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G90-989 Drinking Water: Bacteria (Revised November 1998)

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Drinking Water: Bacteria

"This NebGuide discusses recommended practices to manage bacteria in a domestic water supply."

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The presence of bacteria and pathogenic (disease-causing) organisms is a concern when considering the safety of drinking water. Pathogenic organisms can cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera, and other illnesses.

Sources of Bacteria in Drinking Water

Bacterial contamination can result from a number of sources.

Human and animal wastes are a primary source of bacteria in water. These sources of bacterial contamination include runoff from feedlots, pastures, dog runs, and other land areas where animal wastes are deposited. Additional sources include seepage or discharge from septic tanks and sewage treatment facilities. Bacteria from these sources can enter wells that are either open at the land surface, or do not have water-tight casings or caps, or do not have a grout seal in the annular space (the space between the wall of the drilled well and the outside of the well casing).

Insects, rodents or animals entering the well are other sources of contamination. Old wells were dug by hand and lined (cased) with rocks or bricks. These wells usually have large openings and casings that often are not well-sealed. This makes it easy for insects, rodents, or animals to enter the well.

Another way bacteria can enter a water supply is through inundation or infiltration by flood waters or by surface runoff. Flood waters commonly contain high levels of bacteria. Small depressions filled with flood

water provide an excellent breeding ground for bacteria.

Whenever a well is inundated by flood waters or surface runoff, bacterial contamination is likely. Shallow wells and wells that do not have water-tight casings can be contaminated by bacteria infiltrating with the water through the soil near the well, especially in coarse-textured soils.

Older water systems, especially dug wells, spring-fed systems and cistern-type systems are most vulnerable to bacterial contamination. Any system with casings or caps that are not water-tight, or lacking a grout seal in the annular space, are vulnerable. This is particularly true if the well is located so surface runoff might be able to enter the well. During the last five to 10 years, well and water distribution system construction has improved to the point where bacterial contamination is rare in newer wells.

Indications of Bacteria

Bacterial contamination cannot be detected by sight, smell or taste. The only way to know if a water supply contains bacteria is to have it tested. The Environmental Protection Agency (EPA) requires that all public water suppliers regularly test for coliform bacteria and deliver water that meets the EPA standards. Frequency of testing depends on the size of the population served. Bacteria test results are available from the supplier and there must be a public notification if the water supply does not meet the standard.

Owners of private water supplies are responsible to themselves for having their water supply tested to ensure it is safe from bacterial contamination. Generally, private water supplies should be tested for bacterial safety as follows:

- at least once a year;
- when a new well is constructed;
- when an existing well is returned to service;
- any time a component of the water system is opened for repair – the water system includes the well, pump, pressure tank, piping, and any other components the water will contact;
- whenever the well is inundated by flood waters or surface runoff;
- whenever bacterial contamination is suspected, as might be indicated by continuing illness;
- when a laboratory test indicates high nitrate and human or livestock waste is suspected.

Often, lending agencies require private water supplies be tested before home loans will be approved, including refinancing a loan.

Potential Health Effects

Coliform bacteria may not cause disease, but can be indicators of pathogenic organisms that cause diseases. The latter could cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera and other illnesses. However, these illnesses are not limited to disease-causing organisms in drinking water. Other factors not associated with drinking water may be the cause.

Intestinal infections and dysentery are generally considered minor health problems. They can, however, prove fatal to infants, the elderly, and those who are ill. Today typhoid, hepatitis and cholera are rarely encountered in the United States.

Other bacteria also may be present in water. No specific sanitary significance or health standards have been indicated for non-pathogenic non-coliform bacteria.

Testing

Testing for all individual pathogens is impractical and expensive. Instead, the EPA has designated total coliform bacteria as a standard to determine bacterial safety of water.

Coliform bacteria originate in the intestinal tract of warm-blooded animals and can be found in their wastes. Coliforms also occur in soil and vegetation.

Coliform bacteria are relatively simple to identify and are present in much larger numbers than more dangerous pathogens. Coliform bacteria react to the natural environment and treatment processes in a manner and degree similar to pathogens. By monitoring coliform bacteria, the increase or decrease of many pathogenic bacteria can be estimated.

Due to this association, bacterial safety of drinking water is monitored by testing for coliform bacteria. Bacterial testing is provided, for a fee, by the Nebraska Health and Human Services System Laboratory, some city/county health department laboratories, and some commercial water testing laboratories. See NebGuide G89-907, *Testing for Drinking Water Quality*, for a list of laboratories in Nebraska that provide bacterial testing.

After selecting a laboratory, contact them to obtain a drinking water bacterial purity test kit. The kit will contain a sterilized sampling bottle, an information form, sampling instructions, and a return mailing box. Use of the bacterial test kit is necessary to help ensure the test is accurate. The bottle in the kit is completely sterilized. This assures the sample is not contaminated by bacteria in the bottle. The use of any other container is discouraged.

