Summer 1998
Vol. 9, No. 3

Pipeline

Small Community Wastewater Issues Explained to the Public

CONSTRUCTED WETLANDS: A NATURAL TREATMENT

What type of images first come to mind when you think about wastewater treatment? Chances are you wouldn't immediately picture your wastewater system as a good place to watch a sunrise or catch a glimpse of a moose, a crane, or other exotic wildlife. But for the growing number of homes and small communities using constructed wetland systems, effective wastewater treatment can be achieved without disturbing the natural beauty and serenity of rural areas.

It has long been known that natural wetland areas (such as marshes, swamps, and bogs, for example) play an important role in protecting water quality. Constructed or artificial wetland systems mimic the treatment that occurs in natural wetlands by relying on plants and a combination of naturally occurring biological, chemical, and physical processes to remove pollutants from water. In fact, some constructed wetland system designs closely resemble natural wetlands and even provide additional habitat area for the many birds, animals, and insects that thrive in wetland environments. But because constructed wetland systems are designed specifically for wastewater treatment, they work more efficiently than natural wetlands.

Constructed wetlands can treat wastewater from a variety of sources. One of their more common uses is to provide additional or advanced treatment of wastewater from homes, businesses, and communities. This means they are used by homes and com-munities to treat wastewater that has already had most solid materials removed from it through some type of primary or secondary treatment (for example, in a septic tank, lagoon, aerobic unit, or treatment plant).

While the exact roles of some of the natural treatment processes in wetlands are still not completely understood, enough information currently is available for experienced wastewater consultants to design systems that perform reliably and meet environmental treatment standards. Communities should hire a consultant or firm that has specific experience designing wetland systems.

Low-Cost, Low-Energy Option

Constructed wetland systems have only been used for wastewater treatment since the 1970s, which makes them a relatively new wastewater treatment technology. However, interest in their use has quickly become widespread. For example, in a recent survey of Pipeline readers, constructed wetlands was the technology most frequently recommended as a topic for future articles. Wetland systems also are a popular subject with the many community leaders, health officials, and homeowners.

One of the reasons that people are curious about constructed wetlands is the low cost associated with these systems. Compared to many other treatment methods, wetland systems are inexpensive to construct and maintain, and operating costs are low because energy is not required to provide treatment.

This issue of Pipeline offers some basic information for homeowners and community leaders about the two types of constructed wetland systems—surface flow systems and subsurface flow systems—how they work, and some of their advantages and disadvantages. Readers are encouraged to reprint the articles in local newspapers, and include them in flyers, handouts, newsletters, and educational presentations. Please include the name and phone number of the NSFC on the reprinted information and send us a copy for our files.

If you have any questions about any of the topics in this newsletter, please contact the NESC at (304) 293-4191.

How Wetlands Are Used

Constructed Wetland Systems

Advantages

- Compared to many other treatment methods, constructed wetlands are inexpensive to build and maintain.
- They require little or no energy to operate.
- They can provide effective waste-water treatment.
- They can help systems comply with environmental regulations.
- They can enable the development or use of difficult sites.
- They can help protect local water resources.
- They can provide additional habitat area for wildlife.
- They can be aesthetically pleasing additions to homes and neighbor-hoods.
- They are viewed as an environmen-tally-friendly technology and are generally well-received by the public.

Disadvantages

- Constructed wetlands require more land area than some other treatment options.
- Surface flow wetlands can attract mosquitoes and other pests.
- Wetlands are not appropriate for treating some wastewater with high concentrations of pollutants.
- Although wetland systems that are properly and adequately designed consistently perform within accept-able standards, their performance within that range may be more variable and less predictable than other treatment methods.
- There may be a prolonged initial start-up period before vegetation is adequately established in the wetland and before system performance is optimal.
- Because there are still some un-knowns with wetlands, as a precau-

Constructed wetland systems have many uses. When they are used to treat domestic sewage or wastewater from typical small community sources, they provide addition-al, secondary, or advanced treatment to waste-water that already has had most solid wastes removed in a septic tank or by some other form of preliminary treatment.

Constructed wetlands can be used as part of onsite wastewater treatment or with larger centralized and decentralized systems that serve residential developments, resort areas, or entire communities.

To find out whether constructed wetlands are an option in your area, contact your local health department or state environ-mental health agency for permit information. (Refer to the contacts list on page 7.)

