Technical Note environmental

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Microbes in Private Water Supplies

This Technical Note has been prepared to provide an overview of the most common problems arising from microbiological contamination of private water supplies. Note that the term "**Potable Water**" is often used to refer to water which is safe to be used for drinking purposes.

WHAT ARE MICROBES?

The term "Microbes" is commonly used to refer to bacteria, and bacteria are one of a group of micro-organisms (only visible using a microscope). Other microbes include protozoa (such as amoeba, Giardia and Cryptosporidium) and viruses.

Note that there are very large numbers of microbes in the environment (soil, air and water), but only a small number of these are "Pathogenic" (ie capable of causing disease). Examples of pathogenic organisms are bacteria such as faecal streptococci and enterococci, protozoa such as Giardia and Cryptosporidium, and viruses such as those causing infectious hepatitis and polio.

Most private water supplies come from one, or more, of three sources. Each of these has its own potential problems.

- Rainwater from roofs, etc
- Surface water such as dam, pond, stream or spring
- Groundwater from a bore or well

Rainwater. Rain washes dust, leaves, insects, bird and possum faeces, etc, off the roof into the tank. Fertiliser and spray residues may also wash off. The quality of rainwater will vary with the amount of rain and the time since the last rainfall. Testing is not necessary as bacteria will always be present, and rainwater pH is about 5.8. Spend the money on a treatment system if concerned.

Surface Waters. Animals walk through, drink from, fly over and die in surface waters! Surface waters are also affected by run-off from the land after rain. The quality will vary with season, rainfall, etc. Treatment is always needed.

Groundwaters. A deep bore will have little, if any, microbiological contamination. Christchurch city, for example, gets most of its drinking water from bores and this is circulated untreated. The filtration effect of soils as the water trickles down will remove most contamination, and deep water sources (aquifers) have little oxygen to support microbes. Shallow bores and open wells are liable to contamination from surface water, especially if close to septic tank overflows, effluent ponds, dairy sheds, etc. Note that separation distances will vary with terrain and soil type.

Microbiological contamination of a water supply has a significant potential for causing sickness within a community. Diseases may be caused by consuming

- untreated water containing faecal matter eg from a dam, pond, stream or spring, or rainwater collected from a roof.
- inadequately treated water as a result of faulty equipment or poor maintenance.
- treated water that has been polluted because of unsafe or unsanitary plumbing (eg no back-flow preventer, so water drawn back from cattle troughs into the main water supply).

Although the transmission of diseases through a water supply requires the presence of disease causing organisms, testing specifically for these organisms is complex, and often too insensitive and slow to provide a practical means of monitoring and control.

TESTING FOR PATHOGENIC BACTERIA

Since the entry of disease causing organisms into a water supply is always accompanied by a much larger number of bacteria characteristic of faecal pollution, the absence of such bacteria can reliably be taken to indicate the absence of disease causing organisms.

A family of microbes known as Coliforms (Thermotolerant organisms) have been studied for decades for this purpose and reliable data has been established for many years relating coliforms to faecal pollution.

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Testing for coliforms is commonly done by one of three methods;

1. **Presence/absence**. This is a screening method which gives a rapid result and can be carried out using relatively simple equipment. If any bacteria are found, a fresh sample must be collected and checked using one of the other methods.

2. **MPN (Most probable number) or Multiple Tube method**. Measured volumes of water are added to sets of tubes containing liquid medium which supports growth of faecal coliform organisms, and incubated at 35°C for a set period. Any growth is confirmed in a second, selective medium and the count is calculated on how many tubes grow bacteria. Results are reported as "MPN (most probable number)/100 mL", which is a statistical count based on the total number of positive tubes compared to the total number of tubes inoculated.

This method has a limit of detection of 1.1 MPN/100 mL, so that results where faecal coliforms/E coli have not been detected are reported as < (less than) 1.1 MPN/100 mL.

3. **MF (Membrane Filtration) Method.** The sample is filtered, the filter placed on a nutrient medium and incubated for a set time. The number of bacterial colonies which grow are then counted under a microscope. The detection limit is related to the volume of sample filtered, and the result should be <1/100 mL.

This method can have difficulties where samples are turbid because of suspended sediment or high iron levels and these problems with the water source should be fixed and the source retested.

Special attention is given to Faecal Coliforms, a separate group of organisms within the Coliform family with readily identifiable characteristics, and to E coli (*Escherichia coli*), a subset of faecal coliforms, which are only found within the bowels of warm blooded animals. These bacteria do not generally cause problems themselves, but indicate the likelihood that pathogenic bacteria from the same source will be present.

