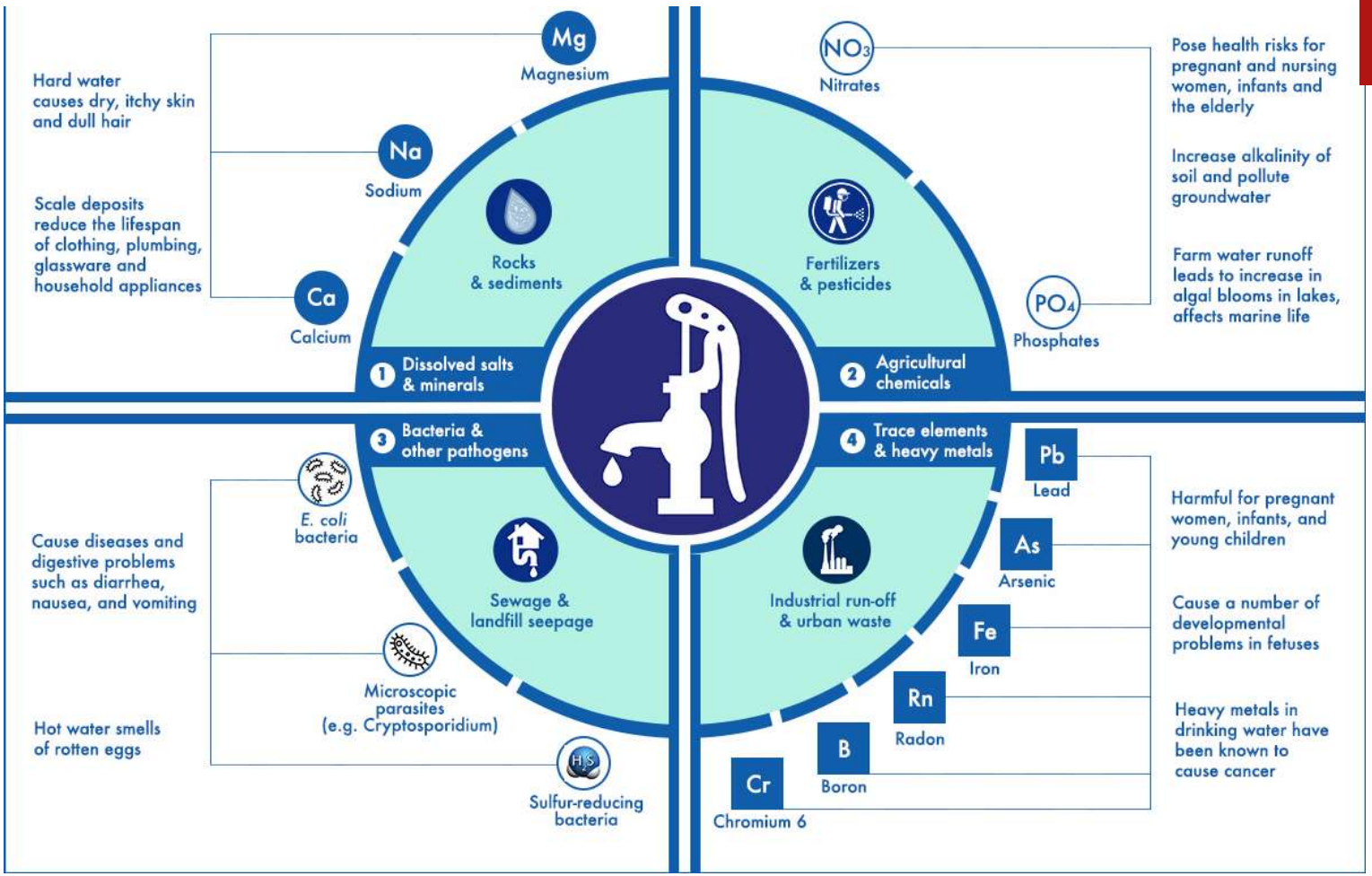
MODULE 3: TYPES OF CONTAMINATION

INSPECTION CERTIFICATE ASSOCIATES


Hard water causes dry, itchy skin and dull hair
Mg
Magnesium
Na
Sodium
Scale deposits reduce the lifespan of clothing, plumbing, glassware and household appliances
Ca
Calcium
Rocks & sediments
1 Dissolved salts & minerals
NO3
Nitrates
Pose health risks for pregnant and nursing women, infants and the elderly
Increase alkalinity of soil and pollute groundwater
Fertilizers & pesticides
PO4
Phosphates
Farm water runoff leads to increase in algal blooms in lakes, affects marine life
2 Agricultural chemicals
3 Bacteria & other pathogens
E. coli bacteria
Cause diseases and digestive problems such as diarrhea, nausea, and vomiting
Sewage & landfill seepage
Microscopic parasites (e.g. Cryptosporidium)
Hot water smells of rotten eggs
H2S
Sulfur-reducing bacteria
4 Trace elements & heavy metals
Pb
Lead
As
Arsenic
Fe
Iron
Rn
Radon
B
Boron
Cr
Chromium 6
Industrial run-off & urban waste
Harmful for pregnant women, infants, and young children
Cause a number of developmental problems in fetuses
Heavy metals in drinking water have been known to cause cancer

Ferrous vs. Ferric (Rust)

For optimum treatment, it's important that you distinguish between soluble clear-water iron, or "ferrous", and insoluble red-water iron, also called "ferric" but commonly known as rust. Then there is organic iron and bacterial iron.

- **Ferrous (Fe^{2+})**
- **Ferric (Fe^{3+})**
- **Organic iron**
- **Bacterial iron**

Ferrous (Fe^{2+})

Ferrous may be contained in anaerobic groundwater at levels of up to several parts per million without causing turbidity or discoloration when directly pumped from a well. It comes out of the faucet still clear and will only start to turn red after standing for a while being exposed to oxygen in the air. Thus the name clear-water iron.

Ferric (Fe^{3+})

Ferric is contained in oxygen-rich water sources. The water already has a reddish or yellowish color when drawn from the tap. Because ferric is insoluble and gelatinous, it's also what causes clogging in your plumbing system and household appliances.

Organic iron

It occurs in shallow wells and those being affected by surface water. It has formed compounds with naturally occurring acids and other organic matter. These compounds are usually heavily colored and can cause severe staining. When it comes to treating water containing organic iron, the problem is that the compounds are very stable and the iron is not free to react.

How to Remove Iron

Water Softener
