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"Technology has made large populations possible; large populations now make technology indispensable."

Joseph Wood Krutch, Author, 1932

Introduction

The French are considered the first to use an underground septic tank system in the 1870s. By the mid 1880s, two-chamber, automatic siphoning septic tank systems, similar to those used today, were being installed in the United States. Even now, more than a century later, septic tank systems represent a major household wastewater treatment option. Fully one-fourth to one-third of the homes in the United States use such a system [1].

On-site sewage disposal systems are used in rural areas where houses are spaced so far apart that a sewer system would be too expensive to install, or in areas around cities where the city government has not yet provided sewers to which the homes can connect. In these areas, people install their own private sewage treatment plants. As populations continue to expand beyond the reach of municipal sewer systems, more families are relying on individual on-site wastewater treatment systems and private water supplies. The close proximity of on-site water and wastewater systems in subdivisions and other developed areas, reliance on marginal or poor soils for on-site wastewater disposal, and a general lack of understanding by homeowners about proper septic tank system maintenance pose a significant threat to public health. The expertise on inspecting, maintaining, and installing these systems generally rests with the environmental health staff of the local county or city health departments.

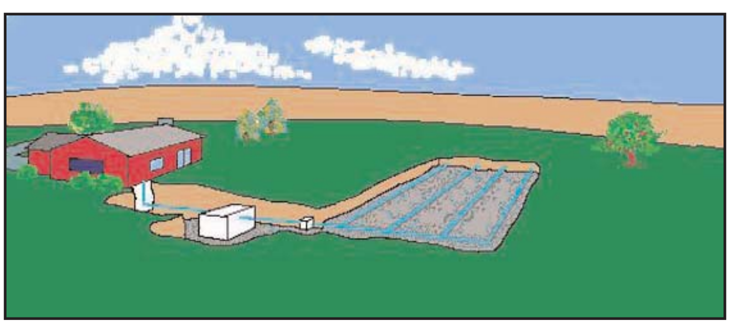

Figure 10.1. Conventional On-site Septic System [2]
Effluent leaves home through a pipe, enters a septic tank, travels through a distribution box to a trench absorption system composed of perforated pipe.

These private disposal systems are typically called septic tank systems. A septic tank is a sewage holding device made of concrete, steel, fiberglass, polyethylene, or other approved material cistern, buried in a yard, which may hold 1,000 gallons or more of wastewater. Wastewater flows from the home into the tank at one end and leaves the tank at the other (Figure 10.1) [2].

Proper maintenance of septic tanks is a public health necessity. Enteric diseases such as cryptospordiosis, giardiasis, salmonellosis, hepatitis A, and shigellosis may be transmitted through human excrement. Historically, major epidemics of cholera and typhoid fever were primarily caused by improper disposal of wastewater. The earliest epidemiology lesson learned was through the effort of Dr. John Snow of England (1813–1858) during a devastating cholera epidemic in London [3]. Dr. Snow, known as the father of field epidemiology, discovered that the city's water supply was being contaminated by improper disposal of human waste. He published a brief pamphlet, *On the Mode of Communication of Cholera*, suggesting that cholera is a contagious disease caused by a poison that reproduces in the human body and is found in the vomitus and stools of cholera patients. He believed that the main, although not only, means of transmission was water contaminated with this poison. This differed from the commonly accepted belief at the time that diseases were transmitted by inhaling vapors.

Treatment of Human Waste

Safe, sanitary, nuisance-free disposal of wastewater is a public health priority in all population groups, small and large, rural or urban. Wastewater should be disposed of in a manner that ensures that

- community or private drinking water supplies are not threatened;
- direct human exposure is not possible;
- waste is inaccessible to vectors, insects, rodents, or other possible carriers;
- all environmental laws and regulations are complied with; and
- odor or aesthetic nuisances are not created.

Figure 10.2. Straight Pipe Discharge
Source: Donald Johnson; used with permission.

Figure 10.3. Clear Creek Water Contaminated With Sewage
Source: Donald Johnson; used with permission.

Epidemiology

John Snow, a London physician, was among the first to use anesthesia. It is his work in epidemiology, however, that earned him his reputation as a prototype for epidemiologists. Dr. Snow's brief 1849 pamphlet, *On the Mode of Communication of Cholera*, caused no great stir, and his theory that the city's water supply was contaminated was only one of many proposed during the epidemic.

