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Small Community Wastewater Issues Explained to the Public

Gravelless and Chamber Systems: Alternative Drainfield Designs

Because they are simple, stable, and inexpensive, subsurface soil absorption fields (also called drainfields or leachfields) usually are considered to be the best method for treating and dispersing effluent from septic tanks and other onsite wastewater treatment systems. Residents and health officials in small communities and rural areas are familiar with conventional septic tank/drainfield systems, their advantages, and their limitations.

One limitation of conventional onsite systems, and a reason some potential homesites fail to qualify for onsite wastewater permits, is the quantity and quality of land needed for the drainfield. Depending upon the drainage patterns, soil characteristics, and topography of the lot, homesites sometimes lack enough suitable land for installing conventional drainfield beds or trenches.

Property owners facing land limitations may hear claims that certain alternative drainfields require less land to provide the same level of treatment as do conventional systems. While it is true that gravelless and chamber systems have advantages and can perform at least as well as conventional drainfields, the U.S. Environmental Protection Agency and several state health agencies stop short of endorsing land area reductions for these systems. This is due to a lack of scientific evidence that less land is needed with these systems under specific site conditions.

In this issue, learn . . .

This *Pipeline* issue highlights facts about gravelless and chamber soil absorption systems. It explains how these systems differ from conventional drainfields and their advantages and disadvantages. The regulatory requirements of each state regarding the use of gravelless and chamber systems also are listed.

Conventional Gravel-Filled Drainfields Provide Simple, Affordable Treatment

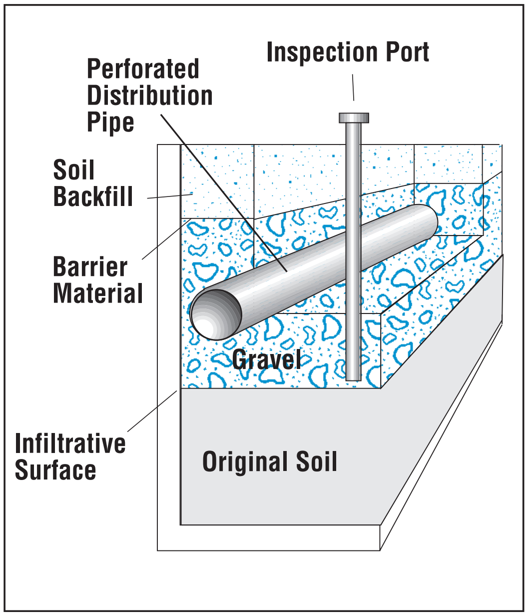
In areas where sewer systems are unavailable or impractical, onsite wastewater treatment units, such as septic tanks, sand filters, and home aerobic treatment units, pretreat of the wastewater that individual homes and businesses generate. Raw sewage flows from a building into a septic tank or other pretreatment unit, where solids, oils, and greases separate from the rest of the wastewater. Some onsite systems, such as sand filter systems, incoporate additional preliminary treatment steps.

In areas where it is permitted, after sufficient pretreatment, the effluent can be disinfected and discharged to the ground surface or to a surface water source. In the vast majority of installations, however, the effluent receives final treatment and dispersal underground via a subsurface drainfield system.

Conventional Drainfield Design

Drainfields usually are constructed as a series of level trenches or beds lined with gravel or coarse sand and buried 1 to 3 feet below ground surface. Perforated pipes or drain tiles run through the trenches to distribute the wastewater over the gravel media before it enters the soil. The gravel helps to disperse the effluent, to support the sidewalls of the drainfield trenches, to prop up the pipe or tiles so they don't lie directly on the soil, and to provide a storage area during times of peak wastewater flows.

Additional gravel is placed over the pipe, and the trench or bed is covered with a semipermeable barrier, such as a geotextile fabric, so the finer backfill material doesn't filter in *(see the graphic above)*. The septic tank effluent is treated as the wastewater effluent slowly trickles from the pipes, through the gravel, and down through the soil.



How Treatment Occurs

As the wastewater percolates or moves down through the soil, a variety of complex physical, biological, and chemical processes combine to provide treatment. Particles in the wastewater are filtered by, adhere to, or chemically bond or react with the the soil. Bacteria and other organisms in the soil consume the organic matter in the wastewater and perform most of the treatment. Although some treatment also may occur in the gravel layer, most of the work is accomplished in the soil.

As a drainfield matures, organisms in the wastewater and soil multiply and form a dark layer called the biomat on or near the infiltrative surface. The biomat is a miniature ecological system. If oxygen is present, organisms such as worms and parasites, feed on the bacteria as well as material in the wastewater. The biomat is also where most pathogen removal occurs. When the drainfield system is in balance, these organisms prevent the biomat from becoming so thick that it clogs the system completely, but rather, allow the wastewater to flow through the soil below at a slow, but steady rate.

The biomat also aids the treatment process in medium and coarse soils by maintaining unsaturated conditions in the soil layers below the drainfield and above the groundwater.

The Drainfield Advantage

According to the U.S. Environmental Protection Agency, where site conditions are suitable, subsurface soil absorption is usually the best way to disperse wastewater dispersal to the environment because of its simplicity and low cost.

Potential Drawbacks of Gravel-Lined Drainfields

Gravel is traditionally used in soil absorption system construction, because it is relatively inexpensive and readily available in most areas, not necessarily because it outperforms other materials as a treatment media. In fact, there may be a few drawbacks to gravel-lined systems.

Although many contractors recognize the importance of only using washed gravel in drainfield systems, dust or "fines" (very fine particles) can remain in the gravel or can be created when it is installed in the drainfield trenches. These fines may clog the infiltrative surface.

Another potential problem with gravel-lined trenches is that the soil layer can be compacted from the weight of the gravel and the machinery used to transport and install it. Wastewater may have difficulty percolating through the compacted soil. In addition, as the gravel settles against the soil, some say that it may "mask" or "shadow" (block) a significant percentage of the soil surface area that could otherwise contribute to biomat formation and treatment.

Advantages of Gravelless Systems

As the name suggests, a gravelless system is an onsite system that does not use gravel in its drainfield trenches or beds. Instead, these systems may use alternative materials in place of gravel, such as rubber, sand, fiber membrane, plastic, glass, or expanded clay, shale, or polystyrene foam chips.

The alternative media in gravelless systems can function similarly to gravel. It can support the sidewalls of the drainfield trenches and prop up the perforated drainfield pipes so they don't lie directly on the soil and clog. When soil is saturated from the weather or surge wastewater loadings occur, the effluent can be stored in the media until the soil absorbs it. Like gravel, the alternative media also can help to distribute the wastewater along the length of the trenches.

Gravelless Pipe Systems

In some gravelless drainfields, wrapped or slitted corrugated pipe is used instead of an alternative media material.

One gravelless drainfield design consists of large corrugated plastic pipes, with inside diameters of 8 to 10 inches, covered with a geotextile fabric or a spun bonded nylon filter fabric. *(Refer to Figure B on page 4.)* The effluent infiltrates the areas of the soil that come in contact with the fabric.

Gravelless pipe systems should include a cleanout to allow the pipe to be inspected and for any sludge that may accumulate in the pipe to be flushed out.

Chamber systems, which are discussed in more detail beginning on page 5, are another popular type of gravelless system.

When Are Gravelless Systems a Good Choice?

Like conventional drainfields, gravelless systems can be designed to work on a variety of homesites and under most conditions. Some studies suggest that they may perform better than gravel-lined drainfields. These systems also require the same maintenance as traditional drainfields.

Homeowners should first check with their local health department about local and state regulatory requirements *(refer to the contacts list on page 7 and to page 6 for state requirements)*. Also, most communities require a professional site evaluation be performed to assess the appropriateness of the site for any onsite system *(see the sidebar at right for more information)*.

Why Gravelless May Be Better In Some Cases

- **Cost**—Although gravel is a common natural resource and is usually fairly inexpensive, high-quality gravel is not readily available in every community. In certain parts of the country, the cost of transporting a heavy shipment of gravel can raise the cost of onsite system construction considerably. In these areas, using a light-weight or locally available alternative media may be preferable. However, in many areas, gravel-lined systems are still the most economical systems to construct.
- **Easier To Handle**—Because some alternative media materials are light weight, heavy equipment may not be needed to haul the media to the installation site. This can help minimize the disruption to property that machinery can cause. Also, the lighter weight media is easier to handle, which can reduce labor costs and allow the systems to be constructed in areas inaccessible to heavy machinery. The pipe in gravelless pipe systems is lightweight and flexible, allowing it to easily conform to sloped or curved trenches.

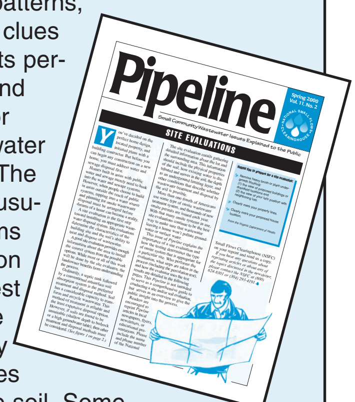
continued on page 4

Site Evaluations

In most communities, before a homeowner or developer can obtain a permit to install any type of onsite wastewater system, a professional site evaluation of the lot is required. In a site evaluation, a sanitarian, soil scientist, or other wastewater professional examines the characteristics of the soils, landscape features, and past surveys of the site. He or she also may consult public records, such as soil surveys or maps prepared by the National Resource Conservation Office or by a state geological survey office.

Before approving a site for onsite treatment, the evaluator notes the location of nearby drinking water wells, neighboring homes and onsite wastewater systems, and the minimum vertical and horizontal separation distances to these and other features as required by law. He or she also examines the slope of the land and the depth to groundwater and impermeable layers, such as bedrock. The evaluator also considers the natural drainage patterns and boundaries of the lot.

An important feature of a site evaluation is a thorough study of the soil. The sanitarian digs an observation pit at the most likely location of the soil absorption field to examine the soil layers for texture, structure, and color patterns, which give clues regarding its permeability and potential for seasonal water saturation.The sanitarian usually performs a percolation or "perc" test to measure how quickly water moves through the soil. Some states require additional methods for testing soil permeability.



Advantages of Gravelless Drainfields

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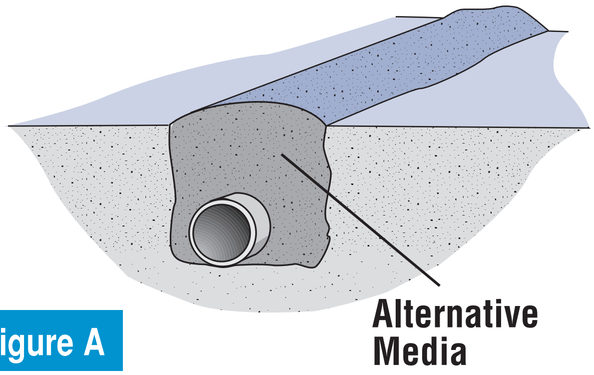


Figure A

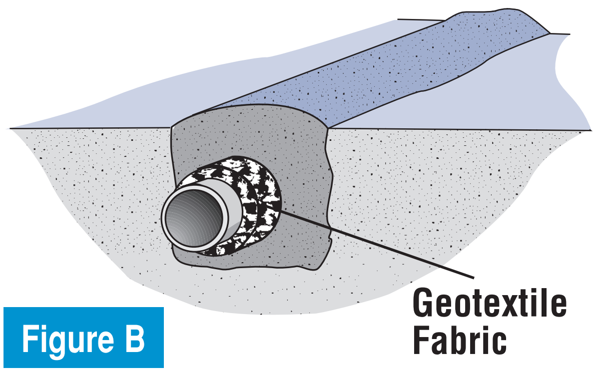


Figure B

- **Easier on Soils**—Gravelless systems may be a good choice in areas that have soils susceptible to "smearing" or other structural damage. Soil structure can be impacted by the weight of gravel itself or by construction and heavy machinery on the site.

  Constructing a typical gravel-filled drainfield requires several tons of gravel and numerous trips up and down the sides of trenches with a front loader or gravel truck. This can cause the soil around the drainfield to compact, reducing its permeability.
- **Avoids Dust and Fines**—Another disadvantage of using improperly washed gravel as media is the possibility that dust and other fine materials from the gravel will find its way into the system as the gravel is dumped and shoveled during installation. The dust and debris can clog the soil. Problems with fines can be minimized or avoided completely by using such alternative media as plastic.
- **Simple To Maintain**—In general, gravelless drainfields are as easy to maintain as gravel-lined drainfields. Many are proprietary designs, and, therefore, homeowners should follow manufacturer recommendations concerning operation and maintenance.

  Proper onsite system maintenance begins inside the home or business. Solids and greases, such as food scraps, coffee grounds, and leftover cooking oils, should be disposed of in the garbage rather than down the drain. Cigarette butts and items other than toilet paper should not be flushed down the toilet. Allowing extra solids and greases into the system can overburden the septic tank. If the septic tank becomes too full, solids sometimes will be discharged into the drainfield. For this reason, onsite systems should be inspected regularly or pumped every three to five years.

  In addition, system owners should take care to fix leaky faucets and running toilets immediately to conserve water and to avoid overloading the septic tank and the drainfield. It is important to maintain a grass cover over the drainfield to keep the soil adequately aerated. Also, homeowners should prevent anyone from driving or placing heavy materials on the drainfield.

Sizing Gravelless Drainfields

The term *infiltrative surface* refers to places in a drainfield where effluent is absorbed into the soil. Some researchers believe that gravel and other media may mask as much as 50 to 75 percent of the potential infiltrative surface in a drainfield. In other words, by lying against the soil, the media may create areas where the effluent does not pass through into the soil and the biomat does not form.

Some gravelless system proponents claim that because less masking occurs with certain gravelless systems, these systems can be sized significantly smaller than conventional drainfields. While some state regulations do allow reductions in gravelless drainfield size *(refer to page 6)*, the U.S. Environmental Protection Agency and others advise caution before doing so due to a lack of sufficient scientific evidence backing up this practice and the increase of organic loading that may occur as a result. Instead, drainfield size should always be based upon the amount of wastewater flow the household generates and the amount of effluent the soil can effectively receive (its hydraulic capacity).*

It should be noted that adding secondary treatment or a gravelless or chamber drainfield system does not change the overall hydraulic capacity of a lot. It may be possible to reduce the overall area of the trenches required with a system, but not the overall length of the system across the slope of a lot.

Chamber Systems Are Easy To Install

Chamber systems, sometimes called leaching chambers, are a type of gravelless drainfield becoming increasingly popular. *Chamber* refers to the open-bottomed pipes used in these systems. They are commercially available and usually constructed of high-density plastic. Chambers also may be constructed of fiberglass, block, or brick.

The chambers are molded into a dome-like shape (refer to the figure below and on page 1). Their design usually is proprietary and manufacturer recommendations should be followed regarding system installation, design, operation, and maintenance.

How Chamber Systems Work

Leaching chambers are manufactured in widths varying from 15 to 40 inches. Although some chamber systems are constructed of light-weight material, they are strong enough to support a soil cover and normal backyard activities. However, as with any onsite system, homeowners should prevent anyone from driving, paving, building, or placing heavy materials on top of the system.

Because some chamber panels are light weight, installers can manually carry and place them in level trenches. Chamber panels are designed to interlock, and they may be fastened by screws at the interlocking connections. Some designs interlock without the use of screws or other fasteners, further reducing installation time and costs.

Backfill, composed of native soil or other porous material the manufacturer suggests, is placed along the sides of the chambers and usually is compacted just enough to add support to the dome structure. Each system should include at least one inspection port to allow water levels in the chamber to be monitored.

A 4-inch pipe transports effluent from the septic tank or other treatment unit to the chambers. Although some systems are designed with perforated distribution pipes within the chambers *(see the graphic below)*, pipes are not necessary within the chambers themselves. Geotextile fabric also is not needed around the chambers or pipes. The wastewater enters the chambers and is absorbed and treated by the soil below.

A chamber system is appropriate for any site where a conventional drainfield is appropriate. These systems also can be used on sloped and wooded sites inaccessible to heavy equipment. Distribution devices can channel wastewater between chamber segments at different elevations as is possible with gravel-lined systems.

Chamber System Advantages

Because they are easy to install, chamber systems often are an attractive choice for homeowners who wish to minimize the type of damage to landscaping that heavy machinery can cause. In addition to being light weight, some chambers are stackable, making them less expensive to transport. Their easy installation also may reduce labor costs.

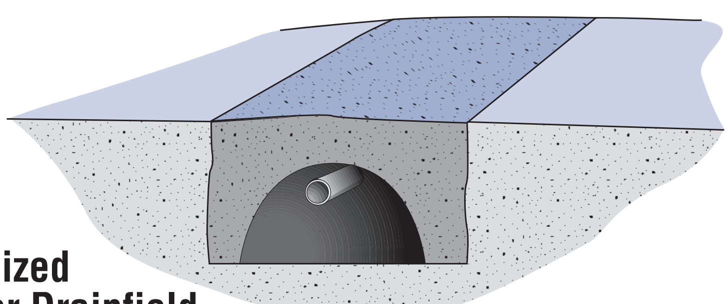
Chamber systems have many of the same advantages as other types of gravelless systems. For example, there are no problems with clogging from dust and fines because gravel is not used. Chamber systems also are very flexible. They can be reconfigured and adapted to different features of the lot, and the systems can be easily expanded and even relocated if necessary—an option not easily available with conventional systems.

Perhaps the most significant advantage of chamber systems is they can store a large amount of effluent. This feature becomes especially important for onsite systems that frequently experience surge or shock loadings (for example, from running toilets or leaky fixtures, extra house guests, or periods of heavy rains). However, while a large storage capacity is helpful when dealing with shock loadings, prolonged periods of effluent storage can be detrimental to soil performance.

In addition, several states allow drainfield size reductions for chamber systems even when they do not allow them for other types of gravelless systems *(refer to page 6)*. Smaller drainfields mean lower construction costs. This is an important advantage for property owners with small lots.

Possible System Drawbacks

Cost is the most significant drawback with chamber systems. Except in those areas where high-quality gravel is expensive or hard to come by, gravel-lined systems usually cost less overall. However, reduced labor and transportation costs may offset higher material costs with chamber systems. Homeowners who are considering installing any type of gravelless system should first compare prices with those for conventional gravel-lined systems.



Generalized Chamber Drainfield

State Regulations for Gravelless and Chamber Systems*

**This information first appeared in the Fall 2000 issue of* Small Flows Quarterly *magazine. Because regulations change, readers should contact their regulatory authority to ensure that these systems are approved.*

State	Gravelless System Allowed	Chamber System Allowed	Reduction Allowed
Alabama		Yes	Yes
Alaska	Yes	Yes	None
Arizona	Yes	Yes	Yes
Arkansas		Yes	Some reduction is allowed
Colorado	Yes	Yes	Yes
Connecticut	No	Yes	Yes
Delaware	Yes	Yes	Yes
Florida		Yes	Yes
Georgia	Yes	Yes	Yes for chamber systems; none for gravelless systems
Hawaii	No	Yes	17 to 20% for specific manufacturers of chamber systems
Idaho	Yes	Yes	Yes
Illinois	Yes	Yes	county by county approval for chamber systems
Indiana	Yes	Yes	Yes
Iowa	Yes	Yes	Yes for chamber systems; 8" gravelless pipes require additional 20% length, and 10" gravelless pipes receive 24" wide credit.
Kansas	Yes	No	Yes for chamber systems on a county by county approval process
Kentucky	Yes	Yes	Yes for chamber systems; no reduction for 8" diameter gravelless, and 30% reduction on 10" as experimental only
Louisiana	Yes	Yes	Some reduction is allowed
Maine	Yes	Yes	Yes
Maryland	Yes	Yes	None
Massachusetts	Yes	Yes	Yes
Minnesota	Yes	Yes	Yes for chamber systems
Mississippi	Yes	Yes	Yes for chamber systems
Missouri	Yes	Yes	Yes
Nebraska		Yes	Yes
Nevada		Yes	Yes
New Hampshire	Yes	Yes	Yes for chamber systems; gravelless-sizing is approved on a product-specific basis
New Jersey	Yes	Yes	sizing is product specific
New York	Yes	Yes	
North Carolina	Yes	Yes	Yes for chamber systems
North Dakota	Yes	Yes	None
Ohio	Yes	Yes	None
Oklahoma	Yes	Yes	Some reduction is allowed
Oregon		Yes	Some reduction is allowed
Pennsylvania	(as experimental only)	Yes	Yes for chamber systems
Rhode Island	No	Yes	Yes for chambers systems in trenches and repairs only
South Carolina	Yes	Yes	Yes for chamber systems under "Provisional & Demonstration Protocol."
South Dakota		Yes	Yes for chamber systems
Tennessee	No	Yes	Yes for standard chamber systems
Texas	Yes	Yes	Yes for chamber system and gravelless systems
Utah		Yes	None
Vermont	Yes	Yes	None
Virginia	Yes	Yes	None
Washington	Yes	Yes	Reductions based on soil condition
West Virginia	Yes	Yes	Yes for chamber systems; gravelless receive no reduction
Wisconsin		Yes	Some reduction is allowed
Wyoming	Yes	No	Some reduction is allowed

Three Schools Choose Chamber Systems

As players in the outfield at John Cornwall Elementary await the next hit, little do they know that just beneath their feet a chamber drainfield is busy treating and dispersing the school's wastewater.

John Cornwall is one of three schools in Hampshire County, West Virginia, that chose to install state-of-the-art recirculating sand filter/ chamber drainfield systems. Alan Cox, the school district's director of maintenance, explains that these systems are a big improvement for the district.

"We used to have failing package plants that were discharging into intermittent streams," said Cox. "I was getting frequent visits from our local department of environmental protection officer, and we were like two cats in a sack. Now we're good friends, and when he does come by, he usually brings someone to tour our system."

Cox says John Cornwall's system was a hard sell at first due to its $100,000 price tag, but the school needed an upgrade, and unlike other systems, this one can be easily expanded as enrollment grows.

"The school district has been very happy with the two systems that are in the ground," says Cox. "A third sand filter/chamber system is being built at Springfield Elementary. All will be remotely monitored by the contractor, so if a problem arises, it can be addressed immediately."

Choosing chambered drainfields also reduced installation costs. And because flows from the school are heavy during the day, the extra storage capacity in the chambers is helpful. Cox says effluent is stored in the recirculation tank and dosed throughout the day. The size of the drainfield trenches were not reduced even though chambers were used.

For information about this project, contact Cox at (304) 822-3121.

CONTACTS

Local Health Agencies

Property owners interested in alternative drainfield designs and other onsite wastewater treatment options should first contact their local health department or state health agency. Health officials are familiar with local onsite wastewater regulations and which options are appropriate and permitted in their jurisdictions. These agencies are usually listed in the government section of local phone directories.

National Environmental Services Center (NESC)

The NESC offers technical assistance and free and low-cost information about wastewater technologies for small communities. Call the NESC at (304) 293-4191 or visit our Web site at *www.nesc.wvu.edu* for more information.

National Onsite Wastewater Recycling Association, Inc.

The National Onsite Wastewater Recycling Association, Inc. (NOWRA) is a national professional organization created to advance and promote the onsite wastewater industry. NOWRA members include government and regulatory personnel, installers, field practitioners, suppliers, distributors, engineers, research professionals, designers, consultants, manufacturers and educators. Call NOWRA at (301) 776-7468 or visit their Web site at *www.nowra.org*.