Section 16

Water Quality Testing

There is no single measure that constitutes good water quality ... it depends on its use. Also, keep in mind that some water quality problems (iron, manganese and turbidity) can be treated (**see Appendix M**). Water quality is defined by analyzing it in terms of its:

1. **Chemical Content**: Hardness (calcium + magnesium), Metals (iron etc), nutrients (nitrogen and phosphorus), chloride, sodium, organic compounds, etc.
2. **Physical Content**: Turbidity, colour, odour, etc.
3. **Biological Content**: Fecal coliform, total coliform, viruses, etc[(1)].

Good quality (potable) drinking water is free from disease-causing organisms, harmful chemical substances and radioactive matter, tastes good, is aesthetically appealing and is free from objectionable colour or odour. It should be emphasized that there is a difference between "pure water" and "safe drinking water". Pure water, often defined as water containing no minerals or chemicals, does not exist naturally in the environment. Safe drinking water, on the other hand, may retain naturally occurring minerals and chemicals such as calcium, potassium, sodium or fluoride which are actually beneficial to human health. These will impart a taste to the water that may take some getting used to.

In some cases, however, groundwater can be contaminated with chemicals or bacteria. For example, a recent study has found that the health of many people has been put at risk due to the presence of **naturally occurring arsenic** in drinking water wells!

Recommended Sampling Program

***After a new water well is completed or when the quality of a water supply is suspect (because of turbid water, unusual colour, taste or smell), water samples should be collected and analyzed chemically and bacterially*. If possible, local health officials should check the water for purity and contamination. When the proper authority has pronounced it safe to drink, it may be used by the community.**

Often, however, many communities with Lifewater wells do not have reasonable access to commercial laboratories. In these cases, it is still desirable to sample but it must be done at the well site for minimum cost.

Tests for nitrate-nitrogen (NO3-N), pH, turbidity, total dissolved solids (TDS), odours, total coliform (the most important test), aerobic and sulphate reducing bacteria can be performed with minimal equipment and cost and provide accurate information on the state of the well water. Ideally, these tests should be done every 6-12 months to ensure that the water is still safe to drink. The tests will indicate if the well water quality is staying the same or will give an early indication that some activity is impacting it. Any indication of quality deterioration can then be corrected at an early stage.

Recommended Test Methods

Water samples should be taken in the following manner:

1. Pump water from the well for about three minutes. While the water is still flowing, immerse a **nitrate** test strip in the stream for one second and withdraw the strip and allow the colour to develop for 60 seconds. Compare the colour against the enclosed colour strip and record the result. Do the same with a **pH** strip.
2. Collect a sample in a clean clear glass vial or bottle; and

   - make visual observations concerning the **turbidity**.
   - make statements about any **odours** observed in the water.

3. With the sample in the clear glass, measure the **TDS** with a TDS pocket meter (if available). Record the number in ppm using the appropriate multiplier.
4. Bacteria tests must be carefully performed to obtain meaningful results. The pipe from the pump should be briefly scorched with a match to insure that any detected bacteria are from the water itself and not the pump surfaces. Then the water should flow for 2-3 minutes before a sample is obtained. Fill the sterile plastic sample bag; take care that the inner surface of the bag is not touched by anything (including hands).

   For **total coliform,** carefully pour water into the sample vials until the liquid level reaches the fill-line (the LaMonte test requires 5 vials; the COLI-MOR test uses 1 jar with a red liquid media). Ensuring that the lip of the vials and the inner surface of the cap do not touch anything, place the cap back on. Place the vials upright in the provided box and set aside for 24-36 hours. Record colour

changes, gas formation and position of the thimble in the vials. After the test, carefully remove the lids, rinse the vials with bleach and then crush and bury them 2 feet in the ground where children cannot find them and play with (they contain potentially dangerous bacteria).

