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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 strive to maintain drinking water nearly microorganism-free.

Microorganisms that have the most significance to human health are those that cause disease, 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. These pathogens are transmitted by the fecal-oral route of exposure; this means that feces from an infected person or animal are transmitted directly or indirectly to another person's mouth. An example of direct transmission would be from person-to-person, such as in day care settings serving young children in diapers. Examples of indirect transmission include food contaminated due to poor food handling and sanitation practices, and contaminated drinking water.

It is not possible to regularly test drinking water 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 regularly. Consequently, public health agencies and water suppliers in this country rely on certain kinds of bacteria that are known as "indicator organisms". These indicators do not generally cause disease, but do occur in large numbers, are associated with fecal pollution, are generally hardier in the environment than pathogens, and are easy to test for. In other words, the indicators serve as markers for the kind of fecal contamination that can lead to disease under some circumstances.

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. If coliforms are found it is possible, though not certain, that the water could contain disease-causing organisms as well.

Water that contains coliforms must generally be treated, at least by disinfection with chlorine, before it can be safely used for drinking water or for other domestic purposes. Until the water can be reliably disinfected, it should be boiled before consumption.

FECAL COLIFORM BACTERIA

This is a subgroup of total coliform bacteria consisting of those which can grow when incubated in the laboratory at a temperature too warm for most coliforms (44.5 degrees C, or 112 degrees F.). The organisms that are found by this method are more likely to be associated with fecal contamination than are total coliforms, although a few of these coliforms can also be associated with woody plant material. Therefore, fecal coliforms are a better indicator of fecal contamination than total coliforms in drinking water, but the actual presence of disease-causing organisms is still not certain. Nevertheless, water containing fecal coliform bacteria should never be consumed without at least disinfection treatment. Until the water can be reliably disinfected, it should be boiled before consumption.

ESCHERICHIA COLI (E. COLI)

This bacterium is a member of the fecal coliform group and grows only in the digestive tract of warm-blooded animals and humans. It is present in the fecal material of all healthy warm-blooded animals and humans and it is rarely harmful. Its presence in drinking water, however, definitely shows that sewage or other fecal contamination has occurred and that the organisms in that waste are still living in the water. It is very likely that water that contains *E. coli* could contain disease-causing organisms. Such water should never be consumed without adequate disinfection treatment or boiling.

PATHOGENIC *E. COLI (E. COLI O157:H7)*

This organism is a very specialized and rare strain of *E. coli* that causes illness and its presence in drinking water would be an extreme health concern. There has been one outbreak of infection by this organism attributed to contaminated public drinking water in the United States. Generally, the source of *E. coli O157:H7* transmission is undercooked or mishandled hamburger or other meat products, raw milk, or other foods that have been contaminated with human or animal fecal waste and not adequately cooked. Current routine water testing methods can not distinguish between this organism and the harmless indicator strains, so water containing any *E. coli* should not be consumed without treatment or boiling.

EMERGENCY TREATMENT MEASURES

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 the water to a rolling boil for one full minute. Chlorination or other chemical disinfection techniques are also effective if properly applied.

The procedure for chlorination is as 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 5% 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 coliform 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.