bacteria levels may slowly return, and an annual "shock" disinfection may be needed to keep the problem under control. If the problem is related to a damaged well, the well needs to be fixed. If there is an obvious nearby contamination source, the problem needs to be resolved. Tracing the cause may need systematic detective work to eliminate potential causes.



BEFORE investing in water treatment equipment, it is recommended that all attempts be made to solve the problem by sanitizing the well, ensuring that the well construction is in good order and that nearby potential contamination sources are removed. Some states will not approve wells that need treatment to remove bacteria.

5 Treatment Techniques

Bacteria are most effectively eliminated from drinking water by chlorine disinfection, filtration, ultraviolet irradiation or ozonation. All of the methods require careful attention to equipment selection.

Buying an over-designed system will not necessarily provide any better protection. Make sure that the water equipment salesperson is knowledgeable and that the company specializes in water treatment. Some water treatment specialists may not be familiar with all the latest technologies and treatment equipment options. Always obtain cost quotations from more than one company and always have your water analysis done by an independent laboratory. Some bacteria treatment devices do not work properly if certain minerals are present. Water treatment is not a "one size fits all" operation. Once installed, it is very important to adhere to the equipment maintenance schedule.

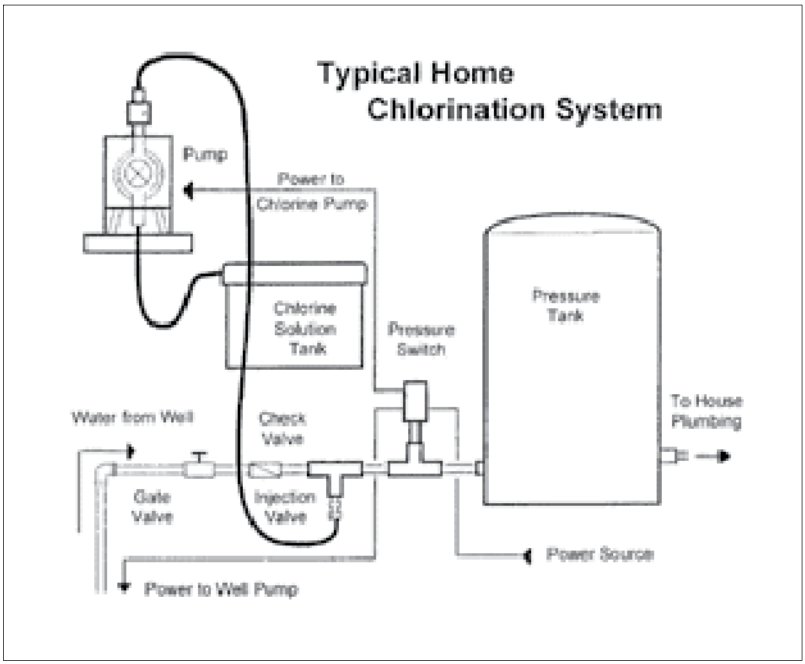
Filters

Filtration cannot readily remove bacteria or viruses from drinking water. Fine filtration can be a very effective means of straining out large organisms like protozoan cysts and worm eggs, but it needs to be complimented with a disinfection method to eliminate bacteria. Some filtration devices at the level of 0.25 microns absolute, and finer, may be effective for bacteria removal but may also cause reduction in water pressure. Filters must be checked and changed regularly.

Chlorine

Disinfectant-dispersing equipment should be automatic, require minimal maintenance and treat all water entering the home. It should also be fail-safe so that it is not possible to unknowingly use or consume untreated water. There are many devices available for dispensing doses of chlorine. Some operate by releasing pellets into the well, others inject a chlorine solution into the water line.

Chlorine is the most widely used method in the United States for disinfecting municipal and individual water supplies. It destroys bacteria by oxidizing their internal enzymes. However, if water has a high organic level, dangerous chlorinated organics (trihalomethanes) can be produced. Some of these chlorinated organic chemicals are suspected of being carcinogenic to humans. Chlorination systems need to be checked and maintained regularly by the homeowners.



Iodine

Iodine is chemically more stable than chlorine but more expensive. Iodination equipment is usually installed between the pump and holding or pressure tank, and a precisely measured continuous flow of concentrated iodine is fed into the water pipe. This type of equipment is simple to operate and requires little maintenance. Iodine can impart a slight taste to the water.

