Protecting Household Drinking Water

Lesson Description

Plentiful supplies of high-quality potable water are integral to our daily life. Most homeowners take their drinking water for granted, assuming it is safe to drink, or that “someone” is responsible for monitoring the quality of private domestic water supplies. However, it is the homeowners’ responsibility to test their private drinking water and implement practices that will protect their groundwater quality.

Lesson Objectives

1. Understand the concepts of groundwater, infiltration, percolation and recharge.
2. Learn how wells are constructed.
3. Identify the source of your drinking water and understand your responsibilities in protecting the quality of your drinking water.
4. Understand how and when to test your water, and how to interpret the results.
5. Be able to assess risks to your water supply and apply corrective actions on your property.

Module 3, Lesson 2

Protecting Household Drinking Water

Handouts:

1. Domestic Well Maintenance Record Activity Sheet
2. Drinking Water Well Management Activity Sheet
    - Assessment 1- Well Location
    - Assessment 2- Well Construction and Maintenance
    - Assessment 3 – Water Testing and Unused Wells

Supplemental Handouts:

1. Protect Your Drinking Water: Simple Tips for Well Maintenance, WSU Clark County Extension
2. Clark County Water Service Providers, Clark County Public Health
3. Simple Fixes for Wellhead openings, Washington State Department of Health
4. 12 Simple Things you can do to Protect Well Water - OSU Ext
5. Home Water Saving Methods, WSU Extension
6. Shock Chlorinate Your Water System, Clark County Public Health

Other Activities:

1. Map the location of your well head. Go out and inspect the well head.
    - Do you see any cracks or defects in the area around the well?
    - Does the soil slope away from the well?
    - Is there any runoff across the well head area?
    - If you push on the pipe, does it move?
2. Check for leaks in your house and outbuildings. Dyes can be used in toilet tanks over night to test for leaks. Fix any leaky faucets, toilets, hoses, etc.
3. Call your local certified drinking water lab for sample collection instructions, and have your water tested if it has been more than one year since the last test. Keep the test results and all other information gathered in this lesson in your notebook as a permanent record of your property.

Public Drinking Water Supply Standards Information Sheet

http://www.epa.gov/safewater/contaminants/index.html#listmcl

Primary Standards Approved by the EPA

Contaminant	Maximum Contaminant Level
Arsenic (As)	0.01 ppm[1]
Barium (Ba)	2 ppm
Fluoride (F)	4 ppm
Mercury (Hg)	0.002 ppm
Nitrate (NO_3 as N)	10 ppm
Turbidity	1 turbidity unit
Coliforms, Fecal Coliform, E. coli	Cannot be present

Secondary Standards Approved by the EPA

Contaminant	Maximum Contaminant Level
Chloride (Cl)	250 ppm
Color	15 color units
Copper (Cu)	1 ppm
Fluoride (F)	2 ppm
Iron (Fe)	0.3 ppm
pH	6.5 – 8.5
Sulfate (SO_4)	250 ppm
Total Dissolved Solids (TDS)	500 ppm
Zinc (Zn)	5 ppm

Lead/Copper Action Level

Contaminant	Action Level[2]
Copper (Cu)	1.3 ppm
Lead	0.015 ppm

Additional Water Characteristics

Characteristic	Consideration
Alkalinity[5]	
Boron [4,5]	Too much boron is harmful to plants
Bicarbonate (HCO_3)[5]	
Calcium (Ca)[3,4,5]	High levels increase pH in water and soils
Carbonate (CO_3)[5]	
EC (Electrical Conductivity)[5]	Measures salt concentration of water in umhos/cm 0 – 400 excellent 400 – 8,500 satisfactory over 8,500 objectionable
Hardness	0 – 75 ppm soft 75 – 150 ppm moderately hard 150 – 300 ppm hard Over 300 ppm very hard
Magnesium (Mg)[3,4,5]	Laxative effect, quickly adjusted to by newcomers
Potassium (K)[4]	Plant nutrient; adds to TDS. Consult personal physician for health implications
Silica[5]	
Sodium (Na)[5]	Consult personal physician for health implications

