Water Movement and Soil Treatment
Video Script

Wastewater is a product of our daily lives. It is generated by the normal and necessary activities that fill our days. But this byproduct can be harmful if ignored. It must be treated and reclaimed into the environment. Millions of Americans use onsite wastewater treatment systems in their homes and businesses. If designed, constructed, and properly maintained, these systems remove pollutants and protect both the environment and public health.

Soil is the key component in these systems. Its natural ability to treat and disperse this wastewater is what makes such systems possible. It is an invaluable resource.

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Wastewater is primarily generated in the bathroom, kitchen, and laundry. As we use water, we add contaminants such as bacteria, dirt, soaps, detergents, lint, and grease. The wastewater sources are collected in the plumbing system and move (sources are plural) out of the house into the septic tank.

A septic tank is an enclosed watertight container consisting of one or two compartments. It collects wastewater and provides primary treatment by allowing floatable and settleable solids to separate from the water. Settleable solids accumulate at the bottom of the tank, while floatables, such as oil and grease, rise to the top. For optimal treatment, water should remain in the tank for at least 24 to 36 hours.

As much as 50 percent of the solids remain in the tank, decomposing there. Still the majority of the organic matter, solids, nutrients, and pathogens remain in the wastewater.

Wastewater can be distributed over the soil treatment area by either of two distinct methods: gravity or pressure distribution.

Gravity distribution trenches typically use three- to four-inch diameter, perforated pipe set in a media-filled trench. Generally, the water exits the first few pipe perforations and follows the path of least resistance to infiltrate soil.

Here, microbes will feed on the nutrients in wastewater. As microbial activity increases, a biological layer develops at the soil's infiltrative surface called the biomat. This living barrier slows water movement into the soil, so the effluent moves farther along the trench to infiltrate. The biomat serves as a flow control, converting water movement from saturated to unsaturated flow.

Pressure distribution uses a pump to periodically dose wastewater through distribution piping, typically one- to two-inch diameter pipe. This system results in wastewater being distributed over the entire length of the trench. Wastewater is dosed at a rate greater than the infiltration rate creating a temporary (need the adjective, not the adverb) saturated flow.

By adjusting the frequency of doses, we allow time for the water to disperse into the soil treatment area converting the flow condition from saturated to unsaturated. The slower the wastewater is added, the easier the system can treat and disperse the water.

Soil contains particles of sand, silt, and clay. Their relative proportion defines the soil texture. Sand particles are the largest while clay particles are the smallest. Soil containing sand particles will have less surface area while soil containing more silt and clay-sized particles has a greater surface area.

Pores are the openings between the particles. They contain microbes, air, and water. The pores between the sand particles will be larger than the pores between clay particles.

Pore size affects the rate water moves through soil. Sandy soil allows water to move rapidly with less time for treatment. In comparison, clay soils result in slower water movement and better treatment (more accurate to say that more time for treatment).

Water moves through the soil profile under two different and important flow conditions: unsaturated and saturated.
An unsaturated flow condition means that the water is flowing around the soil particles with air remaining in the pores. A saturated flow condition is when water fills and flows through the pores.

In unsaturated conditions, the air filling pore spaces forces water to flow along the surface of soil particles and maintains an environment for aerobic soil microorganisms. These degrade waste products and remove pathogens.

The ability of air to move in and out of the soil is critical for maintaining aerobic treatment conditions. Placing patios, storage buildings, or tennis courts over the soil treatment area limits its ability to breathe. Keeping the wastewater in contact with the soil particles allows the contaminants to be adsorbed to the particles surface.

In saturated conditions, some water will not contact the soil particles and treatment will be reduced. Since there will be a lack of oxygen, anaerobic organisms dominate the microbial population. These organisms are less able to breakdown the waste and result in less treatment.
The final stage of the wastewater treatment process is dispersing the now reclaimed water into the environment. This is accomplished through evaporation, transpiration by plants growing in and around the soil treatment area, and downward or lateral percolation.

In dry regions of the country, evaporation and transpiration can account for most, if not all, of the water loss from the system (or dispersed by the system). These regions simply need to distribute the water throughout the soil treatment area and the plants will do the rest. However, some locations experience seasons, i.e., times (or periods – you choose) when plants can accept all of the water and times/periods when plants are not available for transpiration. These periods of lower transpiration may result in excess water percolating out of the soil treatment area. Proper vegetation maintenance must be performed if the system design depends on transpiration for water removal.

Water percolating downward will reach either groundwater or a restrictive layer that forces lateral water movement. When the water moving downward under unsaturated flow meets a saturated area, this location is called the capillary fringe. Here, the soil is extremely wet but not saturated.

If the soil becomes saturated and the water cannot move easily, the water level can rise. This is called groundwater mounding. The amount or height of the groundwater mound is directly related to the soil texture and structure, slope that the water is moving through, and amount of water added to the site. In finer texture soils, this rise can be significant.

If the mounded groundwater reaches the trench bottom, the aerobic unsaturated zone is compromised and wastewater treatment is reduced. The potential for groundwater mounding should be considered when designing systems in areas with shallow groundwater or restrictive layers.

The orientation of the soil treatment area has a large impact on how much mounding can occur. If placed on a sloping site, the water will move down slope. A long narrow system placed on the contour will minimize the volume of water that must flow down slope for a given length of field. A system oriented up and down the slope will require more water to move through a smaller area for a given length of field. If the flow requirement is too great, the water may mound up into the trenches or even to the ground surface. For the same reason, storm water should be diverted around the soil treatment area to prevent saturation with rainwater. A field saturated with rainfall will not be able to accept and treat wastewater.

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The last defense against contaminating groundwater is the soil treatment system. A properly designed, installed, and maintained onsite wastewater treatment system assures that the environment, groundwater, and you and I are protected and at the same time recycles this valuable resource.