Designed to remove minerals that cause hard water, softeners do remove small amounts of iron. Unfortunately, water softeners are not a filtration media so iron seems to settle into the tank, and backwash rates are never high enough to purge concentrations of heavy metals. So a water softener alone is not the solution.

Aeration
This method adds oxygen to the water to oxidize the iron. (Iron

Oxidizing Filter
This causes immediate oxidation and adds a reverse (backwash) flush system.

Chemical Oxidation
Adds Chlorine or Hydrogen Peroxide to oxidize/destroy the iron. A water filter treatment system is then used to remove the chlorine or hydrogen peroxide from the water before use. (Iron

Iron Filtration

- Depending on the condition of the water and the filter media in use, pre-oxidation is required to reach adequate dissolved oxygen levels. The oxygen will act as a catalyst. Methods for pre-oxidation are aeration and the injection of chlorine, ozone or peroxide among others. For aeration, an air pump or air inductor can be used.
- Just like softeners, iron filters require periodic backwashing to clean out the precipitated rust that accumulates in the media bed. This in turn requires sufficient water flow. The flushing also ensures that no bacteria can grow inside the purifier, so it's essential for water safety. Every once in a while, the filter media also needs to regenerate to retain its oxidizing and adsorption capabilities.
- By the way, insufficient backwash and regeneration are the most common reasons for the filters to fail.

Bacterial iron

- The term refers to water that contains iron bacteria. There are a number of different species of iron bacteria that can affect a water well. The bacteria generally are long, threadlike organisms that secrete a slime. The slime allows the bacteria to adhere to a substrate and also forms a protective sheath. New bacterial growth will occur on top of older growths, forming a layer-like structure. The result is large masses of brown gelatinous bacterial growths that can quickly plug screen openings and pump intakes.

Hydrogen Sulfide

- Hydrogen sulfide is a colorless gas that can exist naturally in groundwater. Sulfur-reducing bacteria present in groundwater use sulfur as an energy source to chemically change sulfates to hydrogen sulfide. The bacteria use sulfur from decaying plants and other organic matter in oxygen-deficient environments. They can occur in deep or shallow wells, and reside in plumbing systems.

Hydrogen Sulfide

- Hydrogen sulfide crops up in other ways too. The magnesium rod used in water heaters for corrosion control can chemically reduce sulfates to hydrogen sulfide, and sewage pollution can be a source. Hydrogen sulfide also can enter surface water through springs.