1 ppm (parts per million; your report may instead report as mg/l which is an equivalent unit)
2 If your first-draw sample exceeds these levels, consider the need to take preventive action
3 Used to calculate hardness
4 Required for plant growth. Influence on humans or livestock from concentration in water not available. No known health risk
5 Laboratory use

When to Test Your Drinking Water Information Sheet

Test your drinking water if any of the following has occurred:

- Water has an undesirable taste or smell.
- Water leaves scaly residues and soap scum, or stains plumbing fixtures or laundry.
- Water is cloudy or colored.
- Pipes show signs of corrosion.
- Water supply equipment wears out rapidly, including pumps or water heaters.
- You are considering the purchase of water treatment equipment.
- You want to check the performance of existing water treatment equipment.
- Anyone in the household has recurrent gastrointestinal illnesses.
- You are purchasing a new home, and want to know if the water supply is of good quality.
- You have drilled a new well, and want to know if the water is safe to drink.
- You are pregnant, are planning a pregnancy, or have an infant less than 6 months old.
- Your well does not meet construction codes.
- Your well is in or close to a livestock confinement area, such as a corral or feeding area.
- You have mixed or used pesticides near the well, or have spilled pesticides or fuel near the well.
- You have a heating oil tank near the well that you know has leaked.
- Back-siphoning has occurred.
- Your well is located near a gas station or fuel storage tank, retail chemical facility, gravel pit, mining operation, oil or gas drilling operation, dump, landfill, junkyard, factory, dry-cleaning business, road-salt storage area, or heavily salted road.
- Your septic system absorption field or your neighbor's is close to the well (within 100 feet).
- The area around the wellhead has been flooded or submerged.

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pH: pH is a measure of the hydrogen ion concentration in water. The pH of water indicates whether the water is acid or alkaline. The measurement of pH ranges from 1 to 14 with a pH of 7 indicating a neutral condition (neither acid nor alkaline). Numbers lower than 7 indicate acidity; numbers higher than 7 indicate alkalinity.

Drinking water with a pH between 6.5 and 8.5 is generally considered satisfactory. Acid waters tend to be corrosive to plumbing and faucets, particularly if the pH is below 6. Alkaline waters are less corrosive. Waters with a pH above 8.5 may tend to have a bitter or soda-like taste.

The pH of water may have an effect on the treatment of water and also should be considered if the water is used for field application of pesticides. Water with a pH of 7.0 to 8.5 will require more chlorine for the destruction of pathogens (disease organisms) than will water that is slightly acid.

Conductivity: Conductivity is a measure of the conductance of water to an electric current. Conductivity (or E.C.) is commonly reported as umhos/cm (micromhos per centimeter) or dS/m (deciSiemens per meter). This is an easy measurement to make and relates closely to the total dissolved solids content of water. The total dissolved solids is approximately 70 percent of the conductivity in umhos/cm.

Total dissolved solids (TDS): High concentrations of total dissolved solids (TDS) may cause adverse taste effects. Highly mineralized water may also deteriorate domestic plumbing and appliances. It is recommended that waters containing more than 500 mg/l of dissolved solids not be used if other less mineralized supplies are available. This does not mean water containing more than 500 mg/l TDS is unusable.

Total hardness: Hardness is the property which makes water form an insoluble curd with soap and is primarily due to the presence of calcium and magnesium. Waters that are very hard have no known adverse health effects and may be more palatable than soft waters. Hard water is primarily of concern because it requires more soap for effective cleaning, forms scum and curd, causes yellowing of fabrics, toughens vegetables cooked in the water and forms scales in boilers, water heaters, pipes and cooking utensils.

The hardness of good quality water should not exceed 270 mg/l (15.5 gr/gal) measured as calcium carbonate. Waters softer than 30 to 50 mg/l may be corrosive to piping depending on pH, alkalinity and dissolved oxygen.

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Chloride: High concentrations of chloride ions may result in an objectionable salty taste to water and the corrosion of plumbing in the hot water system. High chloride waters may also produce a laxative effect. An upper limit of 250 mg/l has been set for the chloride ions, although at this limit few people will notice the taste. Higher concentrations do not appear to cause adverse health effects. An increase in the normal chloride content of your water may indicate possible pollution from human sewage, animal manure or industrial wastes.

