Texas Agricultural Extension Service
The Texas A&M University System

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On-site wastewater treatment systems

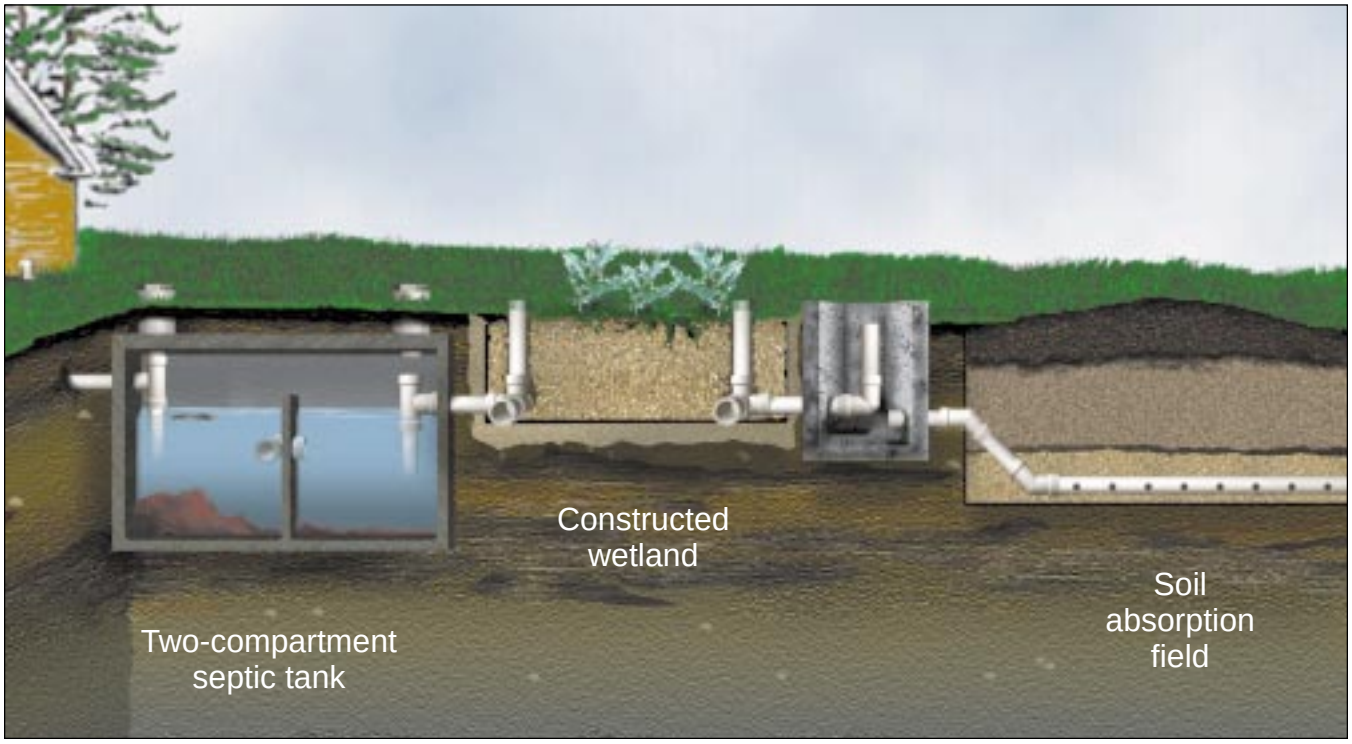

Figure 1: A constructed wetland system.

Constructed wetlands

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A constructed wetland system for domestic wastewater treatment is designed to mimic the natural wetland treatment processes by Mother Nature. This system uses plants and microbes to improve the wastewater quality.

Natural wetlands generally have visible water in the system. However, for those at homes, the water flows beneath the soil surface, which limits contact between residents and wastewater.

The constructed wetland wastewater treatment system has three main components that work together to purify wastewater:

- ✓ A septic tank, which is an enclosed watertight container that provides primary treatment by removing the settling solids and floating solids (oils and greases) from the wastewater;
- ✓ A constructed wetland, which is a bed of graded stone, with water beneath the surface, where aquatic plants are grown. It removes nutrients, organic matter, suspended solids and pathogens; and
- ✓ A land application system, which disperses the wastewater into the soil for final treatment and disposal/reuse.

