

Chapter 2. WASTEWATER COMPOSITION/ENVIRONMENTAL AND HEALTH EFFECTS

A. Microbial Diseases

Wastewater is generally divided into two categories: black water and gray water. Black water refers to toilet waste and gray water refers to the remaining wastewater from sinks, showers, laundry, etc. The septic tank provides primary treatment of both types of wastewater by settling out the solids and providing space for floating scum to be retained. Relatively clear, but not clean, water is discharged from the septic tank to the absorption field. The soil provides for further treatment when the waste water percolates through the soil profile.

Untreated or improperly treated wastewater contains biological contaminants known to cause disease. These contaminants are known as germs or pathogens. Pathogens fall into five main categories: bacteria, viruses, protozoans, fungi and worms. Most of these pathogens use the fecal/oral route to spread disease. Fecal material, including human waste, contains pathogens. The usual method of infection requires you to touch the fecal material with your hands and then transfer it to your mouth, either directly or through food. Pathogens can also contaminate water supplies when the wastewater is allowed to reach the water table before adequate treatment occurs.

1. *Bacteria*

Bacteria are microscopic, single celled organisms that are typically round (Cocci), rod shaped (Bacillus), or spiral (Spirochetsia). Bacterial shapes come from three groups. Diplo means two bacteria attached together, Strepto means a twisted chain of bacteria, and Staphylo means a large clump of bacteria. You need a microscope to see bacteria, but not to see the damage they can do. Some diseases caused by bacteria are *cholera*, which causes vomiting, diarrhea, dehydration and even death; *typhoid*, which causes fever, chills, and sometimes death; *salmonella*, which causes fever, nausea, vomiting, bloody diarrhea, cramps and sometimes death; *shigella*, which causes fever, nausea, vomiting and diarrhea; and *staphylococcus*, which causes skin infections and mucus membrane infections.

2. *Virus*

Viruses use living cells to reproduce and cause infections. The virus penetrates the cell wall of the host, injects genetic material into it, and the host's infected cell makes more virus. Viruses are generally smaller than bacteria, but they can be more deadly. Diseases caused by viruses include *hepatitis A*, a viral infection of the liver which causes nausea, vomiting, diarrhea, skin and urine discoloration, weakness, and sometimes liver damage; *gastroenteritis*, a viral infection of the intestinal tract which causes fever, nausea, vomiting, diarrhea and pain; and *polio*, which causes inflammation of motor neurons of the spinal cord and brainstem, leading to paralysis, muscular atrophy and deformity, and sometimes death.

3. *Fungi*

Fungi are non-photosynthetic living organisms such as yeast. They can be a single cell or a body mass of branched filaments. Diseases caused by fungi include *candidiasis*, which is transmitted by contact with feces or secretions from infected people. Although it usually causes mild infections, occasionally it may cause ulcers in the intestinal tract or lesions in the kidneys, brain or other organs.

4. Protozoans

Protozoans are large (compared to bacteria) single celled animals which have the ability to move. Diseases caused by bacteria include *amoebiasis*, which causes bloody diarrhea and sometimes death; and *giardiasis*, which causes diarrhea and severe gas.

Perhaps the best known incidence of sickness caused by a protozoan is “Cryptosporidiosis”. Caused by *Cryptosporidium*, the infection in humans can be divided into two distinctly different diseases, depending on the patient’s immune status. Both forms have an incubation period of four to fourteen days. In the immune competent host, the onset is sudden. There is marked watery diarrhea, cramping, abdominal pain, and flatulence. Nausea, vomiting, fever, anorexia, weight loss, myalgia, and malaise may also be present. Symptoms usually begin to subside in five to ten days. In immunocompromised patients (cancer, AIDS, elderly, previously diseased), the onset is more gradual, and the symptoms are more severe. Fluid losses may be excessive. Weight loss may exceed 10% of the patient’s original body weight. The duration of the illness may be indefinite. The deaths are usually in the immunocompetent host and are usually from loss of water to the system, loss of nutrition and no ability to fight the disease. There are few medications available to fight this disease.

5. Worms

This category includes hook, round, pin, tape and flatworms. In an *ancylostomiasis* infection, a hookworm penetrates the skin of the feet and travels to the gut. *Ascariasis*, a roundworm, lays eggs in sewage contaminated soil, which is ingested by an individual with dirty hands. The worms develop in the gut, attack the lungs, liver and other organs.

B. Nitrates

The primary health concern is the reduction of nitrate to nitrite in the digestive tract by nitrate-reducing bacteria. Nitrite is readily absorbed into the bloodstream where it combines with the oxygen-carrying hemoglobin, forming “methemoglobin”. Methemoglobin cannot carry oxygen and if the situation is not corrected, it can be life threatening. As methemoglobin levels increase, oxygen supply to tissues decreases and people and livestock are stressed. They will exhibit symptoms of suffocation when levels are high enough. This condition is called methemoglobinemia or “blue baby syndrome” in infants, because of the blue color that develops around the eyes and mouth.

Infants are particularly susceptible to nitrate poisoning because bacteria capable of converting nitrate to nitrite are abundant in their digestive systems. Infants have little acid in the digestive tract, and depend on these bacteria to help digest food. Generally, by six months of age, hydrochloric acid in

a baby's stomach increases to a level where bacteria that convert nitrate to nitrite cannot thrive.

When people ingest food and water containing nitrate, it is readily absorbed from the digestive tract. In older children and adults, nitrate that is ingested and absorbed is normally excreted in urine. There are few known health effects of ingesting high levels of nitrate by healthy adults. However, pregnant women and those with health problems are advised to avoid high nitrate. The health effects of chronic, long term consumption of high levels of nitrate are uncertain and the subject of ongoing research.

C. Water Pollution

Failing septic systems allow excess nutrients to reach nearby lakes and streams, promoting algae and weed growth. Algal blooms and abundant weeds make the lake unpleasant for swimming and boating, and affect water quality for fish and wildlife habitat. As plants die, settle to the bottom, and decompose, they use oxygen that fish need to survive.

Synthetic cleaning products and other chemicals used in the home can be toxic to humans, pets, and wildlife. If allowed to enter a failing septic system, these products may reach groundwater, nearby surface water, or the ground surface.

In the soil treatment portion of the septic system, bacteria and viruses in the sewage are filtered by the soil and microscopic organisms that occur naturally in the soil. Nutrients are absorbed by soil particles or taken up by plants. These processes only work in unsaturated soil that has air in it. Soil conditions may be saturated near lakes, streams and wetlands, and in areas with seasonal or perched high water tables. In these cases, biological breakdown will be incomplete and nutrients will move much greater distances. Ironically, numerous unsewered communities exist around lakes, where saturated conditions are likely to exist. Originally intended as part time vacation homes, residents now occupy the homes year round, taxing already stressed onsite systems.

D. Pollution Control

In order to avoid or reduce the health, chemical and environmental hazards posed by inadequately treated wastewater, it is necessary to get the wastewater into an adequate treatment system. This can be accomplished in many ways. The two extremes are individual onsite systems for every home, and completely centralized collection and treatment. In between falls "decentralized" sewage collection and treatment systems which will also be explored in the later portions of this handbook (See Chapter 6).