Alkalinity: Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemical system present in natural waters is one where carbonates, bicarbonates and hydroxides are present. The bicarbonate ion is usually prevalent. However, the ratio of these ions is a function of pH, mineral composition, temperature and ionic strength. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality. Alkalinity is not considered detrimental to humans but is generally associated with high pH values, hardness and excess dissolved solids. High alkalinity waters may also have a distinctly flat, unpleasant taste.

Nitrate: Nitrate (NO_3) levels should not be higher than 10 mg/l if reported as nitrogen (N) or nitrate-nitrogen ($N\text{-}NO_3$) or higher than 45 mg/l if reported as nitrate (NO_3). High nitrate may cause methemoglobinemia (infant cyanosis or "blue baby disease") in infants who drink water or formula made from water containing nitrate levels higher than recommended. Adults can drink water with considerably higher concentrations than infants without adverse affects. Livestock water can contain up to 100 mg/l of nitrate-nitrogen, but young monogastric animals such as hogs may be affected at nitrate levels of considerably less than 100 mg/l.

Fluoride: At concentrations greater than 1.0 mg/l, fluoride will reduce the incidence of dental cavities. At concentrations over 1.5 mg/l, fluorosis (mottling) of teeth may occur. Some municipal water supplies have added fluoride to reach the optimal level of 1.2 mg/l to reduce cavities. Some water supplies contain naturally occurring fluoride in amounts high enough to cause mottling of the teeth.

Turbidity: Turbidity is a measure of light transmission and indicates the presence of suspended material such as clay, silt, finely divided organic material, plankton and other inorganic material. Turbidities in excess of 5 turbidity units are usually objectionable for aesthetic reasons. If turbidity is high, be aware of possible bacterial contamination.

Calcium and magnesium: Calcium and magnesium are important contributors to water hardness. When water is heated, they break down and precipitate out of solution, forming scale. Maximum limits have not been established. Magnesium concentrations greater than 125 mg/l may have a laxative effect on some people.

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Iron and manganese: Iron in concentrations greater than 0.3 mg/l and manganese in concentrations greater than 0.05 mg/l may cause brown and black stains on laundry, plumbing fixtures and sinks. A metallic taste may also be present and it may affect the taste of beverages made from the water. High concentrations of iron and manganese do not appear to present a health hazard.

Potassium: Potassium concentrations in water are generally very small. Although excessive intakes may have a laxative effect, public health authorities have not established a maximum limit.

Sodium: Sodium is a very active metal that does not occur naturally in a free state. It is always combined with other substances. In the human body sodium helps maintain water balance. Human intake of sodium is mainly influenced by the consumption of sodium as sodium chloride, or table salt. The contribution of drinking water is normally small compared to other sources. The treatment for certain heart conditions, circulatory or kidney diseases or cirrhosis of the liver may include sodium restriction. Diets for these persons should be designed with the sodium content of their drinking water taken into account. The National Academy of Sciences has suggested a standard for public water allowing no more than 100mg/l of sodium. This would ensure that the water supply adds no more than 10 percent of the average person's total sodium intake. The American Health Association has recommended a more conservative standard of 20 mg/l to protect heart and kidney patients.

High concentrations of sodium will reduce the suitability of water for irrigation or house plant watering use. High sodium water will alter the soil chemistry and absorption properties, eventually sealing the soil surface.

Softening water by the ion exchange or lime-soda ash processes will increase the sodium content. Softening by ion exchange will increase the sodium content approximately 8 mg/l for each gr/gal (grains per gallon) of hardness removed.

Sulfates: Water containing high levels of sulfates, particularity magnesium sulfate (Epsom salts) and sodium sulfates (Glauber's salt) may have a laxative effect on persons unaccustomed to the water. These effects vary with the person and appear to last only until one becomes accustomed to using the water. High sulfate content also affects the taste of water and will form a hard scale in boilers and heat exchangers. For these reasons the upper recommended limit for sulfates is 250 mg/l.