The kit contains detailed instructions on how to collect the water sample. Follow the instructions carefully to avoid outside contamination and to obtain a good representative sample.

To avoid unnecessary delays and possibly a need for resampling, mail or carry the sample to the laboratory immediately. The sample must be received at the laboratory within 48 hours after collection or it will not be tested. Avoid mailing samples when they may be delayed over a weekend or a holiday. In most cases, samples need to arrive at the laboratory on Monday, Tuesday, Wednesday or Thursday.

Be sure the form accompanying the sample is accurate and complete. If there is no date or time of collection on the form, it will be assumed the sample is over 48 hours old. If there is no return address, test results cannot be sent to you.

When a laboratory receives a water sample, it gives the sample a number and the time of arrival is stamped on the accompanying form. One hundred milliliters (ml) (about 3.4 fl. oz.) of the sample is then drawn through a membrane filter. This filter is placed on a nutrient broth culture plate and placed in an incubator for 24 hours at 35° C (95° F) for culturing. The plates then are removed from the incubator and the number of coliform bacteria colonies are counted.

Interpreting Test Results

The EPA establishes standards for drinking water which fall into two categories – Primary Standards and Secondary Standards.

Primary Standards are based on health considerations, and are designed to protect people from three classes of toxic pollutants; pathogens, radioactive elements and toxic chemicals.

Bacterial contamination falls under the category of pathogens. The EPA Maximum Contaminant Level (MCL) for coliform bacteria in drinking water is zero (or no) total coliform per 100 ml of water.

The number of coliform colonies found in the incubated water sample, if any, is reported and the form is

checked to indicate whether or not the water meets the EPA bacteriological standard of zero. At times, excessive numbers of other bacteria in a sample can interfere with the counting of coliform types. These samples may be classified as "too numerous to count" or "confluent growth."

If the laboratory report indicates the presence of coliforms, or states "too numerous to count," or "confluent growth," the Nebraska Health and Human Services System Department of Regulation and Licensure recommends another sample be analyzed to help evaluate the contamination.

If you suspect bacterial contamination in your water supply, use an alternative water supply or disinfect your water supply while waiting for test results.

Options

If laboratory tests confirm the presence of coliform bacteria in your water supply, use an alternative water supply or disinfect your water supply until the problem can be corrected.

For short term disinfection of small amounts of water, two options exist. Water can be boiled at a rolling boil for at least three minutes to kill disease-causing bacteria. Alternately, water can be treated with chlorine to kill bacteria.

Use household chlorine bleach that does not have scents or other additives. The percent chlorine in the bleach should be in a range between four and six percent.

Add eight drops of bleach to each gallon of water; mix thoroughly and let it stand for 30 minutes. The water should have a light chlorine odor. If it doesn't, repeat the dose and let the water stand for an additional 15 minutes.

The next step is to attempt to identify and eliminate the source of contamination.

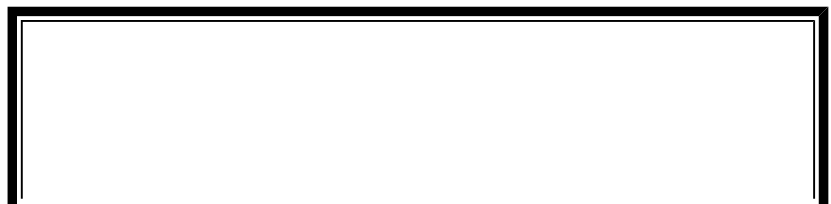
As you attempt to find the source of contamination, evaluate both well location and well construction. Check the entire water distribution system for potential problem areas.

A well's surface location is a crucial safety factor. A well downhill from a source of bacterial contamination runs a greater risk of contamination than a well on the uphill side of the pollution source. Good well location is encouraged by requiring minimum separation distances from sources of potential contamination, thus using the natural protection provided by soil.

To evaluate well location, ask the following questions. You should be able to answer "yes" to all of the following.

- Is the well located at least 50 feet from a septic tank or any non-watertight sewer line?
- Is the well located at least 100 feet from any seepage pit, cesspool, tile field, privy or other subsurface disposal system?
- Is the well located at least 100 feet away from any feedlot, manure pit, manure or sewage lagoon or livestock lot?
- Is the well located uphill from potential sources of bacterial contamination?

Proper well design reduces the risk of pollution by sealing the well from contaminants that might enter it from the surface. The way in which a well was constructed and is maintained, even if the design was sound, affects its ability to



keep out contaminants.

To evaluate well construction ask the following questions. You should be able to answer "yes" to all of the following.