Ultraviolet Light

Ultraviolet irradiation will kill bacteria by creating photochemical changes in its DNA. No chemicals are added to the water by this process. Most ultraviolet water treatment units consist of one or more ultraviolet lamps usually enclosed in a quartz sleeve, around which the water flows. The UV lamps are similar to fluorescent lamps and the quartz sleeve surrounding each lamp protects the lamp from the cooling action of water. The killing effect of the lamp is reduced when the lamp temperature is lowered. Ground water is usually a constant temperature year round and so

it is possible to set a flow rate that will not lead to excess cooling.

The effectiveness of UV irradiation depends on the intensity of the light, depth of exposure and contact time. Water passes in a relatively thin layer around the lamp; therefore, water flow must be regulated to ensure that all organisms receive adequate exposure. If the water is at all turbid, or if it contains traces of iron, the effectiveness of UV is greatly reduced. In such cases, the water needs to be filtered before it reaches the UV system.

Ultraviolet irradiation units are automatic and require little maintenance. There are several commercially available UV systems designed for home wells.

Ozone

Ozone contains three oxygen atoms. It has been used in water treatment since 1903. It is more effective against bacteria and viruses than chlorine and adds no chemicals to the water. Ozone cannot be stored and requires an on-site ozone generator. In general, ozonation equipment and operating costs are higher than other treatment procedures.

6. Where to Go for Advice

The **American Ground Water Trust** can provide a contact telephone number in each state for well drillers who are members of their professional state ground water or water well association. Call the Trust at (603) 228-5444. The Trust can also assist with contacts in state agencies and can provide information about the availability of Bacteria Test Kits. [The Trust's mission is to assist the public and communities with information about ground water. See the back cover of this pamphlet for more information about the American Ground Water Trust.]

County Health Departments have trained staff who can provide advice to consumers and homeowners about water quality issues. Many county level departments and agencies have useful information about wells, water quality and aquifer protection. Agricultural Extension Service personnel also provide information. Most telephone directories list such services.

Water Well Contractors are local experts who can usually provide practical insight to questions concerning water well quality. The Yellow Pages will list well drillers, pump installers and treatment specialists in your area. Select contractors who are licensed, registered, and who are members of their state or national trade associations.

State Agencies and Departments have staff to help with citizen inquiries. The state list below includes the number to call for inquiries about well bacteria. Just about every state has a different agency or department. Most will provide information and advice to the public. You may have to be patient as you negotiate state agency telephone switchboards and voice mail! After your initial call, you may be referred to a specific office or laboratoy that deals with your area.

State List of Telephone Numbers for Well Bacteria Inquiries

The information in this table was obtained August 2006. State agency responsibilities may change. You may be referred to a different department or local office.

Abbreviations used in table

Conservation - Cons.	Environmental - Env.
Department - Dept.	Natural - Nat.
Division - Div.	Program - Pgm.
Environment - Env.	Resources - Res.

STATE	PHONE#	STATE AGENCY/DEPT.
Alabama	(334) 271-7790	Div. of Drinking Water
Alaska	(907) 375-8200	Dept. of Env. Cons., Env. Health Lab
Arizona	(602) 771-4511	Dept. of Env. Quality, Water Quality Division
Arkansas	(501) 661-2171	Dept. of Env. Health Protection
California	(916) 449-5600	Dept. of Health Serv. Drinking Water Program
Colorado	(303) 692-3500	Dept. of Water Qual. Control, Div. of Water Resources

STATE	PHONE#	STATE AGENCY/DEPT.
Connecticut	(860) 509-7333	Dept of Public Health, Drinking Water Section
Delaware	(302) 741-8630	Dept. of Public Health, Office of Drinking Water
Washington, D.C.	(202) 612-3440	Env. Health, Water Quality Division
Florida	(850) 245-4240	Dept. of Env. Health
Georgia	(404) 657-2700	Dept. of Public Health
Hawaii	(808) 586-4258	Dept. of Health, Safe Drinking Water Branch
Idaho	(208) 378-5746	EPA, State Water Division
Illinois	(217) 782-5830	Public Health, Div. of Env. Health
Indiana	(317) 232-4160	Dept. of Natl Resources, Division of Water
Iowa	(515) 725-0282	Dept. Env. Nat. Res., Water Supply Section
Kansas	(785) 296-5500	Dept. of Health & Env., Bureau of Water
Kentucky	(502) 564-7398	Public Health Protection & Safety
Louisiana	(225) 342-7273	Dept. of Health & Hospitals; Safe Drinking Water Pgm.
Maine	(207) 287-5674	Dept. of Human Services, Drinking Water Pgm.
Maryland	(410) 537-3784	Water Mgmt, Onsite System Program
Massachusetts	(617) 292-5770	Dept. of Env. Protection, Drinking Water Program
Michigan	(517) 373-2161	Dept. of Env. Quality
Minnesota	(651) 201-4600	Health Dept., Well Water
Mississippi	(601) 576-7518	Dept. of Env. Health, Div. of Water Supply
Missouri	(573) 368-2165	Dept. of Nat. Res., Wellhead Protection Division