Adapted from “Interpreting a Mineral Analysis” by V. Dean Adams, University of Nevada Cooperative Extension

Recommended Minimum Separation Distances Between Wells and Potential Sources of Contamination Information Sheet

Recommended Minimum Distance (feet 0	Potential Source of Contamination
10	Neighboring property line Building Home
50	Animal shelter or corral Cistern, feed storage Plastic silage storage tube (ag bag) Silo with concrete sealed floor Filter strip Building sewer drain
100	Fuel oil/gasoline storage tanks Manure storage Liquid tight pesticide/fertilizer storage facilities Streams or watercourses Other sources of water supply Septic tanks and leach fields
150	Springs or wells not sealed to first 50 feet of depth Septic system leach fields greater than three feet below the surface of the land
250	Liquid animal waste disposal systems Stacked animal wastes Wastes in earthen or excavated storages, including trenches or pit silos

How Can I Protect My Private Water Supply? Information Sheet

Carefully managing activities near a well's water source, including keeping contaminants away from sink-holes, the well, and septic systems, can protect your water supply. The following tips can help you protect your water source:

- Periodically inspect exposed parts of the well for problems, such as cracked, corroded, or damaged well casing, broken or missing well cap, and settling or cracking surface seals.
- Keep accurate records of any well maintenance, such as disinfection or sediment removal that may require the use of chemicals in the well.
- The wells' casing should extend a minimum of 20 feet below the ground surface and preferably be driven at least 5 feet into bedrock.
- Keep your well records in a safe place. These include the construction report, as well as the annual water well system maintenance and water testing results.
- When landscaping, keep the top of your well at least 12 inches above the ground.
- Hire a certified well driller for any new well construction, modification, or abandonment and closure.
- Be careful when working or mowing around your well. A damaged casing could jeopardize the sanitary protection of your well. Don't pile snow, leaves or other materials around your well.
- Avoid mixing or using pesticides, fertilizers, herbicides, degreasers, fuels, motor oil, and other pollutants near the well.
- Install a well cap or sanitary seal that prevents animals or other vermin from getting into your well, and that hinders the unauthorized use of, or entry into, the well.
- Don't allow back-siphonage. When mixing pesticides, fertilizers or other chemicals, don't put the hose inside the tank or container.
- Do not dispose of wastes in dry wells or in abandoned wells.
- A sanitary seal or concrete platform should be set around the wellhead to keep pollutants from entering the well bore.
- Do not cut off the well casing below the land surface.
- Always maintain proper separation between your well and buildings, waste systems or chemical storage facilities. As a rule of thumb, maintain a minimum of 100 feet between the water source and a subsurface sewage absorption area. Contact a professional well contractor for specific information.
- Existing wells in areas with a history of flooding should have the casing elevated at least 2 feet above the highest known flood level and also should have a watertight sanitary seal at the top of the grouted casing.
- Disinfect drinking water wells at least once per year with bleach or hypochlorite granules, according to the manufacturer's directions.
- Slope the area around the well to drain surface runoff away from the well.
- Have the well tested once a year for coliform bacteria, nitrates, and other contaminates of concern. Any source of drinking water should be checked any time there is a change in taste, odor, or appearance, or anytime a water supply system is serviced.
- When your well has come to the end of its serviceable life (usually more than 20 years), have a qualified water well contractor properly decommission your well after constructing your new system.
- Never dispose of hazardous materials in a septic system.
- Pump and inspect septic systems as often as recommended by your local health department.

Domestic Well Maintenance Record Activity Sheet

Address _____

Well

Name of driller _____

Phone number _____ Date drilled _____

Type of well (dug, drilled, etc.) _____

Location _____

Capacity (gallons/minute) _____

Pump

Name of pump installer _____

Phone number _____

Type of pump _____

Pump capacity (gallons per minute) _____

Brand name _____

Serial number and model _____

Depth to pump or intake line _____ Date purchased _____

Water Quality (save a copy of each laboratory analysis for comparison)

Date tested	Tests	Problems Noted

Well Repairs

Date Repaired	Type of Repair Done	Shock Chlorinated?

Copies of well drilling reports are generally filed with the state or a local municipality. Check with your local entity to obtain a copy of the original report, if you don't have one.