In New Zealand, water quality guidelines are published by the Ministry of Health in 'Drinking Water Standards for New Zealand', and vary depending on the source of the water.

In all cases, water that contains faecal coliforms/E coli is considered unsuitable to drink without treatment (chlorination, ozonation, boiling, adequate filtration).

Total Coliform counts give an indication of the contamination potential of the water, but are no longer used (by the Ministry of Health) for sanitary purposes. The result may be included in the report as it forms part of the test, and is sometimes useful to Health Protection Officers, but there are no interpretative guidelines now available.

To be acceptable, potable water must be reported by the laboratory as follows

Acceptable result	Method used
Absent	Presence/absence method
<1.1 /100 mL	MPN method
<1/100 mL	MF method

Any other result means that the water is unsafe to drink.

"Iron Bacteria"
Iron bacteria use iron as an energy source. They are not pathogenic, but may accumulate over time and form a gelatinous mass which can block pipes, irrigation fittings, etc. Stock will also find this water unpalatable, and will restrict their intake to metabolic needs only.
To be acceptable, potable water must be reported by the laboratory as follows.

Testing for iron bacteria is not necessary as their presence is usually obvious. Chlorination will destroy these bacteria and should be followed by vigorous flushing to remove the mass from the pipework, and to reduce the unpleasant taste caused by high chloramine levels.

"Film Forming" bacteria
These are form a film which can block filters, etc. Listeria monocytogenes is an example of a film forming bacteria.

Efficient sterilisation of the water with chlorine, ozone, etc, will prevent their growth. Containers used for water storage in a refrigerator should be regularly sanitised, and water should not be stored for more than 72 hours.

Testing for Protozoa
Testing for Giardia and Cryptosporidium is very expensive (about $250-$400) and requires a special sampling kit which contains a pump, flow meter and filter, to be sent out from the testing laboratory. A large volume, usually 200 - 400 L, of water must be filtered and the kit returned to the laboratory.

Hill Laboratories does not test for protozoa, only a few specialised laboratories in NZ do. Contact your local Medical Officer of Health, or Hill Laboratories for a list of laboratories able to test for protozoa.

WHAT CAN BE DONE IF THE WATER IS CONTAMINATED?

1. Inspection
If the water is stored in a tank, then inspect the inside of the tank using a strong portable light source (don't use a light connected to mains power because of the risk of electrocution!). Consider getting the tank cleaned out and disinfected by a professional tank cleaning service.

Inspect all plumbing connections, including the inlet to the tank, and overflow pipe. There are many cases of birds getting trapped in tanks and contaminating the supply!

Install a settling pipe, or coarse filter between the roof and tank if rainwater is being collected.

2. Treatment
There are a number of treatment options, all requiring specialised technical expertise not available at Hill Laboratories. Look in the Yellow Pages of the Telephone Book under "Water Treatment" and "Water Purifiers"

Options include;

- **Filtration (almost always necessary).** Coarse filters remove suspended matter, and fine filters may remove much of (but not all) microbial contamination. Fine filters (0.2 mm = 0.2 micron) are used to remove protozoan cysts.
- **UV (Ultraviolet) from a special lamp**. Will kill bacteria and protozoa, but NOT protozoan cysts. Needs clean water, so usually preceded by filtration.
- **Ozonisation**. Ozone is a form of oxygen having three oxygen atoms per molecule, normal oxygen only has two. This makes it very reactive, and it has greater germicidal power than chlorine.
- **Chlorination**. Still the most widely used for treatment of public water supplies. Chlorine is very toxic and difficult to handle, so is rarely used for private water supply treatment.

[Emergency treatment with 8 mL Softchlor or 40 mL Janola/1000 L will give a FAC (Free available chlorine) level of about 1 ppm, flush all of the ***cold*** *water water system thoroughly. Do not flush the hot water pipes as the chlorine solution is corrosive under hot conditions. A residual level of 0.2 ppm FAC is desirable. Water with high iron may require more chlorine solution.]*

- **Distillation**. Will remove biological contamination and sterilise the water. Will not remove some chemicals. Has a high energy cost, so not likely to be used for all household water. May be cost effective when camping or holidaying in areas with contaminated water.
- **Others.** Silver, iodine and permanganate have all been used for treatment of drinking water.

3. Down Bore Sterilisation
It is possible to sterilise contaminated bores with chlorine. This process is time consuming and requires specialised knowledge and equipment.