STATE	PHONE#	STATE AGENCY/DEPT.
Montana	(406) 444-3444	Public Health Laboratory
Nebraska	(402) 471-2541	Div. of Env. Health
Nevada	(775) 687-9520	Div. of Env. Prot., Bureau of Safe Drinking Water
New Hampshire	(603) 271-2998	Dept. of Env. Services, Water Supply Engineering Bureau
New Jersey	(609) 292-5550	Bureau of Safe Drinking Water
New Mexico	(877) 654-8720	Env. Dept., Bureau of Drinking Water
New York	(800) 458-1158	Dept. of Health, Env. Health
North Carolina	(919) 733-3221	Ground Water Protection Unit
North Dakota	(701) 328-5210	Health Dept., Division of Water Quality
Ohio	(614) 466-1390	Dept. of Health
Oklahoma	(405) 530-8800	Dept. Env. Quality, Public Information & Education
Oregon	(503) 731-4317	State Health Drinking Water Program
Pennsylvania	(717) 787-5017	Dept. of Env. Protection, Bureau of Water Supply & Community Health
Rhode Island	(401) 222-6867	Dept. of Health, Drinking Water Quality
South Carolina	(803) 898-4300	DOH, Bureau of Water
South Dakota	(605) 773-3754	Dept Env. & Nat. Res., Drinking Water Program
Tennessee	(615) 532-0191	Div. of Water Supply
Texas	(512) 239-6020	Public Drinking Water Section, Public Utilities Commission
Utah	(801) 536-4200	Dept. Env. Quality, Div. of Drinking Water
Vermont	(802) 863-7335	Public Health Laboratory

STATE	PHONE#	STATE AGENCY/DEPT.
Virginia	(804) 864-7000	Dept. of Health, Office of Water Programs
Washington	(360) 236-3100	Dept. of Health, Office of Drinking Water
West Virginia	(304) 558-2981	Env. Health Services
Wisconsin	(608) 267-7649	Dept. of Nat. Res., Drinking Water & Ground Water Div.
Wyoming	(307) 777-6160	State Engineers' Office, Ground Water Div.

Other sources of information and advice:

Centers for Disease Control and Prevention (Georgia) Federal center of expertise in Atlanta. www.cdc.gov (404) 639-2206

EPA Drinking Water Hotline (Washington, D.C.) The EPA provides general information about Federal Drinking Water regulations and guidelines. www.epa.gov/safewater (800) 426-4791

Water Quality Association (Illinois) The WQA maintains a register of information on the effectiveness of commercially available water treatment equipment. www.wqa.com (630) 505-0160

National Ground Water Association (Ohio) The NGWA is an international organization representing all professions of the ground water industry. www.ngwa.org (614) 337-1949

Water Systems Council (Washington, D.C.) The WSC promotes the wider use of water wells as modern and affordable safe drinking water systems. www.watersystemscouncil.org (202) 625-4387

Don't forget local sources of information:

Libraries. Most libraries have information in their reference sections that can provide background about bacteria.

Colleges and Universities. At universities and colleges that focus on water resources, environmental engineering or community health issues, research and teaching faculty members may have useful information related to aquifer protection, water wells and water treatment.

AMERICAN GROUND WATER TRUST

Independent Authority on Ground Water

The Trust - Working Everyday for you and for America:

- Protecting ground water & promoting resource sustainability
- Communicating the environmental & economic value of ground water
- Showcasing ground water science & technology solutions
- Increasing citizen, community & decision-maker awareness
- Facilitating stakeholder participation in water resource decisions

The American Ground Water Trust is a 501(c)(3) non-profit membership organization. Individual, corporate and organization annual memberships help support the Trust's operations and education programs. Information about how to become a member, the Trust's Ground Water Institute training programs for teachers, the calendar of workshop and conference events and its publications, is available on the Trust's web site.

AMERICAN GROUND WATER TRUST

Address: P.O. Box 1796, 16 Centre Street, Concord, NH 03301
Telephone: (603) 228-5444
Fax: (603) 228-6557
E-mail: Trustinfo@agwt.org
Web site: www.agwt.org

Well Owner Information site: www.privatewell.com

Information in this pamphlet is provided in good faith to inform the public about bacteria and related ground water issues. For all matters related to wells and treatment equipment, the Trust recommends that well owners contact local well professionals and that water treatment system design & installation follows local codes, rules, regulations and laws.

© 2006 American Ground Water Trust