Snow, however, was able to prove his theory in 1854, when another severe epidemic of cholera occurred in London. Through painstaking documentation of cholera cases and correlation of the comparative incidence of cholera among subscribers to the city's two water companies, he showed that cholera occurred much more frequently in customers of one water company. This company drew its water from the lower Thames, which become contaminated with London sewage, whereas the other company obtained water from the upper Thames. Snow's evidence soon gained many converts.

A striking incident during this epidemic has become legendary. In one neighborhood, the intersection of Cambridge Street and Broad Street, the concentration of cholera cases was so great that the number of deaths reached over 500 in 10 days. Snow investigated the situation and concluded that the cases were clustered around the Broad Street pump. He advised an incredulous but panicked assembly of officials to have the pump handle removed, and when this was done, the epidemic was contained. Snow was a skilled practitioner as well as an epidemiologist, and his creative use of the scientific information of his time is an appropriate example for those interested in disease prevention and control [3].

In Figure 10.2, a straight pipe from a nearby home discharges untreated sewage that flows from a shallow drainage ditch to a roadside mountain creek in which many children and some adults wade and fish. The clear water (Figure 10.3) is quite deceptive in terms of the health hazard presented. A 4-mile walk along the creek revealed 12 additional pipes that were also releasing untreated sewage. Some people in the area reportedly regard this creek as a source of drinking water.

Raw or untreated domestic wastewater (sewage) is primarily water, containing only 0.1% of impurities that must be treated and removed. Domestic wastewater contains biodegradable organic materials and, very likely, pathogens. The primary purpose of wastewater treatment is to remove impurities and release the treated effluent into the ground or a stream. There are various processes for accomplishing this:

- **Centralized treatment**—Publicly owned treatment works (POTWs) that use primary (physical) treatment and secondary (biologic) treatment on a large scale to treat flows of up to millions of gallons or liters per day,
- **Treatment on-site**—Septic tanks and absorption fields or variations thereof, and
- **Stabilization ponds (lagoons)**—Centralized treatment for populations of 10,000 or less when soil conditions are marginal and land space is ample.

Not included are pit privies and compost toilets.

Historically, wastewater disposal systems are categorized as water-carrying and nonwater-carrying. Nonwater-carried human fecal waste can be contained and decomposed on-site, the primary examples being a pit privy or compost toilet. These systems are not practical for individual residences because they are inconvenient and they expose users to inclement weather, biting insects, and odors. Because of the depth of the disposal pit for privies, they may introduce waste directly into groundwater. It should be noted that these types of systems are often used and may be acceptable in low-water-use conditions such as small campsites or along nature trails [4–6].

On-site Wastewater Treatment Systems

As urban sprawl continues and the population increases in rural areas, the cost of building additional sewage disposal systems increases. One of the prime reasons for annexation is to increase the tax base without increasing the cost of municipal government. The governments involved often buy into short-term tax gains at massive long-term costs for eventual infrastructure improvements to annexed communities. Installing septic tank systems is common to provide on-site disposal systems, but it is a temporary solution at best. Because property size must be sufficient to allow space for septic system replacement, the cost to the municipality installing a centralized sewer system will be dramatically increased because of the large lot size.

Two microbiologic processes occur in all methods that attempt to decompose domestic wastewater: anaerobic (by bacteria that do not require oxygen) and aerobic (by bacteria that require oxygen) decomposition. Aerobic decomposition is generally preferred because aerobic bacteria decompose organic matter (sewage) at a rate much faster than do anaerobic bacteria and odors are less likely. Centralized wastewater treatment facilities use aerobic processes, as do most types of lagoons. Septic tank systems use both processes.

Septic Tank Systems

Approximately 21% of American homes are served by on-site sewage disposal systems. Of these, 95% are septic tank field systems. Septic tank systems are used as a means of on-site wastewater treatment in many homes, both in rural and urban areas, in the United States. If maintained and operated within acceptable parameters, they are capable of properly treating wastewater for a limited number of years and will need both routine maintenance and eventually major repairs. Proper placement and installation is a key to the successful operation of any on-site wastewater treatment system, but septic tank systems have a finite life expectancy and all such systems will eventually fail and need to be replaced. Figure 10.4 shows a typical rural home with a well and a septic system.

