

Causes of Bacteria in Water Samples,

The purpose of this document is to identify possible causes of bacteria in drinking water samples. These causes can be categorized as either:

1. True bacterial contamination of the water source.
2. Errors of various types.

TRUE BACTERIAL CONTAMINATION

Total and fecal coliform (including *E. coli*) grow in the intestinal tract of animals including man. Outside the host, these bacteria die off quickly, typically within 30 days. Therefore, if coliform bacteria are identified in a well over a long period of time, it is presumed that bacteria are continuously entering the well or aquifer as the water is withdrawn. Listed below are a number of pathways by which bacteria may enter a well.

Bacterial Contamination Caused By Poor Well Construction

Poor well construction is by far the most common explanation for bacteria in water samples from wells.

Contamination of Dug Wells

Dug wells are approximately 3 feet in diameter and approximately 15 feet deep. Common construction problems with dug wells include a lack of mounded backfill around the outside of the well casing, insufficient casing height above the general ground level, inadequate or leaky well cover, and holes or unsealed joints in the sidewall of the **upper portion** of the well casing.

Older wells made from fieldstone usually have many of these unsealed passageways and thus have very frequent bacterial problems. These well construction problems can sometimes be confirmed by looking for leakage on the inside of the well casing after a heavy rainstorm or simulated "rain" from a garden hose.

Contamination of Springs

Construction problems in springs are similar to those of a dug wells with one addition: the frequent entry of bacterial contaminants in the **reverse direction** through the overflow pipe.

Contamination of Bedrock Wells (also called artesian / drilled)

Common construction problems with bedrock wells include a buried well head and an inadequate well cap. Installation of a pitless adaptor should prevent the leakage of bacteria-laden surface water directly into the well. Construction problems with bedrock wells can sometimes be confirmed by identifying leakage on the inside of the well casing after a heavy rainstorm or from simulated rain from a garden hose.

Contamination Caused by Recent Well Pump Installation, Replacement, or Plumbing Repair

Recent repair or pump replacement is the second most likely cause of bacteria in water samples.

New Pump Installation or Plumbing Work

When a submersible pump is taken out of a well or when a new pump is prepared for installation, it is typically placed directly on the ground near the well. When this occurs, dirt laden with bacteria often adheres to the pump, the water discharge line, and/or the electrical power cable. This material then contaminates the well when the pump is installed. After reinstallation of the pump, time and flushing are necessary to remove this solid material from the assembly. Only after flushing to loosen this material should disinfection be conducted.

When recent work has been done on the home's plumbing system, such as hot water tank replacement, pipe installation, etc., bacterial problems will likely be experienced for a few days thereafter. Very strong flushing, possibly followed by chlorination if necessary, will likely clean the plumbing system of bacteria.

Newly Constructed Wells

The installation of any new well normally allows substantial bacteria to enter the fractures of the bedrock or the soil around the outside of the dug well casing. Mud and soil particles protect these bacteria from disinfection. Sustained flushing is needed to remove this mud, pulverized rock and bacteria prior to disinfection. In rare cases, the removal of construction debris may take months. Please note that disinfectants can not kill bacteria trapped deep within these construction residuals. The solids must first be flushed away before effective disinfection can be expected.

Contamination Caused by Physical Damage to the Aquifer's Filtration Capability

It is possible, but unlikely, that bacteria will move through the soil or the bedrock faults for significant distance.

Dug Wells

Bacteria and virus may travel through certain coarse soils with insufficient filtration capacity. There is no practical way to improve soil filtration. The location at which the bacteria entered the soil could possibly be found by using tracer dye, however the inadequate soil filtration, caused by large soil particles, still would remain. This means the well would still be vulnerable to other bacterial events in the future. Even if treatment of the well water was added, the varying levels of bacterial contamination could exceed the capability of the treatment process at one or more times in the future. DES generally recommends that a different type of well be installed, if soil filtration is proven to be inadequate.

Bedrock Wells

Contamination of bedrock faults can occur when the overlying soil is stripped from the top of the bedrock or when the upper bedrock is blasted or ripped loose. Drilling a new well can also create localized short-term bacterial contamination of bedrock fractures. Normally these construction activities will be of short duration. When the soil backfill is replaced in the area disturbed, the filtration should be reestablished. Water percolation through soil is the process that removes bacteria from groundwater. Conditions which normally remove filtering soil and expose fractures in the bedrock include:

- Road cuts through bedrock outcrops
- Excavation into bedrock for swimming pools or house foundations
- Well drilling for artesian wells on other lots
- Abandoned but uncapped bedrock wells on other lots

The DES recommends **waiting out** the replacement of the soil backfill at construction sites and the natural die-off and self-cleansing process that will follow. Water quality should improve once the soil is replaced and has achieved compaction. There will likely be weeks of lag time between the replacement of soils and the end of the bacterial presence.

Biological Activity Occurring within Treatment Equipment and Piping

Water treatment equipment often uses sand or other media to filter out bacteria from drinking water. This action typically brings bacteria together on the filter media. In such cases, the filtration provides an easily obtained concentrated food supply for these bacteria to sustain themselves.

Biofilm

Biofilm is a name given to a layer of biological material on the inside of pipes, tanks etc. This material contains both mineral deposits and biological material. For reasons still not well understood, this material may, for certain periods, grow at an accelerated rate. As this occurs, some of this biological material may detach from the pipe, tank or treatment devices and be present in water samples. This material generally cannot be seen. It is difficult to fully kill this biological layer. If this material contains organisms of the total

coliform group, these cells could lead to detection of total coliform. One cannot differentiate between biofilm bacteria generally present in pipes and bacteria originating directly from a source associated with disease.

Although biofilm is a possible cause, not all positive bacterial tests are the result of biofilm. It is critically important that all other technical explanations for the presence of bacteria be fully explored to identify the basic cause of bacteria in water samples. In all of these cases, wellhead samples should be taken after heavy precipitation to help differentiate well construction or soil filtration problems from bacteria associated with the distribution, plumbing or treatment systems.

SAMPLING OR TESTING ERRORS

Each of the instances below identifies a possible error condition. In many cases, errors creating positive bacterial results can be differentiated from those bacteria attributed to poor construction and/or poor soil filtration by taking additional bacterial samples. Errors will not likely be repeated, whereas real construction or filtration problems will show either a constant or highly irregular presence of bacteria. Neither one good (nor one bad) bacteria sample can be considered sufficient testing to judge the long-term consistency of a well's water quality. If the bacterial record, over many samples, alternates between acceptable and unacceptable, it implies that the aquifer is subject to reoccurring contamination or the well is not properly constructed. If all samples but one were good and the samples were taken under the most adverse conditions (after a heavy rainfall), then the single poor sample likely represents an error condition.

Sample Collection Was Improper

Improper bacterial sample collection is the most common error. Poor sampling practice can make a good water sample appear bad.

The following procedure should be used when collecting a bacterial sample.

- *Use a fixed (non-swivel) cold water faucet
- *Remove all faucet devices (aerators, filters)
- *Flush for 5 minutes at high velocity. (See additional comments below)
- *Slow water flow to a trickle
- *Open sample bottle, hold cap facing down (Do not set cap down)
- *Fill bottle, leave air space, recap bottle
- *Now turn off water.

Wiping the sample faucet with a chlorine solution, flaming the faucet, or strong flushing are methods that have been practiced in the past to ensure that the end of the sample faucet is clean. The goal is to prevent a dirty faucet from contaminating an otherwise clean water sample. Remember that any chlorine in the sample container, that has not been neutralized, prevents the sample from being processed for bacteria. For this reason, always flush the faucet thoroughly after wiping with a chlorine solution.

Dirty Sample Bottle, Data Recorded Inaccurately

Other error conditions include old sample bottles or bottles subject to contamination during preparation or transit. Laboratory processing may create positive bacterial test results, as may a variety of clerical errors. These are very rare occurrences and these possibilities can be addressed by taking one or more additional sample(s).

TESTING YOUR WATER

EAI Analytical Labs will provide you with your free water testing kit containing: sample bottles, detailed sampling instructions and a tracking form. Bacteria samples bottles are distributed pre-sterilized and all sample bottles contain their necessary preservatives. Kits are available for pickup or they can be mailed to you. If you are interested or have any questions regarding the analysis of your water, please give us a call.