Individual Sources

Homes, businesses, farms, schools, and other individual wastewater sources in rural areas sometimes can add a construct-ed wetland to a septic system or other onsite system to replace or assist a soil absorption field. Some onsite systems can be specifically designed from the start to use a constructed wetland in addition to a soil absorption field on properties with site constraints, such as soils that are too dense or saturated to work well with a conven-tional onsite system.

Wetlands also are good at handling in-termittent periods of both light and heavy wastewater flows. Therefore, they often work well with wastewater treatment sys-tems that serve hotels, campsites, resorts, and recreational areas.

In environmentally sensitive areas, con-structed wetlands can be used with onsite systems to improve the quality of waste-water before it is returned to the environ-ment. They also are used on farms as an inexpensive way to provide extra treatment to animal wastes, and by certain indus-tries, for example, pulp and paper mills. Constructed wetlands also are common in Appalachia and other mining regions of the U.S. where they are used to treat acid mine drainage.

Wetland systems are not practical for treating every type of wastewater, however. Chemicals in some industrial waste-wa-ters—for example, pesticides, herbicides, and large amounts of ammonia—can kill the plants in wetlands that contribute to treatment. Additionally, wetland plants may accumulate high concentrations of metals from some wastewater sources. This may affect the habitat value of the wetland.

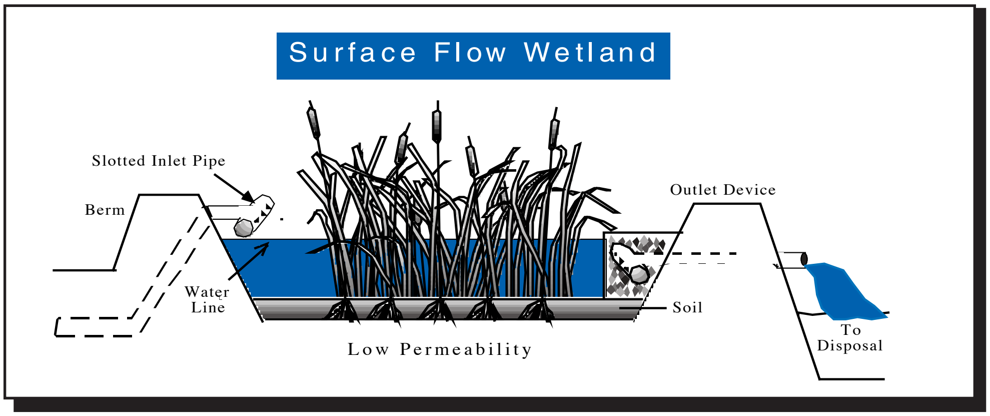
Community Sources

Many small communities have aging centralized wastewater treatment plants, which have fallen into disrepair or have trouble keeping up with the needs of a growing community and no longer consistently comply with environmen-tal regulations. Communities often can retrofit their existing treatment plants with wetland systems to help them reliably meet environmental discharge requirements. Wetlands also can be used with communi-ty systems as added protection for water quality in sensitive areas, such as shellfish beds and estuaries, while at the same time providing additional habitat area for local wildlife species.

Another important way that wetland systems benefit both large and small communities is their usefulness for treating stormwater before it is discharged into receiving waters. Garbage, dirt, grit, leaves, and other solid materials that get washed into storm sewers from streets and yards are first removed or allowed to settle out before the stormwater is sent to the wetland for treatment. Wetland systems provide an inexpensive means of protect-ing water resources by removing some of the harmful chemicals and nutrients from fertilizers and other sources that wash into storm sewers when it rains, and which are not normally removed by preliminary treatment.

Again, wetlands may not be a good option for community systems that accept industrial, agricultural, or commer-cial wastewaters containing significant amounts of toxic chemicals harmful to bi-ological treatment organisms and wetland vegetation.

Surface Flow Systems Work Like Natural Wetlands



In the U.S. and around the world, there are two main types of constructed wetlands used for wastewater treatment: surface flow wetlands (also called free-water-surface wetlands) and subsurface flow wetlands.

Of the two constructed wetland designs, surface flow systems most resemble natural wetlands both in the way they look and the way they provide treatment. Both designs can be used to treat wastewater from indivi-dual and community sources, but surface flow wetlands are usually more economical for treating large volumes of wastewater.

A "Controlled" Environment

Wetlands are areas on land where the ground maintains saturated conditions for much of the year. As the name suggests, surface flow wetlands stay saturated enough to maintain a shallow level of water and wastewater (4 to 18 inches deep) above the soil exposed to the atmosphere.

Wetland plants also are present in surface flow systems, and natural forces, such as wind, sun, rain, and temperature, affect the plants, the water, and the treatment processes in these systems, just as they do in lagoons and natural wetlands.

Although the natural forces and treatment processes at work in wetland systems are always somewhat unpredictable, treatment is controlled to a great extent through some carefully planned design features.

System Design

For example, the size and configuration of surface flow systems are carefully based on such information as the performance of existing systems, estimates of the volume and strength of the wastewater to be treated daily, and/or estimates of how long the wastewater needs to remain in the wetland to receive treatment (the hydraulic residence time). System designers also consider climatic factors, such as average temperatures, evapotranspiration rates, and precipitation amounts, to predict and maintain the level of water in the system.

However, because there are so many variables to consider, some which are less predictable than others, and because no design approach has been established as being the single most effective, engineers usually take a combination of factors into account when designing wetland systems. In addition, they usually size surface flow systems generously as a precaution to ensure that treatment standards are always met, even in the face of such unforeseeable events as unusually prolonged periods of rain or extreme cold.

System designers often design a single system to include multiple wetland basins called cells. Two or more cells providing the same level of treatment may be operated side by side or alternately (parallel operation) to allow for periodic maintenance of each cell, or multiple cells may be operated in series to provide an improving level of treatment in each consecutive cell. Some communities even use hybrid systems that include both surface flow and subsurface flow wetland cells.

Site Considerations

Ideally, wetland systems should be sited as closely as possible to, and down slope from, the septic tank, aerobic unit, lagoon, or other facility that will be providing primary wastewater treatment. This way, the wastewater can travel to the wetland by gravity. If there isn't enough suitable land available nearby, it may be necessary to pump the wastewater to the wetland, which can add to the overall costs for construction, operation, and maintenance.

Most surface flow wetland cells are self-contained rectangular-shaped basins surrounded by banks on all sides. The inlet and outlet are located on opposite sides (refer to the graphic above). Exceptions include certain systems in arid climates designed for no discharge, which do not have an outlet, and systems used for advanced treatment that open directly to natural wetland areas.

The bottoms of surface flow wetland cells should be somewhat free of bumps and ridges and have a slight down grade (approximately 0 to 0.5 percent) to assist the flow of wastewater through the cell by gravity. Unless nature has already provided a site with these features, the cell usually must be excavated either with a backhoe or by hand.

The cell bottom also needs to be self-contained to prevent wastewater from seeping into the groundwater below and the surrounding environment. So, for sites with soils that are not naturally dense or watertight, it often is necessary to line the bottom of the cell with clay, bentonite, or a synthetic liner, and then add soil or other material on top of the lining to form a substrate that will support the growth of wetland plants.

Flow Design

Surface flow systems can treat wastewater much more efficiently than natural wetlands. The reason for this is that the rate and pattern in which wastewater flows through the system is controlled by design.

In natural wetlands, wastewater tends to flow through relatively narrow, well-established channels and may never even come in contact with a large portion of the wetland area. To prevent this short-circuiting of the wastewater flow, and to make the best use of every inch of cell space, the wastewater in constructed wetlands should be evenly distributed across the width of each cell. Wastewater enters surface flow cells by means of perforated distribution pipes, gated pipes, or a series of weirs at the inlet. At the outlet, most systems have

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Surface Flow Wetlands

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control valves and other devices to help operators to adjust the water level.

Even the rectangular shape of the cells and the amount and placement of wetland plants is designed to optimize wastewater flow and treatment. The ratio of the cell's length to its width (the aspect ratio) usually ranges from 2:1 to 4:1, but may be higher depending on the site and other factors.

In addition, system designers must estimate the amount of head loss wetland vegetation is likely to cause in flow rates. The placement of the plants can be planned and arranged as well. For example, some surface flow cells are designed to have areas of open water as well as areas of dense vegetation to allow wind and sunlight to reach parts of the cell to influence flow and treatment.

Most systems are designed for the wastewater to flow once through the system. However, systems can be designed to treat the wastewater more than once.

How Treatment Occurs

As soon as wastewater enters a surface flow wetland cell, natural processes immediately begin to break down and remove the waste materials in the water.

For example, before the wastewater has a chance to travel very far in the wetland, much of the small suspended waste material is physically strained out by submerged plants, plant stems, and plant litter in the wetland. The roots, stems, leaves, and litter of wetland plants also provide a multitude of small surfaces where wastes can become trapped and waste-consuming bacteria can attach themselves.

Bacteria

As is true in most natural environments, wetland systems are teeming with life. Bacteria are among the most plentiful life forms in wetland systems and are believed to be responsible for providing the majority of wastewater treatment.

Aerobic bacteria thrive in wetlands wherever oxygen is present—usually in the water, especially near the surface. Wind, rain, wastewater, and anything else that agitates the water surface can add oxygen to the system.

Conversely, anaerobic bacteria thrive where there is little or no oxygen. In surface flow cells, oxygen is scarce in the lower substrate and soil. In systems that maintain deep water levels, there may be an anaerobic zone near the cell bottom.

When the different types of bacteria in wetlands consume waste particles in the water, they convert them into other substances, such as methane, carbon dioxide, and new cellular material. Some of these substances, in turn, are used as food by plants and bacteria in the wetland.

Worms, protozoa, insects, and other organisms live in wetlands as well, and many of these organisms also contribute to treatment or to maintaining conditions in the wetland conducive to treatment.

Time and Temperature

For any of the natural processes in wetlands to be successful, the wastewater must remain in the system long enough for treatment to occur and for viruses in wastewater to die-off naturally.

Typically, the hydraulic residence time for wastewater in surface flow systems is five to ten days or more. The exact time needed is estimated based on wastewater strength, the level of treatment desired, climatic factors, and how efficiently biologi-cal treatment processes are expected to work. System size is based on this information.

One of the most important factors affecting treatment is temperature. Biological treat-ment processes tend to speed up in warm weather and slow down in cold weather. In cold climates, systems must be large enough to accommodate the longer hydraulic residence times needed for treatment.

The Role of Plants

While most experts agree that plants are important to treatment in wetlands, they do not completely understand exactly to what extent. But plants help treatment processes in several ways—even in winter, when wetland plants appear dead, they often are dormant but still contributing to treatment.

Some of the important contributions of wetland plants that were already mentioned include their role in filtering wastes, regulating flow, and providing surface area for bacteria and treatment. In addition, floating plants, such as water lillies, and emergent plants, such as cattails, shade the water surface and control algae growth.

Plants also contribute to treatment by taking up nutrients, metals, and other substances and retaining them. However, many of these substances can accumulate again in the wetland when plants die and can be released from the system if the wetland is flooded by excessive storm runoff or an increase in hydraulic load. Plant harvesting usually is not a practical solution in surface flow systems.

In some cases, two or more growing seasons may be required before plants are established enough in the system to realize their full treatment potential.

System Performance

When properly designed and operated, surface flow wetland systems effectively reduce biochemical oxygen demand (BOD), suspended solids, nitrogen, metals, trace organics, and pathogens in the wastewater to levels that meet environmental standards. Phosphorus removal usually is minimal, however, and there always is a small amount of residual organic matter in the effluent from dead plant materials. Depending on the level of treatment and local requirements, effluent from surface flow wetlands may be disinfected or discharged directly into the environment.

The performance of wetland systems is more variable than that of many other systems and is affected by changing temperatures and other factors. However, when adequately designed, performance should always remain within regulatory requirements. Performance may be lower in cold weather and during the initial start-up of the system, before wetland plants have become adequately established.

Surface flow wetlands have few operation and maintenance requirements, but maintenance must be performed properly to ensure system performance. Operation may entail alternating cells or adjusting water levels. Some systems may have banks and berms that need to be maintained, and inlet and outlet structures that should be cleaned periodically. Mosquitoes and burrowing animals present problems in some systems. Different control methods are available, including natural solutions, such as trapping and relocating animals,

Subsurface Wetlands Treat Smaller Flows

The next time you admire a neighbor's beautiful rock garden or flower bed, pay close attention. There could be much more to it than just clever landscaping.

Subsurface flow systems are the most common type of constructed wetlands used to treat household wastewater onsite. They are particularly well-suited for on-lot treatment because they require less land area than surface flow wetlands and they usually can be designed to attractively blend in with backyard landscaping. Waste-water is treated below ground in these systems, so they also are less likely to release odors or attract mosquitoes, pests, or pets and children looking for a place to play.

Subsurface flow wetlands are known by a variety of names (rock-plant filters, rock-reed filters, and vegetated submerged beds, for example), and they also are used by many businesses, residential developments, and small communities. Although they have certain advantages over surface flow systems, subsurface flow wetlands tend to be most cost-effective for treating small- to medium-size wastewater flows.

System Design

Like surface flow systems, subsurface flow systems consist of one or more rectangular treatment basins or trenches, called cells, which may be operated in parallel or in series. It is common for subsurface systems to be designed with multiple cells operated in parallel to allow the cells to be alternated and rested during maintenance. The bottoms of subsurface flow cells may be slightly sloped (up to 0.5 percent) to assist the flow of wastewater through the system, and a natural clay or synthetic lining may be necessary for certain sites with high groundwater or permeable soils.

In addition, like other wetlands, subsurface flow wetlands are natural systems that don't require energy to perform treatment. When possible, systems are located near to and down slope from the septic tank or other primary treatment unit to avoid the need to pump the wastewater to the system. They also should be sited away from downspouts and natural drainage areas to avoid excess water from entering the system.

However, subsurface flow systems also differ from other wetlands in many ways because they are designed to provide waste-water treatment entirely below ground.

How Treatment Occurs

Each subsurface flow wetland cell is filled with a treatment media, such as rock or gravel, which is placed on top of the soil or lining on the cell bottom. The depth of the media layer is usually about one to two feet. In properly functioning systems, the wastewater flows just below the media surface and remains unexposed to the atmosphere while it saturates the layers below. The saturated media and soil, together with the wetland plants roots, create conditions below the surface of the system that are conducive to treatment.

Treatment in subsurface flow systems is more efficient than in other wetland

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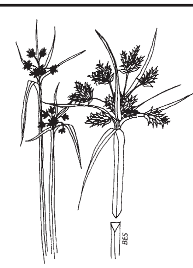
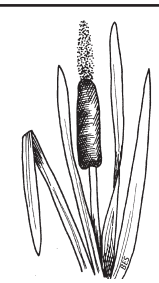
Some Common Wetland Plants

Common reed
Phragmites australis

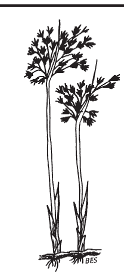
Lake sedge, Ripgut
Carex lacustris



River bulrush
Scirpus flaviatilis



Broad-leaved cattail
Typha latifolia



Salt rush, Baltic rush
Juncus balticus

The plants in constructed wetlands are usually chosen by the system designer, purchased from a local greenhouse or landscaper, and planted by the contractor. System designers often consider several factors when choosing wetland plants, including their native geographic distribution, hardiness, value to wildlife, and the amount of sun they require.

The type of plants most frequently used in the U.S. are cattails, bulrushes, rushes, and sedges (some common varieties are shown above). Reeds are used more in European systems. Some ornamental wetland plants can be included, but it may be better to plant them outside the cells.

Although wetland system designers can plan vegetation in the wetland cells to a certain degree, nature always makes the final decisions. Additional plants may find their way into the system and some species may dominate and crowd out others. Usually the best strategy is to relax and let nature take its course. The existence or lack of variety in the system should not impact treatment.

Contractors sometimes experience problems with getting enough vegetation established in the system during the initial start-up phase. It may be a good idea to contact local plant suppliers or county extension officers for guidance (refer to the list of contacts on page 7). In some cases, two or more growing seasons may be required before the plants become adequately established in the system.

Subsurface Flow Wetlands

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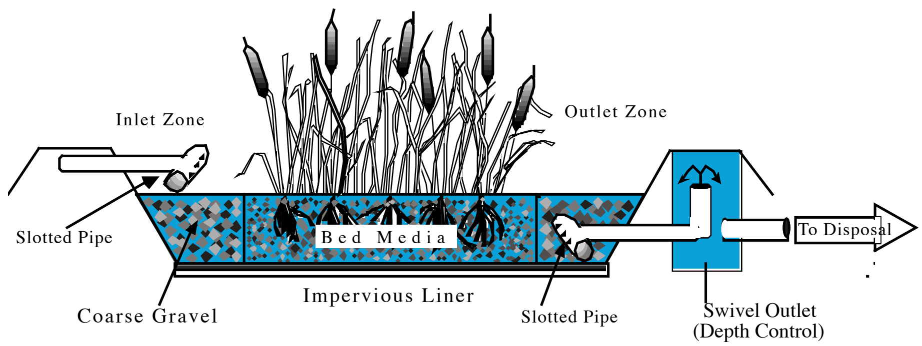

systems because the media provides a greater number of small surfaces, pores, and crevices where treatment can occur. Waste-consuming bacteria attach themselves to the various surfaces, and waste materials in the water become trapped in the pores and crevices on the media and in the spaces between media. Chemical treatment also takes place as certain waste particles contact and react with the media.

Biological treatment in subsurface flow wetlands is mostly anaerobic because the layers of media and soil remain saturated and unexposed to the atmosphere. Cattails, bulrushes, and reeds—the plant species commonly used in constructed wetland systems—are able to grow extensive roots even in these anaerobic conditions. The area where the roots grow is called the root zone, and usually includes the upper 6 to 12 inches of the media. But in cells that are alternated or allowed to rest periodically, or in which the water level is regularly lowered, the roots sometimes reach throughout the media layer.

Wetland plant roots contribute oxygen to the cells, which allows some aerobic treat-ment to take place in the root zone. The plants further contribute to wastewater treatment by providing additional surfaces where bacteria can reside and where waste materials can become trapped. Plants also take up and store some of the metals and other pollutants in the wastewater.

Treatment Media

Choosing the treatment media is one of the most important design considerations for subsurface flow wetlands. It is usually best to use materials that are available locally to reduce construction costs. Buying, inspecting, transporting, and placing the media in the system can add significantly to the cost of subsurface systems and are the reason they tend to be less economical than surface flow wetlands for treating large wastewater flows.

In addition, engineers and system designers must carefully consider the type, size, uniformity, porosity, and hydraulic conductivity of the media material. These characteristics affect the flow of wastewater in the system and system performance.

In the U.S., gravel and rock are the most common media used in subsurface flow wetlands. Whatever type or size media material is chosen, the most important concern is that it be as uniform in size as possible. When different size media are placed together in systems, the result is fewer spaces between the media, and finer materials settle into the remaining spaces, leaving little room in the system for the wastewater to flow.

Therefore, to prevent system clogging, the treatment media should be sorted and measured to ensure its uniformity. It also should be washed to remove any dirt, leaves, or fine materials, and it should be inspected by the engineer or consultant for cleanliness before being applied to the treatment bed.

A method used to analyze the size and uniformity of treatment media includes sorting them through a series of mechanical sieves of diminishing size. These characteristics are expressed as the media's "effective size" and "uniformity coefficient." The effective size of medium-size gravel is about 32 millimeters, whereas the effective size of coarse gravel is about 128 millimeters in diameter.

Flow Design

Certain characteristics of the media determine, in large part, the rate and pattern of flow in subsurface flow systems and the efficiency of treatment. Gravel in the small- to medium-size range tends to work better than coarse gravel because it offers a greater number of surfaces where biological treatment can take place. Medium-size gravel also is not as likely to become clogged by the accumulation of any solids in the wastewater as is fine gravel or sand. In addition, the smaller spaces between medium-size gravel tends to provide better support for plant growth than the large spaces between coarse gravel. Also, medium-size gravel is more likely than coarse media to promote the slow, even, nonturbulent flow of wastewater through the system that is desirable for treatment.

Once the type and size of the media is chosen, its porosity and hydraulic conductivity should be verified in a field or laboratory test. These characteristics are used together with information about the wastewater and the site to design the system.

Most subsurface flow wetlands are designed so that wastewater travels through the length of the cell one time to receive treatment. Typical wastewater retention times range from two to six days.

The inlet and outlet areas of subsurface flow systems are sloped more dramatically than the rest of the treatment bed and are filled with coarse gravel or rock to prevent clogging in these areas (refer to the graphic above). Wastewater enters the system either above the gravel at the inlet or below it through perforated pipe or weirs. It is important that the wastewater is distributed as evenly as possible as it flows into the cell to prevent short-circuiting.

Subsurface flow cells are usually designed with aspect ratios (length to width) of 3:1 or less. Wider cells tend to be more cost-effective because long narrow cells must be deeper and require more treatment media, which add cost. Also, the wastewater is less likely to back up in wider cells if too much water enters the system or if the rate of flow changes.

System designers usually use formulas, such as Darcy's law or Ergun's equation, to

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Ohio County Tries Subsurface Flow Wetlands

If you are lucky enough to own real estate in rural Lorain County, Ohio, you may be sitting on a gold mine—or at least an ancient glacial lake plain consisting of heavy wet clay soils.

Because of its proximity to Cleveland, the demand for buildable lots has been steadily increasing in this northeastern county. But the clay soils have made many local sites unbuildable because they are not appropriate for conventional septic tank/soil absorption systems. However, according to James J. Boddy, R.S., of the Lorain County General Health District, the county has tried several approaches over the years to overcoming these site limitations.

"In the 70s we experimented with home aerobic units and shallow drainfields, in the 80s we tried mound systems, and now it is constructed wetlands," explains Boddy.

So far, the health district has supervised the installation of 12 experimental subsurface flow wetland systems on sites already approved for other onsite systems. Two of the systems are preceded by 500-gallon-per-day aerobic units; the remaining systems use two 1,000-gallon septic tanks for pretreatment. All of the systems include two wetland cells operated in series before surface discharge. Most of the cells measure 15 by 18 feet, but one system has cells measuring 7.5 by 44 feet.

"Normally, we only allow onsite systems to be installed in the highest most well-drained area of the property, which is also where most people want to build their house," Boddy says. "These systems have some advantages because they must be sited in the lowest wettest area of the lot, they rarely require a pump, and they take less space and are less expensive than shallow drainfields."

According to Boddy, one drawback has been that homeowners are responsible for planting and maintaining the vegetation in the system, which has not made it an "out of sight out of mind" solution for them. The plants are not well established in all of the systems. Health district staff has been monitoring the systems and have had varying results. They hope to sample them again this year before the plants become dormant for comparison purposes.

"We are considering entering a new phase of the project that would include permitting more systems preceded by aerobic units and more of the longer cells," added Boddy. "And we might have some

Subsurface Flow Wetlands

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estimate the rate of flow through subsurface flow cells. However, it is impractical for consultants to rely on one set of tools alone when designing subsurface flow systems. Instead, they employ a combination of approaches and built-in safety factors to ensure system performance.

For example, the bottom of cells are slightly sloped to permit drainage, and the level of wastewater in the cells often can be controlled at the outlet by means of an adjustable pipe, which can be swiveled up or down to allow the cell to drain to a desired level. Engineers also usually "overdesign" these systems to offset any unforeseen or unpredictable factors that can affect treatment.

System Performance

Subsurface flow systems that are properly designed, operated, and maintained can effectively reduce biochemical oxygen demand (BOD), suspended solids, nitrogen, metals, and other pollutants in wastewater to levels that meet environmental standards for discharge or disposal. However, like surface flow designs, subsurface flow phosphorus removal is minimal, which may be a concern in some areas.

Also similar to surface flow systems, subsurface flow wetlands are simple to operate and maintain. Their performance may be lower before wetland plants have become adequately established and during prolonged periods of cold weather.

Depending on the level of treatment and local requirements, effluent from subsurface flow wetlands may be disinfected, discharged directly into the environment, or directed to a soil absorption field for further treatment.

CONTACTS

Local and State Health Agencies

Homeowners and residents of small communities wanting more information about constructed wetland systems should contact their local health departments. Health officials have information such as local regulations and permit requirements for onsite and decentralized constructed wetland systems. State health agencies can assist community leaders who wish to evaluate constructed wetlands as a option for centralized treatment. Local and state health agencies usually are listed in the government section or blue pages of local phone directories.

Extension Service Offices

Many universities have U.S. Department of Agriculture Extension Service offices on campus and in other locations that provide a variety of services and assistance to individuals and small communities. For the number of the extension office in your area, check the government pages of your local phone directory, call the NSFC, or call the U.S. Department of Agriculture directly at (202) 720-3377.