Drinking Water Well Management Activity Sheet, page 1 of 3

ASSESSMENT 1 – Well Location

	LOW RISK	MEDIUM RISK	HIGH RISK	YOUR RISK
Position of well in relation to pollution resources	Well is uphill from all pollution sources. Surface water doesn't reach well or is diverted.	Well is level with or uphill from most pollution sources. Some surface water runoff may reach well.	Well is downhill from pollution sources or in a pit or depression. Surface water runoff reaches well.	❑ Low ❑ Medium ❑ High
Separation distances between well and pollution sources*	Distances from potential pollution sources meet or exceed all state minimum requirements.	Some but not all distances from potential pollution sources meet state minimum requirements.	Distances from most or all potential pollution sources do not meet state minimum requirements.	❑ Low ❑ Medium ❑ High
Soil type	Soil is fine-textured like clay loams or silty clay.	Soil is medium-textured like silt or loam.	Soil is coarse-textured like sand, sandy loam, or gravel.	❑ Low ❑ Medium ❑ High
Subsurface conditions	The water table or fractured bedrock are deeper than 50 feet.	The water table or fractured bedrock are 20 to 50 feet deep.	The water table or fractured bedrock are shallower than 20 feet.	❑ Low ❑ Medium ❑ High

*Suggested minimum separation distance is 100 feet. Use Recommended Minimum Separation Distances Between Wells and Potential Sources of Contamination Information Sheet.

*Adapted with permission from Home*A*Syst: An Environmental Risk-Assessment Guide for the Home, NRAES-87.*

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ASSESSMENT 2 – Well Construction and Maintenance

	LOW RISK	MEDIUM RISK	HIGH RISK	YOUR RISK
Well age	Well is less than 20 years old.	Well is 20 to 50 years old.	Well is more than 50 years old.	❑ Low ❑ Medium ❑ High
Well type	Drilled well.	Driven-point (sand-point) well.	Dug well.	❑ Low ❑ Medium ❑ High
Casing height above land surface	Casing is 12 inches or more above the surface. If the area floods, casing is 1 foot to 2 feet above the highest recorded flood level.	Casing is at the surface or up to 12 inches above the surface.	Casing is below the surface or in a pit or basement.	❑ Low ❑ Medium ❑ High
Condition of casing and well cap (seal)	No holes or cracks are visible. Cap is tightly attached. A screened vent faces the ground.	No holes or cracks are visible. Cap is loose.	Holes or cracks are visible. Cap is loose or missing. Running water can be heard or seen.	❑ Low ❑ Medium ❑ High
Casing depth relative to land surface	Casing extends 50 feet or more below the land surface.	Casing extends 20 to 50 feet below the land surface.	Casing extends less than 20 feet below the land surface.	❑ Low ❑ Medium ❑ High
Backflow protection	Anti-backflow devices are installed.	Measures are sometimes taken to prevent backflow.	No anti-backflow devices are installed.	❑ Low ❑ Medium ❑ High
Well inspection and "tune-up"	Well was inspected within the last 10 years.	Well was inspected 10 to 20 years ago.	Well was inspected more than 20 years ago or owner doesn't know when well was last inspected.	❑ Low ❑ Medium ❑ High

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ASSESSMENT 3 – Water Testing and Unused Wells

	LOW RISK	MEDIUM RISK	HIGH RISK	YOUR RISK
Water testing	Consistent, good water quality. Tests meet standards for bacteria, nitrate, and other contaminants.	Some tests do not meet standards or tests approach standards.	Water is not tested. Water is discolored after a rainstorm or during spring melt. There are noticeable changes in color, odor and taste.	❑ Low ❑ Medium ❑ High
Unused wells on your property or in your area	There are no unused wells, or there are unused wells that are properly sealed.	There are unused wells that are not sealed but are capped and isolated from contaminants.	There are unused, unsealed wells that are in poor condition, near pollution sources and/or are uncapped.	❑ Low ❑ Medium ❑ High

*Source: Home*A*Syst: An Environmental Risk-Assessment Guide for the Home, NRAES-87.*

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Aquifer: A sand, gravel, or rock formation capable of storing or conveying water below the surface of the land.