Constructed wetland systems should be designed and built to blend into the home's landscaping. The best way to achieve this goal is to determine where the wastewater treatment system will be located before the house is built. Effective planning before building the house simplifies the system and helps you enjoy it.

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For example, a key factor in determining whether or not your system uses gravity or a pump to move the water between the system components is the location and elevation of the plumbing exit from the house. If the plumbing exit is too low, you will need to install a pump to lift the wastewater back to near the ground surface to have a gravity flow system.

Also, the pipes transporting the wastewater must be installed with a slight slope to help wastewater flow through the system. If the yard slopes in the same direction as the wastewater flow, the wetland will be near the soil surface, thus increasing its aesthetic value.

The wetland consists of a bed of graded stone where aquatic plants are grown. The wetland cell is generally an earthen basin lined with compacted native clay, bentonite clay, concrete, PVC, hypalon or PondGard Ethylene Propylene Diene Terpolymer (EPDM) Rubber. The bed itself is usually gravel but can be any porous material that resists being corroded or dissolved by wastewater.

The media bed has devices to distribute wastewater entering the system and to collect wastewater leaving it. The water to be treated flows horizontally through the bed, remaining below the gravel surface.

Plants in the wetland must be able to survive in a saturated medium. Although soft- and hard-tissue plants can be used, some experts believe that hard-tissue plants are better because they may provide a pathway for oxygen to enter the wetland during winter and reduce the need for plant maintenance. However, residents prefer soft-tissue plants because they generally have flowers and are colorful. Remember that if you use soft-tissue plants, your system may need more maintenance.

Treatment

Wastewater is treated by the septic tank first. The tank, which should have two compartments, should be sized appropriately to allow enough time for the settling solids to separate from the wastewater.

Upon leaving the septic tank, wastewater enters the wetland. It is believed that pollutants entering the wetland are removed from the water by microbes living on the surfaces of the gravel and plant roots. The plants provide oxygen to the bed and remove some of the nutrients. Other processes such as filtering, microbial decomposition and attachment to particle surfaces also help remove pollutants. The longer the water is detained in the wetland, the more pollutants are removed and the better the quality of water leaving the wetland.

After flowing through the gravel, wastewater exits the wetland through a water-level control sump. The sump allows the water level to be adjusted, because the wetland water level must be lower than the media surface to prevent odors.

The water then flows into the soil absorption field, the last treatment stage. If it cannot enter the field by gravity, it enters a collection tank and is pumped to the absorption field, where the soil absorbs it. Microbes and plants growing in the soil use the remaining nutrients in the water.

Design

All components of the wetland system must be designed properly. This fact sheet focuses on the wetland. For information on septic tank sizing and land application systems, see the Extension publication L-5227, "Septic Tank/Soil Absorption Field."

Wetland systems remove biological materials, suspended solids, nutrients and pathogens from the wastewater. To determine a wetland's size, consider:

- ✓ Temperature of the system, which affects how fast it removes nutrients; and

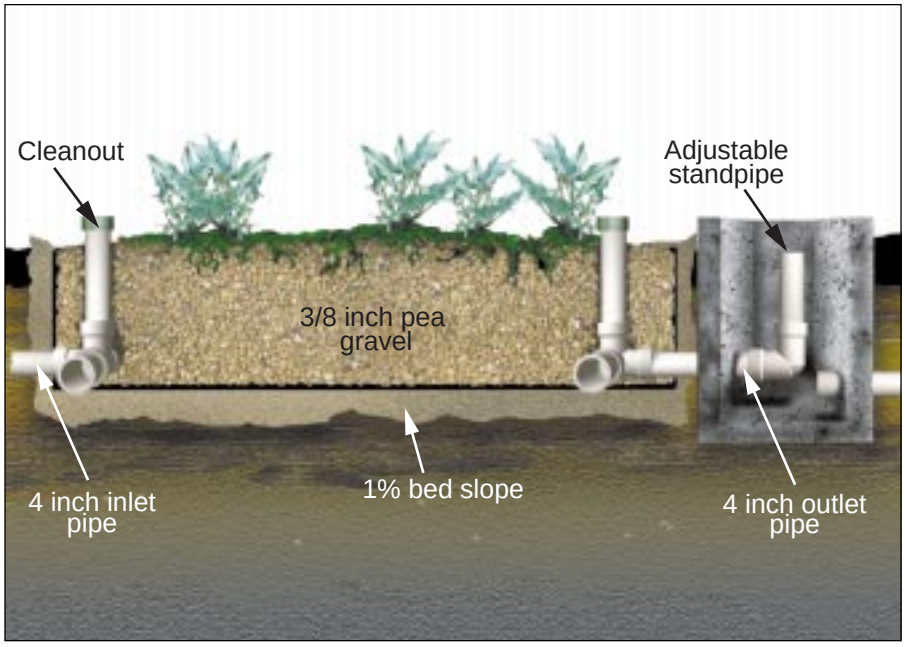

Figure 2: A constructed wetland is a bed of graded stone where water flows beneath the surface and plants grow on top.

✓ Amount of waste. A wastewater treatment system must be designed to treat the most wastewater that a residence generates.

This information is used in an equation to determine the hydraulic retention time, which is the amount of time the wastewater needs to stay in the wetland. It is generally expressed in days. The longer the wastewater stays in the wetland, the more time that microbes and plants have to treat the water. Generally, the water needs to stay in the wetland system for 2 to 3 days.

The relationship between how much water is stored and how long it stays in the wetland determines how much surface area the system needs. In general, a constructed wetland in Texas needs about 1 square foot of surface area for every gallon of wastewater it receives a day. A wetland for an average three-bedroom house producing 300 gallons of wastewater a day would need a surface area of 300 square feet.

Physical limitations, such as wetland depth, bottom slope and length-to-width ratio, also can affect the wetland's performance and sizing. The depth of a wetland can vary, but it generally ranges from 1 to 2 feet. A 1-foot-deep wetland has double the surface area for the same storage volume as a 2-foot-deep wetland.

The wetland should have enough cross-sectional area for water to flow into it. Water flows through the wetland by passing from one pore space to the next while remaining below the surface of the gravel. If the total cross-sectional area of pore spaces is too small, wastewater cannot enter the gravel and the water level rises to the surface of the wetland, causing odors.

One way to determine if you have enough cross-sectional area to accept the flow of wastewater is to divide the length of the wetland by its width. That calculation gives you the wetland length-to-width ratio, which should range from 2 to 3.

An example: Say you need a wetland to be 360 square feet. You could build it 3 feet wide by 120 feet long, but that would give a length-to-width ratio (120 divided by 3) of 40 — way too high. If you built it 12 by 30 feet

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(divide 30 by 12), the ratio would be 2.5 — which falls into the accepted range of between 2 and 3.

When enlarging the wetland, keep the length-to-width ratio relatively constant by extending both the width and the length. If it stays relatively constant, the flow per unit of cross-sectional area increases less than if the wetland size were increased by adding length only.

Gravity pulls the water through the wetland. The slope of the wetland bottom also helps the water move through the wetland. In residential systems, the slope could be used to help flush solids from the pore spaces in the media. Common slopes in residential systems can range from 0 to 1 percent. Bottom slopes for municipal systems need to be designed based on hydraulic loading rates.

How to keep it working

Each of the constructed wetland system's three main components — the septic tank, constructed wetland and land application system — has its own maintenance requirements. See the Extension publication, L-5227, "Septic Tank/Soil Absorption Field," for tips on how to maintain the septic tank and land application system.

In general, maintain the septic tank periodically to make sure solids are removed efficiently. Pump the tank every 2 to 3 years, depending on the size of the home and the number of people living there. If an effluent filter is located at the exit of the septic tank, clean the filter periodically.

Here's how to take proper care of the constructed wetland:

- ✓ Manage the wetland as a rock garden. To keep it looking good, remove dry material as plants freeze in the winter.
- ✓ Keep the pore spaces in the media open. Removing plant roots from the wetland helps maintain the pores needed for the water to flow through the wetland bed. To do this, remove plants from the wetland and replant. Manage the water level to help break down the fixed film on the media. Also, prevent soil from entering the wetland, because soil can fill the pores. If the media is filled with soil or solids, you will need to remove the media and replace with clean media.
- ✓ Control the water level. You may need to adjust the water level in the wetland so that it is below the media surface. When it is too close to the gravel surface, the wetland smells bad. Lowering the outlet pipe in the water level control sump will lower the water level in the wetland and prevent odors..

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