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Pipeline

Small Community Wastewater Issues Explained to the Public

NESC

Septic Systems–A Practical Alternative for Small Communities

Please note that this issue of Pipeline is an update to the Spring, 1995 issue, Vol. 6, No. 2.

The septic system, once thought of as a temporary treatment for domestic wastewater until public sewerage could be obtained, is making great strides and holding strong in the industry today. With nearly one out of every four homes and one out of every three new housing starts in the U.S. relying on some form of septic system to treat and dispose of household wastewater, the concept of septic systems being a temporary treatment is no longer applicable.

When properly designed, installed, and maintained, septic systems can be the most cost-effective and efficient method of wastewater treatment and have a minimum life expectancy of 20 to 30 years.

Because septic systems treat and dispose of household wastewater onsite, they are often more economical than centralized sewer systems in rural areas where lot sizes are larger and houses are spaced widely apart.

By using natural processes to treat the wastewater onsite, usually in a homeowner's backyard, septic systems don't require the installation of miles of sewer lines, making them less disruptive to the environment.

The traditional septic system is simple in design, which makes it generally less expensive to install and maintain. Today, many innovative designs for septic systems allow them to be placed in areas with shallow soils or other site-related conditions previously considered to be unsuitable.

In spite of these facts, septic systems suffer from an image problem.

Septic systems have been in use since the turn of the century. Their use became widespread after World War II when the suburban housing boom outgrew the rate of sewer construction.

At that time, the biggest assumption was that they would ultimately be replaced by central sewers. Throughout the 1960s, the concept of septic tank systems being an undependable, old-fashioned, or temporary solution until a conventional sewer system could be built continued.

Part of the blame for the poor reputation of septic systems can be traced to the popularity of conventional sewer systems in the 1960s and early 1970s, when more government funding was available to install and maintain large, complex systems. These systems were planned for and designed to provide service over the plant's life expectancy of 20 years or more, which ironically is the same life expectancy of a conventional septic system.

Many communities weren't informed about possible alternatives and, therefore, didn't consider more cost-effective or appropriate decentralized technologies, like septic systems. And engineers, local officials, and community residents sometimes were easily impressed by more high-tech solutions to problems.

Pollution of local groundwater, lakes, and streams due to septic system failures is also responsible for their unpopularity in some communities. However, most of these failures can be attributed to old systems with poor design, maintenance, and installation, or inadequate site evaluations before installation.

In the past, a lack of adequate regulations for septic system design, construction, and installation also contributed to septic system failures. With proper management and homeowner education programs, most problems with septic systems can be avoided.

Advantages

- Simple and effective wastewater treatment
- Less disruptive to the environment to install and maintain
- Less expensive to operate than centralized treatment facilities
- Provide wastewater treatment in areas where it would not be available otherwise
- When functioning properly, can help replenish groundwater

Disadvantages

- Must be pumped routinely, usually once every three to five years
- Water use must be monitored to not overload the system
- Must use care not to dispose of chemi-

As the population increases with urban sprawl, the need for properly managed, maintained and operated septic systems is paramount. The total volume of waste disposed of through septic systems is over one trillion gallons per year, according to a study conducted by the U.S. Environmental Protection Agency's Office of Technology Assessment, and virtually all of that waste is discharged directly to the subsurface, which affects groundwater quality.

This issue of Pipeline presents some basic information about septic tank systems, how they work, and where homeowners and community leaders can find further information and assistance.

Septic System Components

Septic systems are wastewater treatment systems that collect, treat, and dispose of wastewater generated by homes or businesses. The wastewater is treated onsite, rather than collected and transported to a centralized community wastewater treatment plant. (See Figure 1.)

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There are several variations of the basic septic system design in use today. While many systems are individually designed or adapted for a specific site, most work using the same basic principles.

A septic system consists of two main parts; a septic tank and a soil absorption system (SAS), also known as a drainfield, leachfield, or disposal field. The entire system is connected by pipes, and a sewer pipe connects the home or business to the septic system.

The Septic Tank

The main function of the septic tank is to collect household wastewater, which includes water from the toilet, commonly referred to as blackwater, and water from the bathtub, showers, sinks, and laundry, which is known collectively as graywater. However, some states include kitchen sink waste as blackwater. The septic tank treats the wastewater naturally by holding it in the tank long enough for solids and liquids to separate.

Treatment begins when the household wastewater flows from the home to the septic tank through the sewer pipe. A baffle (an internal flap) or tee (a T-shaped pipe) at the inlet slows the flow of wastewater going into the tank and directs it downward toward the middle of the tank. The wastewater is then retained for a day or more in the tank to allow the solids in the wastewater to separate from the liquids.

Inside the tank, solids lighter than water—such as greases, oils, and sometimes, other solid materials like toilet paper—float to the top forming a layer of scum. Solids heavier than water settle at the bottom of the tank forming a layer of sludge. This leaves a middle layer of partially clarified wastewater. (See Figure 1a.)

An outlet baffle in the septic tank is positioned to allow only the partially treated liquid waste in the middle layer to flow out of the tank for further treatment.

The layers of scum and sludge remain in the septic tank where bacteria found naturally in the wastewater work to break the solids down. This process takes place anaerobically (without the presence of oxygen), and gases produced from the decaying solids are vented back through the sewer line and released, usually through a plumbing vent located on the roof of the house. The sludge and scum that cannot be broken down is retained in the tank until the tank is eventually pumped.

After the wastewater is allowed to settle and separate in the septic tank, the partially treated liquid from the middle layer flows through the outlet baffle or tee to the SAS.

Septic tanks are usually made of precast concrete, fiberglass, or plastic, and come in a variety of shapes and sizes. In order for septic tanks to work properly, they must be watertight and resistant to corrosion. For this reason, metal tanks are not recommended.

Most septic tanks are single-compartment tanks. Some people prefer tanks with two or more compartments because they feel settling ability may be enhanced. Multi-compartment tanks use the same process to treat the wastewater as single-compartment tanks. Some states recommend or require two or more compartments for septic tanks that hold 1,000 gallons or more, or two or more septic tanks used in series, one after the other, to provide additional treatment.

Septic tank filters, screen- or basket-like devices that trap and retain solids, are another way to enhance treatment inside septic tanks. (See figure 1b.) A relatively new technology, septic tank filters are included with some newer septic tank designs, or can be retrofitted to work with older designs. Homeowners should check with their local health departments to see if septic tank filters are required or recommended.

Septic tanks are usually rectangular, oval, or round. The overall shape of the septic tank has little to do with its performance, but tank size is a very important factor. Septic tanks must be large enough to accommodate the needs of the household.

The size of a septic tank is usually determined by the number of bedrooms (not bathrooms) in a home.

To keep your septic tank and soil absorption system operating properly follow these general

Do not flush or dispose of in the drain:

- Cloggers like diapers, cat litter, cigarette filters, coffee grinds, grease, condoms, feminine hygiene produce, dental floss, prescription or over-the-county medications, or scrap foods.
- Killers such as household chemicals, gasoline, oil, pesticides, antifreeze, paint, and paint thinners.

One way to estimate the size of a septic tank necessary for an average household would be to multiply 150 gallons per bedroom per day, and then multiply this number by two to allow for two days retention time in the tank. Using this formula, a three-bedroom house would use 450 gallons of water per day, and would require at least a 900-gallon septic tank for two days retention. Standard septic tank sizes include 750, 1,000, 1,200, and 1,500 gallons.

While there are several formulas available for estimating septic tank size, it is most important for homeowners to know the specific regulations for septic tank size and design in their state or area.

Soil Absorption System

In a conventional septic system, the wastewater flows by gravity from the septic tank to the SAS or to a distribution device, which helps to uniformly distribute the wastewater flow in the drainfield.

The soil absorption field provides the final step in the wastewater treatment process. The size of a SAS is usually based upon the size of the house and percolation rate of the soil.

A standard field is a series of trenches or a bed lined with gravel or coarse sand and buried one to three feet below the ground surface. Perforated pipes or drain tiles run through the trenches to distribute the wastewater. (See Figure 1d.)

The drainfield treats the wastewater by allowing it to slowly trickle from the pipes out into the gravel and down through the soil. The gravel and soil in a drainfield act as biological filters.

As the wastewater percolates (moves through the soil) to the groundwater below, the filtration process and organisms in the soil work together to remove toxics, bacteria, viruses, and other pollutants from the wastewater. Soil particles, particularly clay, chemically attract and hold sewage nutrients, metals, and disease carrying organisms. This process can effectively treat the wastewater to an acceptable level that will not contaminate the groundwater. Therefore, it is very important that adequate separation exists between the bottom of the trench/bed and a limiting layer, such as groundwater or bedrock.

Certain toxics, such as paints, paint thinners, pesticides, waste oils, and other hazardous chemicals, cannot be treated by the drainfield and should never be disposed of through a septic system. Some of the chemicals also kill the bacteria found in the septic tank, temporarily disrupting the natural treatment process that occurs in the septic tank.

A thorough site evaluation should be conducted at the beginning of the planning stage. Septic system failures are often caused by poorly conducted evaluations or results of evaluations that did not occur at the beginning of the planning process.

Site Evaluation Is Essential

In a typical site evaluation, a sanitarian, engineer, or other wastewater professional examines the soils, landscape features, and past surveys of the potential site. He or she makes special note of the location of nearby wells, other septic systems, the slope of the land, depth to the groundwater source and to impermeable layers (such as bedrock), natural drainage patterns, and the boundaries of the lot.

An important feature of the site evaluation is a thorough study of the soil. Marking the position of the absorption field, the sanitarian digs an observation pit to examine the soil layers for texture, structure, and color patterns that will give clues about the soil's permeability and potential for seasonal water saturation. Sometimes the sanitarian will conduct a percolation, or "perc," test to measure how quickly the water moves through the soil. In some states, other methods of testing soil permeability are used. Check with state and/or local permitting authorities to find out what method is used in your area.

A good site evaluation defines the limitations of a site. If the soil or other conditions are inappropriate for a conventional drainfield, workable alternatives can be designed using the data collected in the evaluation.

Poorly sited onsite systems may fail, causing inadequately treated wastewater to pond on the ground surface or to contaminate the groundwater.

If you are planning to construct an onsite system, be sure to contact your local permitting agency (often the local health department) for more information on site evaluation and permit requirements for your area.

Distribution Systems for Drainfields

Conventional septic systems require the use of a distribution system to ensure that the flow of wastewater coming from the septic tank is evenly distributed to the different parts of the drainfield. Uneven distribution can overload areas of the drainfield, causing it to fail.

Toxic gases, including methane and hydrogen sulfide, are produced by the natural treatment processes in septic tanks. These gases can kill in minutes.

Extreme care should be taken when inspecting your tank, even when just looking in. Never enter a septic tank or try to inspect the tank alone. Most communities have licensed septic contractors who can inspect your system periodically. For guidelines on how to safely and properly inspect your system, call your local permitting authority.

Following are descriptions of some of the most common distribution system components and methods.

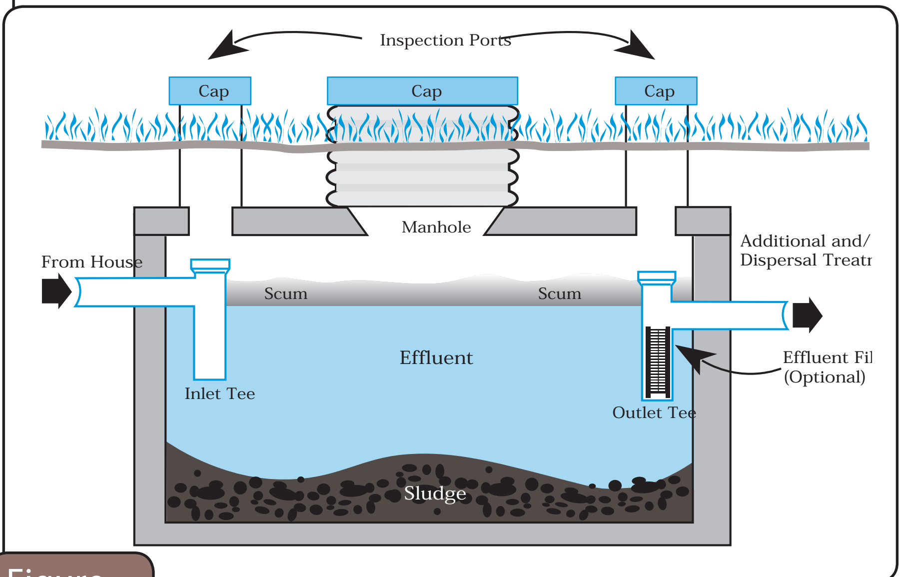
Distribution Box

A distribution box is a tank-like box with as many outlets as there are pipes or lines in the drainfield. (See Figure 1c.) The effluent, or partially treated wastewater, from the septic tank flows into the box and through the different outlets to the drainfield. Because the outlets in the box are level with each other, and because this system relies on gravity to work effectively, it is important that the distribution box be level. If the distribution box is not exactly level, the flow to the drainfield will be uneven.

Advantages of this distribution method include equal distribution, easy inspection (the top of the box opens), and the option of capping outlets to give certain drainfield trenches a chance to rest.

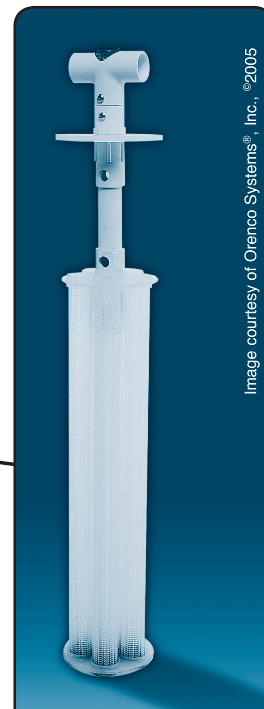
Drop Box

A drop box is also a very simple tank-like box designed for effluent distribution. A series of drop boxes can be used for distributing wastewater to



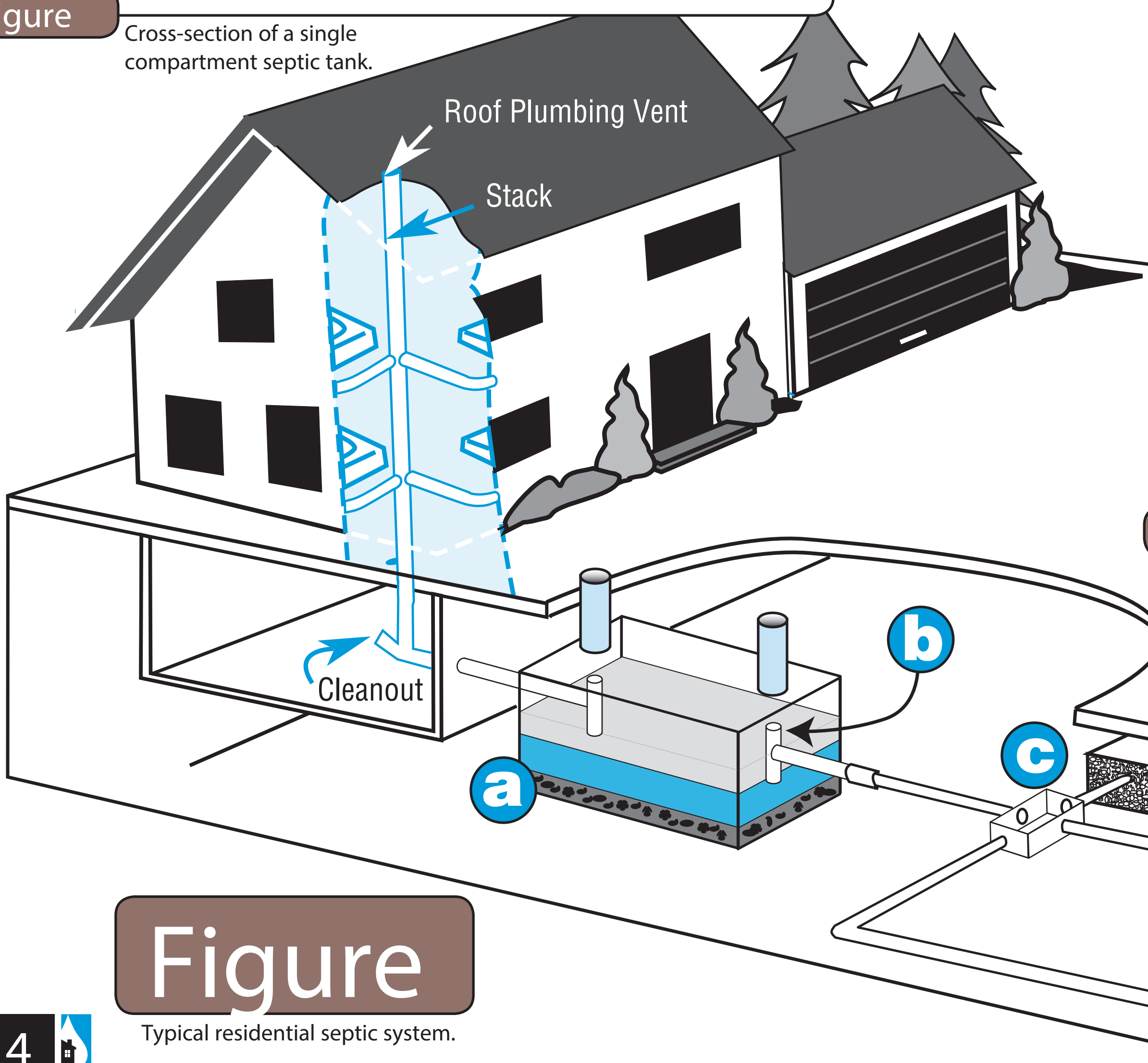
Figure

Cross-section of a single compartment septic tank.



Figure

Septic tank effluent filter.



Figure

Typical residential septic system.

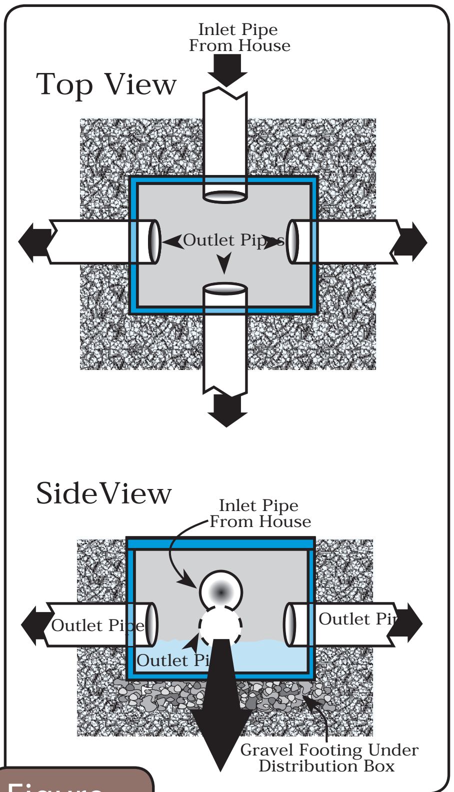


Figure
Plan and cross-section views of distribution box.

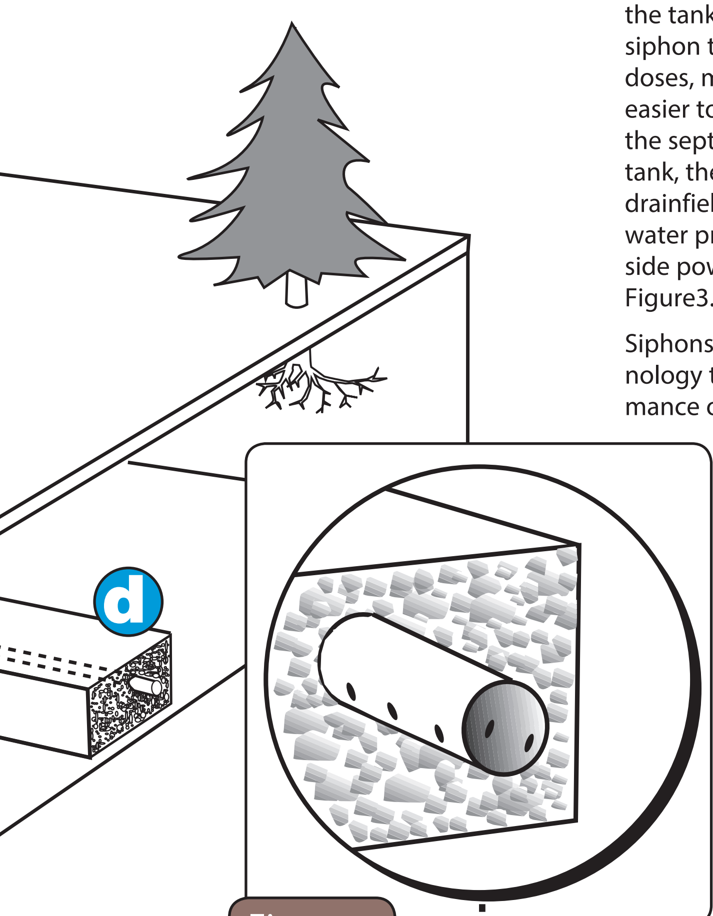


Figure
Cross-section of pipe and gravel trench

drainfields on sloped sites using only gravity.

Inside the drop box, the pipe inlet is higher than the outlet, allowing the wastewater to flow downward to the drainfield trenches. A series of drop boxes can be arranged on the sloped site so that after the highest trench is saturated with wastewater, the flow continues on to the next drop box and trench below. Drop box outlets can also be capped to control the direction of flow and to give the saturated upper trenches a rest. (See Figure2.)

Siphons and Pumps

Some septic systems, because of site conditions, soil conditions, or design, cannot rely on gravity alone to efficiently distribute the flow of effluent from the septic tank to the drainfield. Siphons or pumps are sometimes used as a method of distribution with these systems.

Siphons are often used when septic tank effluent must be evenly distributed over a large area; for example, with drainfields using more than 500 feet of pipe. They are also used when the drainfield is downhill from the tank.The effluent flows from the siphon to the drainfield in pressurized doses, making uniform distribution easier to achieve. The effluent from the septic tank flows into a dosing tank, then through the siphon to the drainfield. Siphons work using only air, water pressure and gravity – no outside power source is necessary. (See Figure3.)

Siphons are a relatively low-cost technology that can improve the performance of the drainfield, but because they require approximately five feet of elevation difference between the septic tank outlet and the drainfield, they are unsuitable for many sites and septic system designs. They also require more maintenance than some other methods of distribution.

Electric pumps are also used to deliver controlled amounts or doses of effluent to the drainfield. Dosing can improve the performance of any drainfield by guaranteeing more uniform distribution, but it is especially advantageous for drainfields with shallow or poor soil conditions. However, electric pumps are more expensive to operate than other distribution systems, and they require regular maintenance. (See Figure 4.)

Some sites and drainfield designs require the use of electric pumps because the drainfield is higher than the septic tank, making it impossible

Landscaping Septic Systems

Planting is recommended for the soil absorption field as opposed to plastics, bark, or gravel. The vegetation helps with oxygen exchange and evaporation. Drought resistant plants, native to your area, should be considered.

Care should be taken to choose plants with non-invasive root systems to avoid infiltrating the drainfield area, possibly damaging or breaking pipes. For this reason, trees and large shrubs are not recommended. Any vegetation chosen should provide coverage for the drainfield all year long.

Grasses are the most recommended type of vegetation because of their high evapo-transpiration rate. Meadow grasses mixed with wildflowers may also be a good choice because they don't have to be mowed regularly. Fertilizers and pesticides may be used with caution. Be sure to read the manufacturer's directions for these products.

Some possible ground covers for sun include: bugleweed (ajuga), carpet heathers (calluga), cotoneaster, ground ivy (glechoma), kinnickinick (arctostaphylos), periwinkle (vinca), and soapwort (saponaria).

Possible shaded area covers are: bunchberry (cornus), chameleon (houtuynnia), ferns, mosses, sweet woodruff (gallium), wild ginger (asarum), and wintergreen (gaultheria).

These are just a small sample of

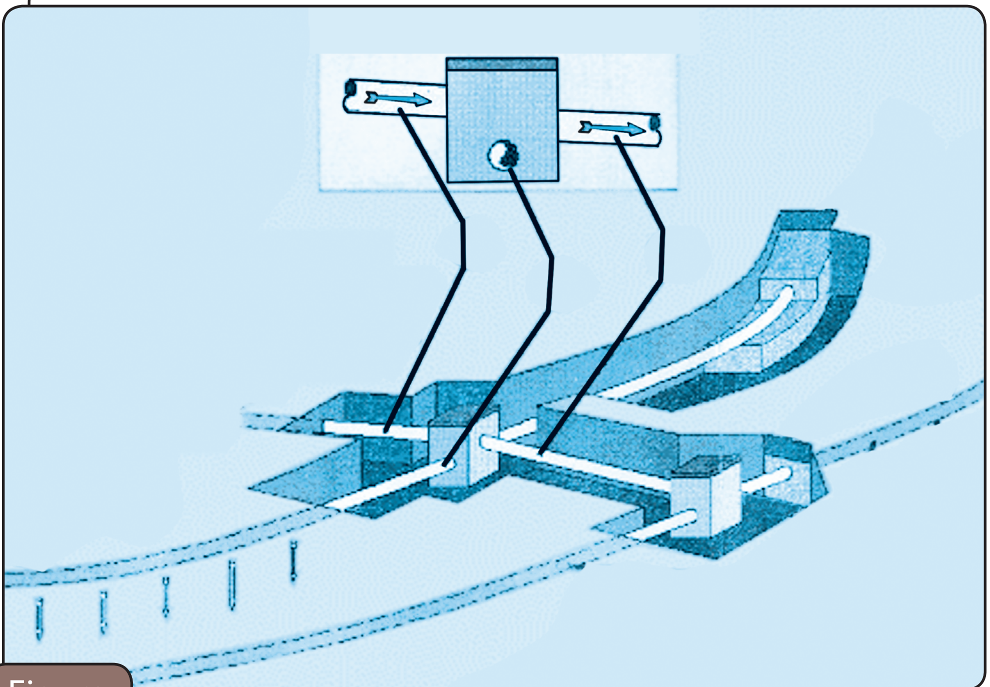


Figure Possible drop box configuration.

to rely on gravity for distribution.

Alternating Fields

The life of a septic system can be significantly extended by having two drainfields and alternating their use. (See Figure 5.) When drainfields were first installed, it was initially believed that they had a limited life. The standard thought was that the field would eventually clog up completely, rendering itself useless.

Although the septic tank removed solids and floatables with the effluent passing to the SAS, the soil in the drainfield works as a filter to physically strain out waste, as well as a biological reactor. The soil particles serve as an attachment point for bacteria where they feed on the waste in the effluent as it passes. When the bacteria feed, they grow and multiply, eventually forming a biological mat in the soil.

The current practice of alternating drainfields helps the long-term acceptance rate of a field so that the bacterial growth rate is balanced by the bacterial die-off rate. It allows one field to rest, while the other is being used. So in theory, the system never completely clogs.

Many factors, such as soil permeability, the amount of oxygen present, the hydraulic and biological loading rates, and the growth and death curves of the bacteria, make the practice of alternating drainfields a difficult science.

Although utilizing two drainfields does require a larger space, the two systems may be interlaced to reduce the amount of space needed. (See Figure 6.)

Water Conservation

Using water wisely can improve the operation of a septic system, greatly reducing the risk of failure. Using more water than the soil can absorb is the most common reason for septic system failure. The more a family conserves, the less water will enter the septic tank.

The average indoor water use in a typical single-family home is nearly 70 gallons per person per day. Toilets alone account for 25 to 30 percent of household water use. A leaky toilet can waste as much as 200 gallons per day.

High-efficiency toilets can also improve the function of a septic tank significantly, reducing the amount of water flushed from 3. 5- to 5-gallons per flush to 1.6 gallons of water or less per flush.

Septic System Cost

The cost of installing and maintaining a septic system varies greatly depending on its location and design. In most areas in the U.S., conventional septic systems cost from $2,500 to $7,500 to install. While certain site conditions or alternative drainfield

Figure Siphon.

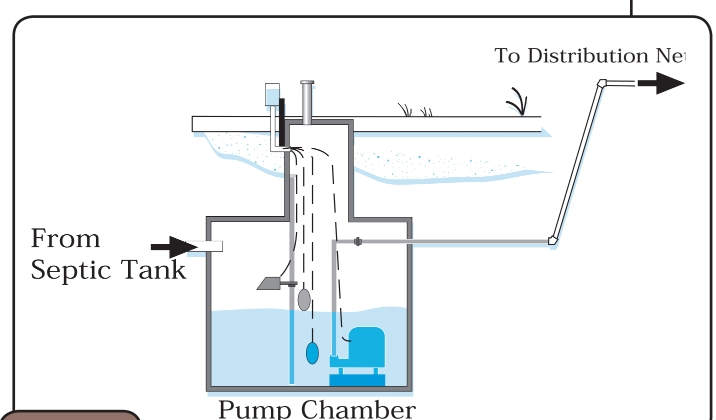
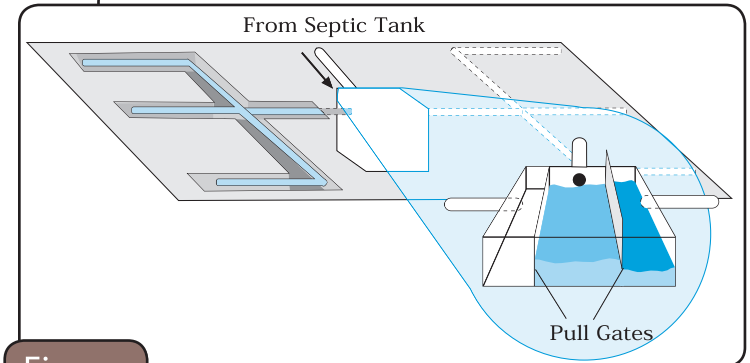
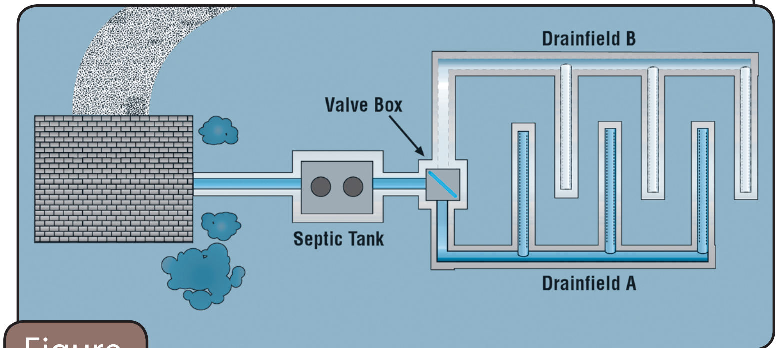


Figure Typical pump system.



Figure

Alternating drainfields.



Figure

Interlacing drainfields.

designs can make installation more expensive, this is a general range for standard septic tank and soil absorption systems. Alternative septic systems requiring pumps or specially constructed drainfields can be considerably more expensive.

In order to accurately estimate what a septic system will cost, homeowners should contact their local permitting agency for more information about the costs of septic systems in their area.

As a general rule of thumb, septic systems are most cost-effective in communities where houses are spaced widely apart, and where connection to a sewer system is not an option. When the cost of operation and maintenance of a centralized treatment plant is factored in, residents in small rural communities may pay many times more per household for a centralized sewer system than residents in more densely populated areas. In certain communities, a centralized sewer system would be so expensive to install and maintain that costs per household could exceed property values.

In order to find the most cost-effective wastewater system for their homes, small community residents should discuss available options with local health department officials, neighbors, and community leaders.

When Conventional Septic Systems Are Used

Originally, septic systems were thought to be stop-gap measures to last until a neighborhood was sewered. It is now realized that some areas will never be connected to sewers, and that septic systems are perfectly capable of treating residential sewage. Indeed, in many cases, septic systems are the preferred solution for wastewater treatment.

Typically, in areas of low-housing density, septic systems work well. Onsite systems are more economical than running sewers between scattered houses. Large lot sizes allow the builder to find suitable soil and reduce the loading of effluent on the soil, improving treatment. It conserves water locally by treating the wastewater on site and returning it to the soil, rather than exporting it to a large treatment plant and discharging it to the surface waters.