Bacteria: Microscopic one-celled organisms which live everywhere and perform a variety of functions. While decomposing organic matter in water, bacteria can greatly reduce the amount of oxygen in the water.

Best management practices (BMP): Practices that have been determined to be the most effective, practical means of preventing or reducing water pollution from nonpoint sources

Confined aquifer: Water-bearing formation with an upper boundary that is a layer that does not transmit water readily.

Contaminant: Any physical, chemical, biological, or radiological substance causing an impurity in the environment.

Drainage: Downward movement of water through the soil. When this happens quickly, the drainage is “good,” “fast,” or the soil is “well drained;” when it happens slowly, the drainage is said to be “slow,” “bad,” or soil is “poorly drained.” Plant roots need oxygen as well as water, and soil that remains saturated deprives roots of necessary oxygen.

Drawdown: Vertical drop of the water level in a well during pumping.

EPA: The United States Environmental Protection Agency.

Groundwater: The subsurface water supply in the saturated zone below the water table.

Hydrologic cycle: The movement of water in and on the earth and atmosphere through processes such as precipitation, evaporation, runoff, infiltration and combustion.

Infiltration: The rate at which water enters the soil. Infiltration depends on the texture, structure and the depth of the soil.

Leaching: The washing out or flushing of a soluble substance from an insoluble one. In high-rainfall areas, rainwater leaches good as well as harmful substances from the soil. Gardeners leach soil with water when they want to remove excess salts.

Nonpoint source pollution (NPS): Pollution from widespread or diffuse sources with no definite point of entry. The source is not a readily discernible point such as a discharge pipe.

Nutrient: That portion of any element or compound in the soil that can be readily absorbed and assimilated to nourish growing plants. Substances required by plants for growth.

Pathogen: Disease-causing biological agent such as a bacterium, virus, or fungus.

Percolation: Movement of water through soil or rock.

Permeability: Capacity of soil, sediment, or porous rock to transmit water.

Pollutant: A substance that contaminates air, soil or water. Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it impairs the water, soil, or air’s usefulness or renders it offensive.

Recharge: Downward movement of water through the soil to an aquifer, replenishing groundwater supplies.

Protecting Household Drinking Water Glossary, page 2 of 2

Recharge area: Land area over which precipitation infiltrates into soil and percolates downward to replenish an aquifer.

Runoff: That portion of the precipitation or irrigation water which moves over the land surface and into surface streams or water bodies.

Saturated zone: Portion of the soil or rock profile in which all pores are filled with water.

Soluble: Capable of being dissolved easily.

Static water level: Water level in a well before pumping.

Total dissolved solids (TDS): Concentration of all substances dissolved in water (solids remaining after evaporation of a water sample).

Toxic chemical, toxic: Substances that even in small quantities may poison, cause injury, or cause death when eaten or ingested through the mouth and stomach, absorbed through the skin or inhaled into the lungs.

Unsaturated zone: Portion of the soil profile which contains both air and water. Water in this zone cannot enter a well.

Watershed (drainage basin): An area of land that collects rain and/or snowmelt and discharges much of it to a stream, river, or other water body, or to groundwater.

Water table: The upper level of a saturated zone in an aquifer below the soil surface.

Wellhead protection: The practice of preventing pollutants from seeping into wellwater at or near any active or abandoned well.

Protecting Household Drinking Water

Web sites for further information

Clark County Publlic Health Well Water Information, http://www.clark.wa.gov/public-health/water/index.html

Well Log Search, WA Dept of Ecology, https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/default.aspx

Washingotn State Dept of Health Drinking Water Page, http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater

National Drinking Water Clearinghouse, http://www.nesc.wvu.edu/drinkingwater.cfm

National Well Owners Association, http://www.wellowner.org/

North Dakota State University Water Quality and Pesticide Information:

http://www.ag.ndsu.edu/waterquality/pesticides

NSF International – assessment of water treatment systems, bottled water, http://www.nsf.org/

U.S. EPA Office of Groundwater and Drinking Water, http://water.epa.gov/drink/index.cfm

U.S. EPA Private Drinking Water Wells, http://water.epa.gov/drink/info/well/

U.S. EPA, Safe Drinking Water Act, http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm