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TECHNICAL BULLETIN

HEALTH EFFECTS INFORMATION

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COLIFORM BACTERIA

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WATERBORNE DISEASE AND MICROORGANISMS

Microorganisms are widely spread over the earth and throughout its atmosphere. Microorganisms include bacteria, viruses, and protozoan parasites; they are microscopic and therefore invisible to the naked eye. They are found in all surface waters, including lakes, streams, and rivers. They can be found in shallow and unprotected wells and springs and, less often, in deep and protected well waters. Many microorganisms can survive extremes of climate. Most microorganisms in the environment and found in water are not harmful, but enough of them are harmful that we try to keep drinking water nearly microorganism-free.

The microorganisms that have the most significance to human health are those that cause disease, which are called pathogens. Examples of common pathogens include bacteria such as *Salmonella* and *Shigella*, protozoans such as *Giardia* and *Cryptosporidium*, and viruses such as hepatitis A and Norwalk. Most of these pathogens are transmitted by what is called the fecal-oral route of exposure; this means that feces from an infected person or animal somehow (directly or indirectly) get into a person's mouth. An example of direct transmission would be changing diapers and then not washing your hands before sticking your finger in your mouth. An example of indirect transmission might be drinking water from a stream contaminated with runoff from a field being grazed by cows upstream

It is not possible to test drinking water regularly for the presence of disease-causing organisms because they exist in very low numbers in water, are hard to isolate and detect, and there are so many different kinds it would be impractical and expensive to test for them all. Consequently, public health agencies and water suppliers in this country generally test only for certain kinds of bacteria that are known as "indicator organisms". These indicators do not themselves cause disease, but are markers for fecal pollution that are easier to test for.

The most common of these test organisms is the broad class of bacteria called coliforms. The presence of coliforms in drinking water suggests microbiological contamination of the source water, a failure of the water treatment system, a break or leak in the water mains, or contamination of the water distribution system by backflow from households

or commercial establishments. When coliforms are detected in drinking water, immediate action should be taken to identify the source or sources of the bacteria and eliminate them.

TOTAL COLIFORM BACTERIA

Total coliform bacteria, often called merely "coliforms", are very widely distributed in nature. Most coliforms live in the intestinal tract of man and other warm-blooded animals, so they are found in significant numbers wherever fecal (intestinal) waste or contamination is present. A few of the bacteria in this class are associated with natural plant material and therefore may be found even where fecal contamination is absent. Coliforms are the most commonly used indicators of contamination in drinking water. Water that contains total coliforms should immediately be tested further for fecal coliforms or *E. coli* (see below). If total coliforms persist in the absence of fecal coliforms or *E. coli*, steps should be taken promptly to identify and eliminate the source of the total coliforms.

FECAL COLIFORM BACTERIA

This is a subgroup of total coliform bacteria consisting of those that can grow at a temperature too warm for most coliforms (44.5 degrees C, or 112 degrees F.). The organisms found by this method are more likely to be associated with fecal contamination than are total coliforms, although again it is not a perfect marker. Some fecal coliforms are associated with woody plant material. But in general, fecal coliforms are a better indicator of fecal contamination than total coliforms in drinking water. Although it doesn't necessarily imply that pathogens are present, water containing fecal coliform is risky to drink unless it is disinfected. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

Escherichia coli (E. coli)

E. coli is one of the fecal coliforms. It lives in the digestive tract of warm-blooded animals and humans. It is present in the feces of almost all warm-blooded animals and humans. Its presence in drinking water is a clear indication of fecal contamination and that the organisms in that waste are still living in the water. Water that tests positive for *E. coli* could contain pathogens and would be risky to drink without adequate

disinfection. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

PATHOGENIC *E. coli*

There are hundreds of different kinds of *E. coli*. Most are harmless, but some can cause illness. The most well-known pathogenic *E. coli* is called *E. coli* O157:H7. Outbreaks caused by this organism often make the news, and are often linked to undercooked meat, raw milk, or other foods contaminated by cattle feces. There have been several outbreaks in the U.S. of *E. coli* caused by contaminated drinking water. All occurred either when people drank untreated water or where water disinfection procedures were not followed properly. Routine water testing methods do not distinguish between pathogenic *E. coli* and the harmless indicator strains. Water containing any *E. coli* is risky to drink without water disinfection. Bringing contaminated water to a boil for one minute is a reliable way of disinfecting it.

ELIMINATING COLIFORMS FROM WELLS

Construction or maintenance work, such as pump replacement in an existing well, can temporarily contaminate well water with coliform bacteria. Bacteria from soil, vegetation, and the tools and hands of the maintenance crew could enter the well. Before using the water, disinfect and flush the entire system and then sample for coliform. The safest temporary measure to kill coliform and other microorganisms in drinking water is to bring water to a rolling boil for one full minute. Chlorination or other chemical disinfection techniques can eliminate coliforms from properly constructed wells.

The procedure for chlorinating a well to eliminate coliforms follows:

For each 100 gallons of well water, add two cups (16 ounces) of household bleach (5% sodium hypochlorite) available from grocery stores.

> EXAMPLE: *How much bleach is needed to disinfect a well with a 6 inch diameter casing and now has 65 feet of water? Answer: The table below shows there are 1.5 gallons of water for each foot of water depth for a 6" diameter well. Multiply the total water depth of 65 feet X 1.50 gallons per foot = 97.5 gallons of water in this 6" diameter well. Since 97.5 feet is about 100 gallons, add 2 cups of 5% bleach to the well to disinfect it.*

Calculate the gallons of water in the well by using the following table:

Well Casing Diameter (inches)	Gallons of Water per Foot of Depth
4	0.65
6	1.50
8	2.60
10	4.10
12	5.90
14	8.00

1. Add the bleach to 4-5 gallons of water and pour in the well. Use a plug or casing vent hole in the top of the sanitary seal.
2. Be sure the bleach mixes thoroughly with the well water. Attach a hose from pump or service line and run water into the well. Use the same hole in the top of the sanitary seal used to add the bleach.
3. After 15 or 20 minutes, open each fixture served by the well until you can detect a bleach smell in the water then close the valves. Let the bleach stand in the well and plumbing for adequate contact time - at least 8 hours.
4. **Thoroughly flush the system**.
5. Sample for total coliform. A good sample location is a bathroom faucet with the aerator removed. Wait until lab results are negative for total coliforms before using the water.

It is difficult to flush an entire system when it is large. The well should be isolated, disinfected, flushed and sampled for total coliform. If total coliform samples are positive, repeat the disinfection process until samples are negative. The repeat procedure must be followed in sequence: disinfect, flush all bleach, and wait for sample results before resuming service. Schedule maintenance in advance so there is adequate time to disinfect and be sure water is safe for use. Warning: Be sure bleach used in this process is flushed thoroughly from all service lines. Remember that bleach contains chlorine and chlorine is harmful to aquarium fish.

If repeated efforts to disinfect a well fail to eliminate coliform organisms or if the organisms return, there could be problems with its construction or protection. Consult a well construction professional for advice on correcting these problems. Identifying and correcting well construction problems is generally a better long-term solution than installing and relying on permanent water treatment equipment.

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