Aerobic and sulphate-reducing bacteria tests[(2)] indicate if bacteria are present which can cause problems ranging from slime formation, turbidity, taste, odour and corrosion through to greater hygiene risks (hydrogen sulphide-producing bacteria have been shown to be associated with the presence of fecal contamination). Although these tests serve as simple indicators, it is recommended that, where a problem is found, further tests be conducted to more precisely determine the nature of the microbial problem.

Test Result Interpretation/Response

If the water is turbid or cloudy, contaminated surface run-off may be entering the aquifer through cracks in the casing or the cement pump pad or through surrounding soil which is very permeable. While turbidity is not dangerous, it reduces the effectiveness of disinfection and indicates the presence of other conditions that need to be further investigated.

Odours should not be present in the drinking water. If present, potentially harmful substances may be entering the water from households (washing activities), agricultural sources (animal fecal matter), or natural sources (sulphates from springs or aquifers).

If total dissolved solids (TDS) exceed 500 mg/l, objectionable taste may drive people to use unsanitary water supplies. Increasing TDS concentrations over time indicates that the well is drawing groundwater from deeper in the earth or that contaminants (such as salt water if the well is near the ocean) are leaching into the aquifer. Serious TDS changes over time will require reducing pumping volumes and/or drilling a new well (likely at a higher elevation).

Readings of pH should be in the range of 5.5 to 8.5 for well waters. If readings are outside this range, the source and corrections may be difficult. The worse effect may be premature corrosion of metal surfaces contacting the water.

Nitrate concentrations above 10 mg/L can cause blood disorders in infants (blue baby disease). Elevated levels indicate that manure, sewage, or nitrogen fertilizers are reaching the water source. One elevated test reading (greater than 50 mg/l nitrate) must be followed up with more frequent testing (weekly). If nitrate levels above 45

mg/l (10 mg/l nitrate as nitrogen) persist, the source of the nitrate (animal confinement areas, privies etc) should be determined and relocated.

Nitrite readings (can be measured with the same test strip) should always be less than 1 mg/l. If nitrite concentrations are above 1 mg/l, the water must not be given to infants and a different source (boiled for disinfection) must be used.

Specific disease-producing organisms are difficult to identify in water. Therefore, while total coliform and aerobic/anaerobic bacteria are themselves not harmful, their presence signals that bacterial contamination from either human or animal fecal sources may be present. If total coliform and/or active aerobic or anaerobic bacteria are found, the water supply should be re-tested with extra careful attention given to all the sampling details.

If bacteria problems are still found, try to get local health professionals to conduct more thorough testing of the water supply. In addition, the well and surrounding area should be carefully examined to determine possible entry points for contaminated water. Note that the same sources that cause nitrate problems are probably responsible for bacterial contamination (see **Section 2.6**). However, bacterial contamination can also indicate a cracked well casing. Each circumstance will require its unique solution to improve the water quality. If problems persist and cannot be corrected, each individual user should disinfect the water they need for drinking, cooking, brushing teeth (**see Appendix T: Learn how to make water safe to drink!**).

Footnotes & References

[1] Coliform bacteria detect both non-pathogenic and disease-producing bacteria. Since the identification of specific disease-producing micro-organisms is difficult, total coliform is often used as an indicator of the water possibly containing disease-producing organisms that normally live in the intestinal tracts of man and warm-blooded animals (Driscoll, 1986). The four major types of pathogenic organisms that can affect the safety of drinking water are bacteria, viruses, protozoa and occasionally worm infections. Typhoid, cholera and dysentery are caused by bacteria and protozoa. Diseases caused by viruses include infectious hepatitis and polio.

[2] The Biological Activity Reaction Tests (BART) by Dryocon Bioconcepts inc. include the nutrient media as a sterile dried matrix on the floor of the tubes (test vials). For the HACH pathoscreen test, the media is contained in small plastic tubes ("pillows") which must be cut and poured into the vial in the field. Only the BART tests do NOT require incubation.

Driscoll, F. (1986) Groundwater and Wells, St. Paul: Johnson Division