- Does the well have a watertight casing, preferably of heavy-gauge metal or National Sanitation Foundation approved plastic?
- Are all joints in the well casing screwed, welded or otherwise properly sealed?
- Does the well casing extend at least 12 inches above the grade of the land surface?
- Is a sanitary well cap used on the casing?
- Is pitless installation used; or, if pit installation of pumping and storage equipment is used, is the pit at least 10 feet away from the well? (See Figure 1.)

Driven and sandpoint wells are not acceptable.

If possible, correct any problems identified in regard to well location or construction.

For additional information on well location and construction, see Extension Circulars EC98-765, *Improving Drinking Water Well Condition* and EC98-766, *Drinking Water Well Condition*. If water test results indicate the presence of coliform bacteria in your water supply, consider completing a voluntary and confidential self-assessment of your drinking water well using the Extension Circulars listed above.

After addressing the contamination source, the entire water system should be disinfected using shock chlorination. Shock chlorination involves placing a strong chlorine solution in the well and the complete distribution system to kill nuisance and disease-causing organisms.

For directions on how to shock chlorinate a water supply, see NebGuide G94-1255, *Shock Chlorination of Domestic Water Supplies*. After shock chlorination, submit another water sample for testing. The water should test negative before use.

More than one shock chlorination treatment may be needed to effectively treat the entire water supply.

Shock chlorination is recommended: 1) upon completion of a new well or when an existing well is returned to service; 2) when any portion of the distribution system is opened for repairs or maintenance; 3) following contamination by flood water or surface runoff; or 4) when lab results indicate a presence of bacteria.

If the source of bacterial contamination cannot be identified and eliminated, continuous disinfection of the water supply may be necessary. Options include: continuous chlorination, ultraviolet radiation, distillation, and ozone treatment. Chlorination is the most common disinfection method.

For information on continuous disinfection options and the advantages and disadvantages of each, contact

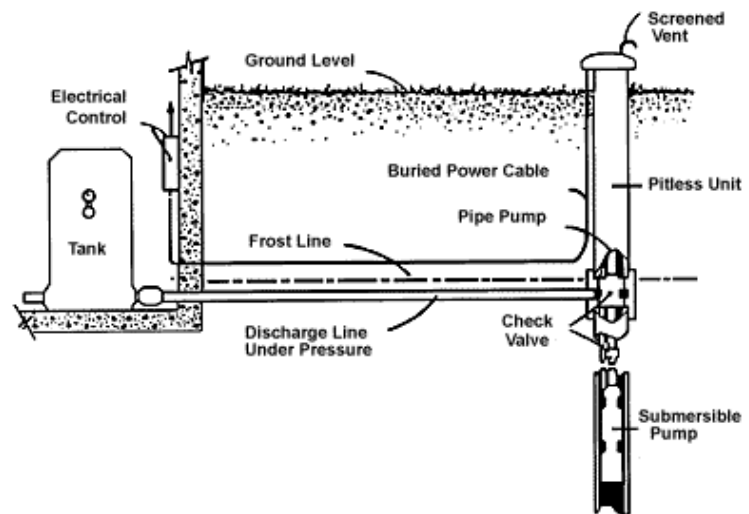


Figure 1. Typical installation of a submersible pump and a pitless unit with the pressure tank in the absement or tank pit. A tank pit should be at least 10 feet away from the well, and it is preferable to have it at least 30 feet away. A buried pressure tank can also be used in this type of installation.

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Summary

Bacterial contamination of drinking water can be a problem. A water test is the only way to evaluate whether bacteria is present in a water supply. Proper well location and construction are keys to avoiding bacterial contamination of drinking water. If contamination is present, attempt to identify and eliminate the source of the contamination. A contaminated water supply can be disinfected.

Related Publications

- EC98-765, *Improving Drinking Well Condition*
- EC98-766, *Drinking Water Well Condition*
- EC90-2502, *Perspectives on Nitrates*
- G89-946, *Water Treatment Equipment: Water Softeners*
- G90-976, *Water Treatment Equipment: A Buyer's Guide*
- G92-1079, *Home Water Treatment Equipment: An Overview*
- G95-1255, *Shock Chlorination of Domestic Water Supplies*
- G96-1274, *Drinking Water: Hard Water*
- G96-1275, *Drinking Water: Sulfates and Hydrogen Sulfide*
- G96-1279, *Drinking Water: Nitrate-Nitrogen*
- G96-1280, *Drinking Water: Iron and Manganese*
- G96-1282, *Drinking Water: Man-made Chemicals*
- G97-1333, *Drinking Water: Lead*
- G98-1360, *Drinking Water: Copper*
- G98-1369, *Drinking Water: Nitrate and Methemoglobinemia*

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