Septic tank systems generally are composed of the septic tank, distribution box, absorption field (also known as the soil drainfield), and leach field. The septic tank serves three purposes: sedimentation of solids in the wastewater, storage of solids, and anaerobic breakdown of organic materials.

To place the septic tank and absorption field in a way that will not contaminate water wells, groundwater, or streams, the system should be 10 feet from the house and other structures, at least 5 feet from property lines, 50 feet from water wells, and 25 feet from streams. The entire system area should be easily identifiable. There have been occasions when owners have paved or built over the area. The local health code authorities must be consulted on required distances in their area because of soil and groundwater issues.

Aerobic, or aerated, septic systems use a suspended growth wastewater treatment process, and can remove suspended solids that are not removed by simple sedimentation. Under appropriate conditions, aerobic units may also provide for nitrification of ammonia, as well as significant pathogen reduction. Some type of primary treatment usually precedes the aerated tank. The tanks contain an aeration chamber, with either mechanical aerators or blowers, or air diffusers, and an area for final clarification/settling. Aerobic units may be designed as either continuous flow or batch flow systems.

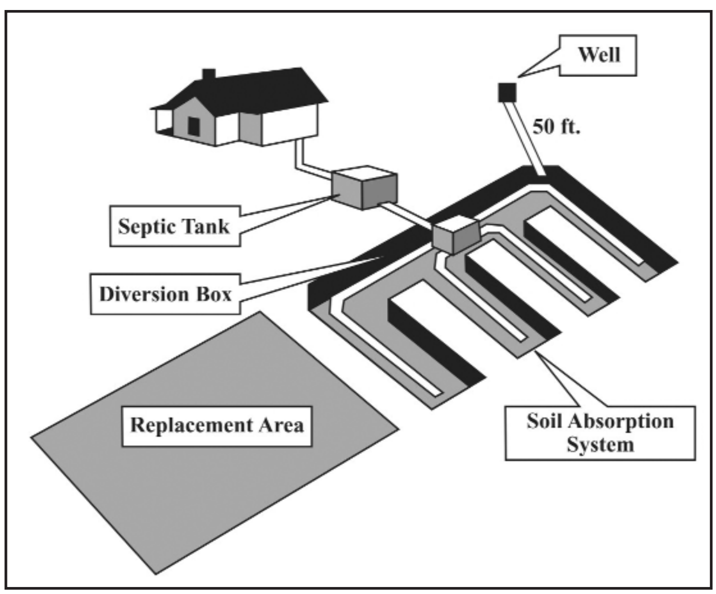

Figure 10.4. Septic Tank System [7]

The continuous flow type are the most commercially available units. Effluent from the aerated tank is conveyed either by gravity flow or pumping to either further treatment/ pretreatment processes or to final treatment and disposal in a subsurface soil disposal system. Various types of pretreatment may be used ahead of the aerobic units, including septic tanks and trash traps.

The batch flow system collects and treats wastewater over a period of time, then discharges the settled effluent at the end of the cycle [8].

Aerobic units may be used by individual or clustered residences and establishments for treating wastewater before either further treatment/pretreatment or final on-site subsurface treatment and disposal. These units are particularly applicable where enhanced pretreatment is important, and where there is limited availability of land suitable for final on-site disposal of wastewater effluent. Because of their need for routine maintenance to ensure proper operation and performance, aerobic units may be well-suited for multiple-home or commercial applications, where economies of scale tend to reduce maintenance and/or repair costs per user. The lower organic and suspended solids content of the effluent may allow a reduction of land area requirements for subsurface disposal systems.

A properly functioning septic tank will remove approximately 75% of the suspended solids, oil, and grease from effluent. Because the detention time in the tank is 24 hours or less, there is not a major kill of pathogenic bacteria. The bacteria will be removed in the absorption field (drainfield). However, there are soils and soil conditions that prohibit the ability of a drainfield to absorb effluent from the septic tank.