Hydrogen Sulfide

- Hydrogen sulfide, if present, will vary by well due to the varying geology. It is most common in shales and sandstones. The occurrence of hydrogen sulfide gas has been correlated to groundwater with low pH and groundwater with high levels of iron and/or manganese. It also may be associated with hydrocarbons and peat formations.

Dangers of Hydrogen Sulfide

- Hydrogen sulfide gas is flammable and poisonous at high concentrations. Usually it is not a health risk at concentrations present in household water. Buildup of hydrogen sulfide concentrations in confined areas has been known to cause adverse health effects.

Micro Organisms

There are many types of micro organisms that may being dwelling in well water, no matter the depth or type of well.

- Bacteria
- Protozoa
- Viruses

Bacteria

E Coli is the most harmful of the bacteria in water.

Escherichia coli (E. coli) are bacteria found in the environment, foods, and intestines of people and animals. Some kinds of e. Coli can cause diarrhea and other symptoms, and can be transmitted through contaminated water or food, or through contact with animals or persons.

Coliform Testing

- Testing for all individual pathogens is impractical and expensive. Instead, the EPA has designated total coliform bacteria as a standard to determine bacterial safety of water. Coliform bacteria originate in the intestinal tract of warm-blooded animals and can be found in their wastes. Coliform bacteria can also be found in soil and on vegetation. Coliform bacteria are relatively simple to identify and are present in much larger numbers than more dangerous pathogens.

Sources of Bacteria in Drinking Water

- Human and animal wastes are a primary source of bacteria in water. These sources of bacterial contamination include runoff from feedlots, pastures, dog runs, and other land areas where animal wastes are deposited. Additional sources include seepage or discharge from septic tanks, sewage treatment facilities, and natural soil/plant bacteria. Bacteria from these sources can enter wells that are either open at the land surface or do not have water-tight casings or caps.

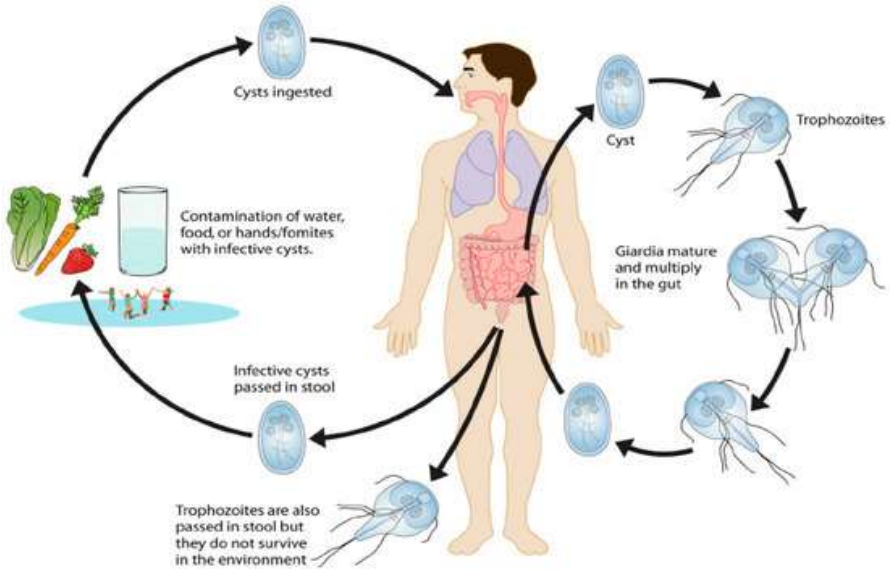
  Insects, rodents or animals entering the well are other sources of contamination. Old wells were dug by hand and lined (cased) with rocks or bricks. These wells usually have large openings and casings that often are not well-sealed. This makes it easy for insects, rodents, or animals to enter the well.

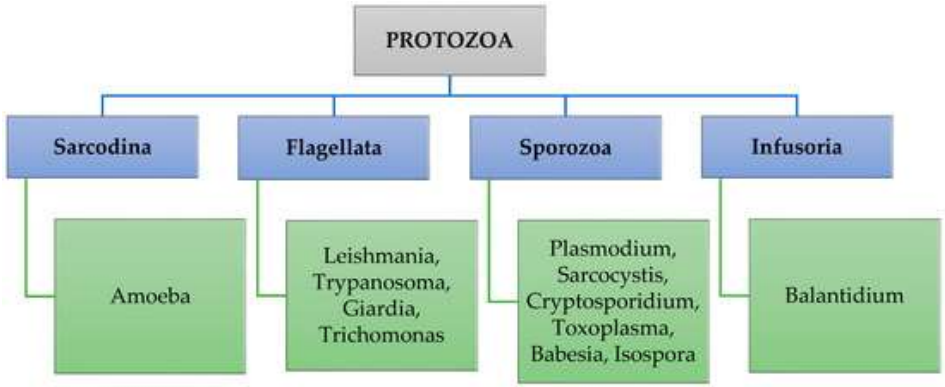
Sources of Bacteria in Drinking Water

- Another way bacteria can enter a water supply is through inundation or infiltration by flood waters or by surface runoff. Flood waters commonly contain high levels of bacteria. Small depressions filled with flood water provide an excellent breeding ground for bacteria. Whenever a well is inundated by flood waters or surface runoff, bacterial contamination is likely. Shallow wells and wells that do not have water-tight casings can be contaminated by bacteria infiltrating with the water through the soil near the well, especially in coarse-textured soils.

  Older water systems, especially, dug wells, spring-fed systems, and cistern-type systems are most vulnerable to bacterial contamination. Any system with casings or caps that are not water-tight are vulnerable. This is particularly true if the well is located so surface runoff might be able to enter the well. During the last five to 10 years, well and water distribution system construction has improved to the point where bacterial contamination is rare in newer wells.

Protozoa


Cysts ingested
Contamination of water, food, or hands/fomites with infective cysts.
Infective cysts passed in stool
Trophozoites are also passed in stool but they do not survive in the environment
Cyst
Trophozoites
Giardia mature and multiply in the gut


PROTOZOA
Sarcodina
Flagellata
Sporozoa
Infusoria
Amoeba
Leishmania, Trypanosoma, Giardia, Trichomonas
Plasmodium, Sarcocystis, Cryptosporidium, Toxoplasma, Babesia, Isospora
Balantidium

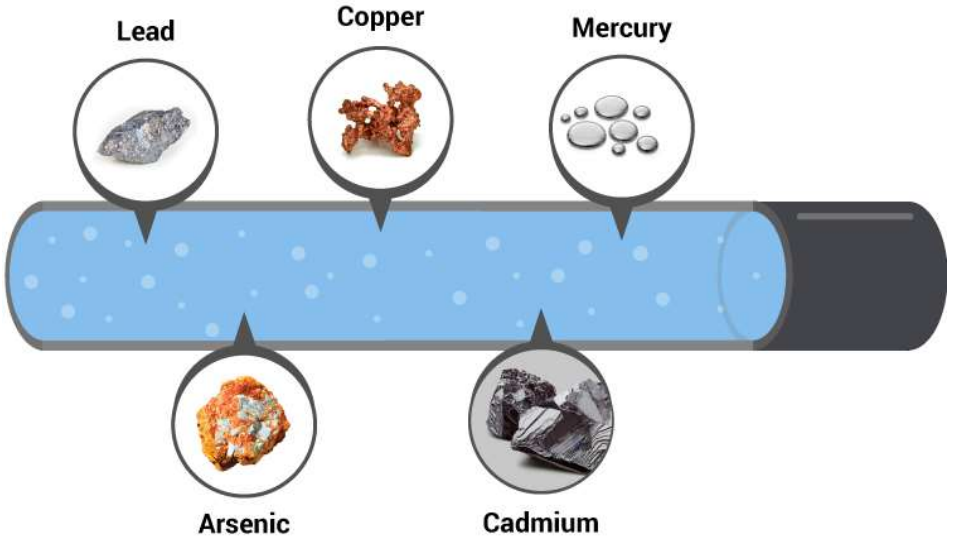
Viruses

Common Viral Contaminants

- **Hepatitis A**
- **Polio**
- **Norwalk Virus**
- **Rotavirus**

Heavy Metals

▶Heavy metals can leach into drinking water from household plumbing and service lines, mining operations, petroleum refineries, electronics manufacturers, municipal waste disposal, cement plants, and natural mineral deposits. Heavy metals include: arsenic, antimony, cadmium, chromium, copper, lead, selenium and many more. Heavy metals can contaminate private wells through groundwater movement and surface water seepage and run-off. People that consume high levels of heavy metals risk acute and chronic toxicity, liver, kidney, and intestinal damage, anemia, and cancer.



Nitrate and Nitrite

- **Nitrate and nitrite** are present in chemical fertilizers, human sewage, and animal waste and fertilizers. They can contaminate a private well through groundwater movement and surface water seepage and water run-off. High levels of nitrate/nitrite in drinking water can cause methemoglobinemia or "blue baby syndrome". These substances reduce the blood's ability to carry oxygen. Infants below six months who drink water with high levels of nitrate can become seriously ill and die.

Organic Chemicals

- **Organic chemicals** are found in many house-hold products and are used widely in agriculture and industry. They can be found in inks, dyes, pesticides, paints, pharmaceuticals, solvents, petroleum products, sealants, and disinfectants. Organic chemicals can enter ground water and contaminate private wells through waste disposal, spills, and surface water run-off. People that consume high levels of organic chemicals may suffer from damage to their kidneys, liver, circulatory system, nervous system, and reproductive system.

Radionuclides

Radionuclides are radioactive forms of elements such as uranium and radium. They are harmful to humans and can be released into the environment from uranium mining and milling, coal mining, and nuclear power production. Radionuclides may also be naturally present in ground water in some areas. Radionuclides can contaminate private wells through groundwater flow, waste water seepage and flooding. Drinking water with radionuclides can cause toxic kidney effects and increase the risk of cancer.

Radon

- Radon is a colorless, tasteless, odorless, radioactive gas. It occurs naturally and is produced by the breakdown of uranium in soil, rock, and water. It can also dissolve into our water supply.

Radon

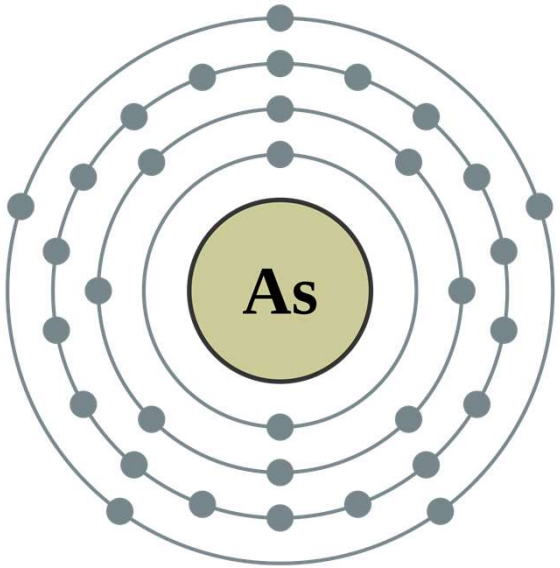
- While most radon-related deaths are due to radon gas accumulated in houses from seepage through cracks in the foundation, 30 to 1,800 deaths per year are attributed to radon from household water. High levels of dissolved radon are found in the groundwater in some areas flowing through granite or granitic sand and gravel formations. If the well is in an area with high radon in groundwater it can get into the water. Showering, washing dishes, and laundering can disturb the water and release radon gas into the air that is breathed.

Fluoride

- **Fluoride** can be present in many aquifers and can be found in private wells. Fluoride can be helpful in preventing tooth decay. However, excessive consumption of fluoride can cause skeletal fluorosis, a condition characterized by pain and tenderness of bones and joints. Excess consumption of fluoride during formative period of tooth enamel may cause dental fluorosis, tooth discoloration and/or pitting of teeth.

Arsenic

- Arsenic is an element that occurs naturally in rocks and soil and is used for a variety of purposes within industry and agriculture. It is also a byproduct of copper smelting, mining, and coal burning. Arsenic can combine with other elements to make chemicals used to preserve wood and to kill insects on cotton and other agricultural crops.



Arsenic

- Arsenic can enter the water supply from natural deposits in the earth or from industrial and agricultural pollution. It is widely believed that naturally occurring arsenic dissolves out of certain rock formations when ground water levels drop significantly. Some industries in the United States release thousands of pounds of arsenic into the environment every year. Once released, arsenic remains in the environment for a long time. Arsenic is removed from the air by rain, snow, and gradual settling. Once on the ground or in surface water, arsenic can slowly enter ground water. High arsenic levels in private wells may come from certain arsenic containing fertilizers used in the past or industrial waste. It may also indicate improper well construction or overuse of chemical fertilizers or herbicides in the past.