Septic tanks are sized to retain the total volume of sewage produced by a household in a 24-hour period. Normally a 1,000-gallon tank is the minimum size to use. State or local codes generally require larger tanks as the potential occupancy of the home increases (e.g., 1,250 gallons for four bedrooms) and may require two tanks in succession when inadequate soils require alternative system installation. Figure 10.5 shows a typical septic tank.

Distribution boxes are not required by most on-site plumbing codes or by the U.S. Environmental Protection Agency. When used, distribution boxes provide a convenient inspection port. In addition, if a split system absorption field is installed (two separate absorption trench systems), the distribution box is a convenient place to install a diversion valve for annually alternating absorption fields.

Absorption Field Site Evaluation

The absorption field has a variety of names, including leach field, tile field, drainfield, disposal field, and nitrification field. The effluent from the septic tank is directed to the absorption field for final treatment. The suitability of the soil, along with other factors noted below, determines the best way to properly treat and dispose of the wastewater.

Most, but unfortunately not all, states require areas not served by publicly owned sewers to be preapproved for on-site wastewater disposal before home construction through a permitting process. This process typically requires a site evaluation by a local environmental health specialist, soil scientist, or, in some cases, a private contractor. To assist in the site evaluation process, soil survey maps from the local soil conservation service office may be used to provide general information about soils in the area.

The form shown in Figure 10.6 is typical of those used in conducting a soil evaluation.

Sites for on-site wastewater disposal are first evaluated for use with a conventional septic tank system. Evaluation factors include site topography, landscape position, soil texture, soil structure, internal drainage, depth to rock or other restrictive horizons, and useable area. If the criteria are met, a permit is issued to allow the installation of a conventional septic tank system. Areas that do not meet the criteria for a conventional system may meet less-restrictive criteria for an alternative type of system.

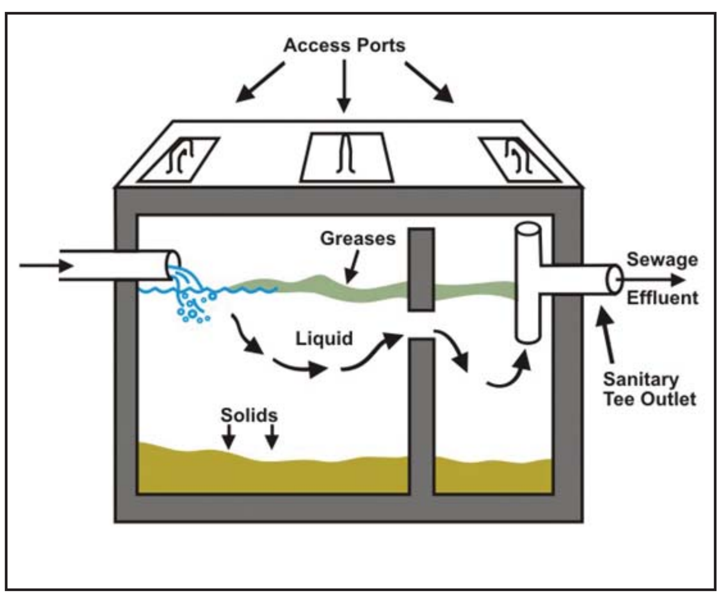

Figure 10.5. Septic Tank [9]

Sample On-site Sewage Disposal System Site Evaluation Form

Location ____________________ Application No. ________________________

Owners Name ____________________ Applicant's Name ______________________

Evaluation Factors	Proposed System Area	Alternative Area 1
1. Topography (slope percent)	S PS U	S PS U
2. Landscape Position	S PS U	S PS U
3. Soil Texture and Group	S PS U	S PS U
4. Soil Structure	S PS U	S PS U
5. Internal Soil Drainage	S PS U	S PS U
6. Soil Depth (inches)	S PS U	S PS U
7. Restrictive Horizons	S PS U	S PS U
8. Available Space	S PS U	S PS U
9. Overall Site Classification	S PS U	S PS U
10. Soil Series (if available)	S PS U	S PS U

S = Suitable PS = Provisionally Suitable U = Unsuitable

11. List site and/or system modifications or alternatives required for site approval and the specific area selected for the system. ______________________________________

12. Percolation test required Yes____ No ____

Figure 10.6. On-site Sewage Disposal System Site Evaluation Form

Many sites are unsuitable for any type of on-site wastewater disposal system because of severe topographic limitations, poor soils, or other evaluation criteria. Such sites should not be used for on-site wastewater disposal because of the high likelihood of system failure.

Some states and localities may require a percolation test as part of the site evaluation process. As a primary evaluation method, percolation tests are a poor indicator of the ability of a soil to treat and move wastewater throughout the year. However, information obtained by percolation tests may be useful when used in conjunction with a comprehensive soil analysis.

Absorption Field Trench

A conventional absorption field trench (Figure 10.7), also known as a rock lateral system, is the most common system used on level land or land with moderate slopes with adequate soil depth above the water table or other restrictive horizons. The effluent from the septic tank flows through solid piping to a distribution box or, in many cases, straight to an absorption field. With the conventional system and most alternative systems, the effluent flows through perforated pipes into gravel-filled trenches and subsequently seeps through the gravel into the soil.

The local regulatory agency should be consulted about the acceptable depth of the absorption field trench. Some states require as much as 4 feet of separation beneath the bottom of the trench and the groundwater. The depth of absorption field trenches should be at least 18 inches, and ideally no deeper than 24 inches. The absorption field pipe should be laid flat with no slope. There should be a minimum of 12 to 18 inches of acceptable soil below the bottom of the trench to any bedrock, water table, or restrictive horizon. The length of the trench should not exceed 100 feet for systems using a distribution box. Serpentine systems may be several hundred feet long and should be filled with crushed or fragmented clean rock or gravel in the bottom 6 inches of the trench. Perforated 4-inch-diameter pipe is laid on top of the gravel then covered with an additional 2 inches of rock and leveled for a total of 12 inches. A geotextile material or a biodegradable material such as straw should be placed over the gravel before backfilling the trench to prevent soil from clogging the spaces between the rocks.

One or more monitoring ports should be installed in the absorption area extending to the bottom of the gravel to allow measurement of the actual liquid depth in the

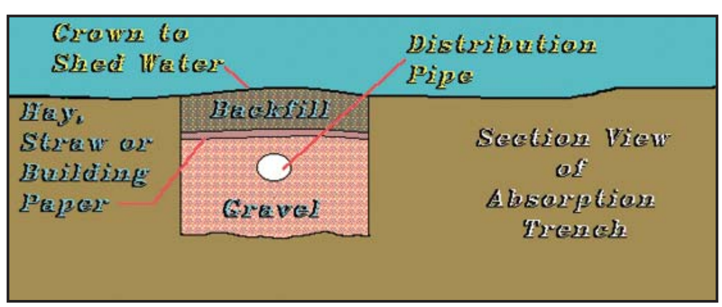

Figure 10.7. Cross-section of an Absorption Field [10]

gravel. This is essential for subsequent testing of the adequacy of the system.

As a general rule, using longer and narrower trenches to meet square footage requirements produces a better working and longer lasting ground absorption sewage disposal system. Studies have shown that as septic systems age, the majority of effluent absorption by the soil is provided by lateral movement through the trench sidewalls. Longer and narrower trenches (such as 400 feet long by 2 feet wide instead of 200 feet by 4 feet to obtain 800 square feet) greatly increase the sidewall area of the system for lateral movement of wastewater.

Alternative Septic Tank Systems

As the cost of land for home building increases and the availability of land decreases, land that was once considered unsuitable is being developed. This land often has poor soil and drainage properties. Such sites require a considerable amount of engineering skill to design an acceptable wastewater disposal system. In many cases, sites are not acceptable for seepage systems within a reasonable cost. These systems are primarily regulated by state and local government and, before use, approval must be obtained from the appropriate regulatory agencies. Even if a site is approved in one state or county jurisdiction, a similar site may not be approved in another.

The primary difficulty with septic tank systems is treating effluent in slowly permeable or marginal soils. Low-water-use devices, when installed, may make it possible to use a small percentage of septic tank systems in marginal soil. However, low-water-use devices are usually required as part of a larger effort to develop a usable alternative sewage disposal system. Alternative sewage disposal methods that can be used if regular subsurface disposal is not appropriate are numerous [11]. Some of the more common alternative systems are described below.

Mound Systems

A mound system (Table 10.1) is elevated above the natural soil surface to achieve the desired vertical separation from a water table or impervious material. The elevation is accomplished by placing sand fill material on top of the best native soil stratum. At least 1 foot of naturally occurring soil is necessary for a mound system to function properly. Minimizing water usage in the home also is critical to prevent effluent from weeping through the sides of the mound (Figure 10.8).

When a mound system is constructed, the septic tank usually receives wastewater from the house by gravity flow. A lift station is located in the second compartment or in a separate tank to pump the effluent up to the distribution piping in the mound. Floats in the lift station control the size of the pumped effluent dose. An alarm should be installed to alert the homeowner of pump failure so that repairs can be made before the pump tank overfills.

Low-Pressure Pipe Systems

Low-pressure pipe (LPP) systems may also be used where the soil profile is shallow. These systems are similar to mounds except that they use naturally occurring soil as it exists on-site instead of elevating the disposal field with soil fill material. LPP systems are installed with a trenching machine at depths of 12 to 18 inches. The LPP system consists of a septic tank, high-water alarm, pumping tank, supply line, manifold, lateral line, and submersible effluent pump (Figure 10.9).

Advantages	Disadvantages
May be used in areas with high groundwater, bedrock, or restrictive clay soil near the surface	Must be installed on relatively level lots
Space efficient compared to conventional rock lateral systems	Periodic flushing of the distribution network is required
Allows home building in areas unsuitable for below grade systems	System may be expensive
Water softener wastes, common household chemicals, and detergents are not harmful to this system	System may be difficult to design
	Regular inspection of the pumps and controls necessary to maintain the system in proper working condition

Table 10.1. Mound System Advantages and Disadvantages

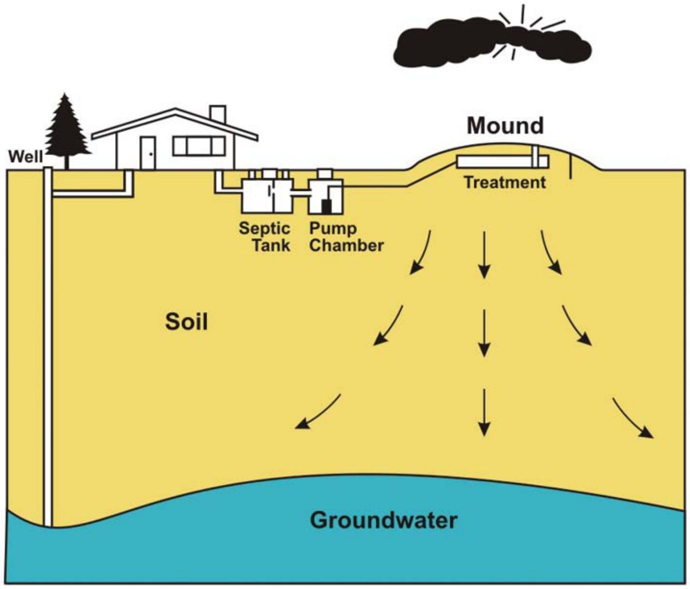

Figure 10.8. Mound System Cutaway [3]

When septic tank effluent rises to the level of the pump control in the pumping tank, the pump turns on, and effluent moves through the supply line and distribution laterals. The laterals contain small holes and are typically placed 3 to 8 feet apart. From the trenches, the effluent moves into the soil where it is treated. The pump turns off when the effluent falls to the lower control. Dosing takes place one to two times daily, depending on the amount of effluent generated. Pump malfunctions set off an alarm to alert the homeowner. The time between doses allows the effluent to be absorbed into the soil and also allows oxygen to reenter the soil to break down solids that may be left behind. If the pump malfunctions, an alarm notifies the homeowner to contact a qualified septic system contractor. The pump must be repaired or replaced quickly to prevent the pump tank from overflowing.
Table 10.2 shows the advantages and disadvantages of LPP systems.

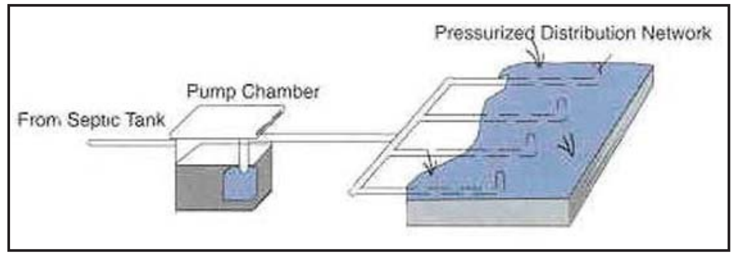

Figure 10.9. Low Pressure On-site System [12]

Plant-rock Filter Systems (Constructed Wetlands)

Considered experimental in some states, plant-rock filter systems are being used with great success in Kentucky, Louisiana, and Michigan. Plant-rock filters generally consist of a septic tank (two-compartment), a rock filter, and a small overflow lateral (absorption) field. Overflow from the septic tank is directed into the rock filter. The rock filter is a long narrow trench (3 to 5 feet wide and 60 to 100 feet long) lined with leak-proof polyvinyl chloride or butylplastic to which rock is added. A 2- to 4-inch-diameter rock is used below the effluent flow line and larger rock above (Figure 10.10).

Plant-rock filter systems are typically sized to allow 1.3 cubic feet of rock area per gallon of total daily waste flow. A typical size for a three-bedroom house would be 468 square feet of interior area. Various width-to-length ratios within the parameters listed above could be used to obtain the necessary square footage. The trenches can even be designed in an "L" shape to accommodate small building lots.

Treatment begins in the septic tank. The partially treated wastewater enters the lined plant-rock filter cell through solid piping, where it is distributed across the cell. The plants within the system introduce oxygen into the

Advantages	Disadvantages
Space requirements are nearly half those of a conventional septic tank system	Some low-pressure pipe systems may gradually accumulate solids at the dead-ends of the lateral lines, therefore maintenance is required
Can be installed on irregular lot shapes and sizes	Electric components are necessary
Can be installed at shallower depths and requires less topsoil cover	Design and installation may be difficult; installers with experience with such systems should be sought
Provides alternating dosing and resting cycles	
Installation sites are left in their natural condition	

Table 10.2. Low-pressure Pipe Systems Advantages and Disadvantages

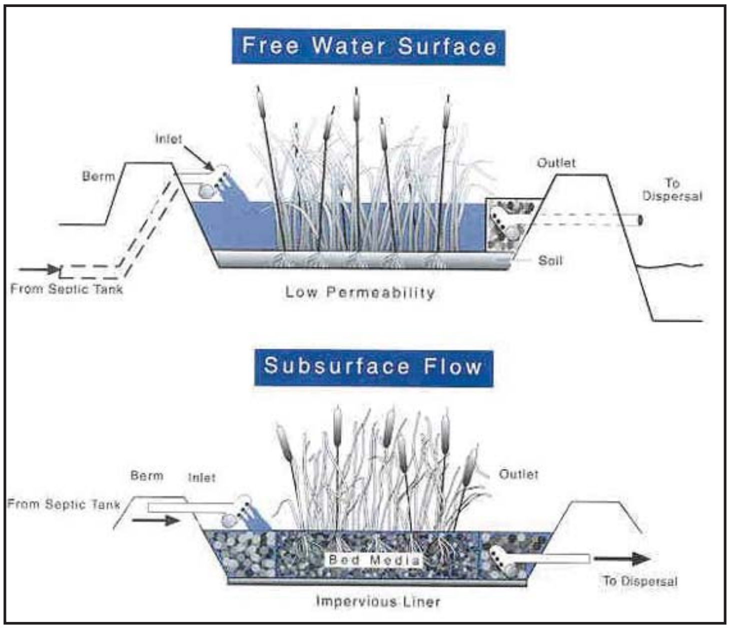

Figure 10.10. Plant-rock Filter System [12]

wastewater through their roots. As the wastewater becomes oxygenated, beneficial microorganisms and fungi thrive on and around the roots, which leads to digestion of organic matter. In addition, large amounts of water are lost through evapotranspiration. The kinds of plants most widely used in these systems include cattails, bulrush, water lilies, many varieties of iris, and nutgrass. Winter temperatures have little effect because the roots are doing the work in these systems, and they stay alive during the winter months. Discharge from wetlands systems may require disinfection. The advantages and disadvantages of the plant-rock filter system are shown in Table 10.3.

Maintaining On-site Wastewater Treatment Systems

Dos and don'ts inside the house:

- Do conserve water. Putting too much water into the septic system can eventually lead to system failure. (Typical water use is about 60 gallons per day for each person in the family.) The standard drain field is designed for a capacity of 120 gallons per bedroom. If near capacity, systems may not work. Water conservation will extend the life of the system and reduce the chances of system failure.
- Do fix dripping faucets and leaking toilets.
- Do avoid long showers.
- Do use washing machines and dishwashers only for full loads.
- Do not allow the water to run continually when brushing teeth or while shaving.
- Do avoid disposing of the following items down the sink drains or toilets: chemicals, sanitary napkins, tissues, cigarette butts, grease, cooking oil, pesticides, kitty litter, coffee grounds, disposable diapers, stockings, or nylons.
- Do not install garbage disposals.
- Do not use septic tank additives or cleaners. They are unnecessary and some of the chemicals can contaminate the groundwater.

Dos and don'ts for outside maintenance:

- Do maintain adequate vegetative cover over the absorption field.
- Do not allow surface waters to flow over the tank and drainfield areas. (Diversion ditches or subsurface tiles may be used to direct water away from system.)
- Do not allow heavy equipment, trucks, or automobiles to drive across any part of the system.

Advantages	Disadvantages
Approximately one-third the size of conventional septic tank absorption field systems	May be slightly more costly to install
	Disinfection required for effluent discharge
Can be placed on irregular or segmented lots	May not find installers knowledgeable about the system
May be placed in areas with shallow water tables, high bedrock, or restrictive horizons	Life span of the system is unknown because of its relative newness
Relatively low maintenance	Perception of being unsightly to some

Table 10.3. Plant-rock Filter System Advantages and Disadvantages

- Do not dig into the absorption field or build additions near the septic system or the repair area.

- Do make sure a concrete riser (or manhole) is installed over the tank if not within 6 inches of the surface, providing easy access for measuring and pumping solids. (Note: All tanks should have two manholes, one positioned over the inlet device and one over the outlet device.)

There is no need to add any commercial substance to "start" or clean a tank to keep it operating properly. They may actually hinder the natural bacterial action that takes place inside a septic tank. The fecal material, cereal grain, salt, baking soda, vegetable oil, detergents, and vitamin supplements that routinely make their way from the house to the tank are far superior to any additive.

Symptoms of Septic System Problems

These symptoms can mean you have a serious septic system problem:

- Sewage backup in drains or toilets (often a black liquid with a disagreeable odor).

- Slow flushing of toilets. Many of the drains will drain much slower than usual, despite the use of plungers or drain-cleaning products. This also can be the result of a clogged plumbing vent or a nonvented fixture.

- Surface flow of wastewater. Sometimes liquid seeps along the surface of the ground near your septic system. It may or may not have much of an odor and will range from very clear to black in color.

- Lush green grass over the absorption field, even during dry weather. Often, this indicates that an excessive amount of liquid from the system is moving up through the soil, instead of down, as it should. Although some upward movement of liquid from the absorption field is good, too much could indicate major problems.

- The presence of nitrates or bacteria in the drinking water well indicates that liquid from the system may be flowing into the well through the ground or over the surface. Water tests available from the local health department will indicate whether this is a problem.

- Buildup of aquatic weeds or algae in lakes or ponds adjacent to your home. This may indicate that nutrient-rich septic system waste is leaching into the surface water, which may lead to both inconvenience and possible health problems.

- Unpleasant odors around the house. Often, an improperly vented plumbing system or a failing septic system causes a buildup of disagreeable odors.

Table 10.4 is a guide to troubleshooting septic tank problems.

Septic Tank Inspection

The first priority in the inspection process is the safety of the homeowner, neighbors, workers, and anyone else for which the process could create a hazard.

- Do not enter septic tanks or cesspools.

- Do not work alone on these tanks.

- Do not bend or lean over septic tanks or cesspools.

- Note and take appropriate action regarding unsafe tank covers.

- Note unsanitary conditions or maintenance needs (sewage backups, odor, seepage).

- Do not bring sewage-contaminated clothing into the home.

- Have current tetanus inoculations if working in septic tank inspection.

Methane and hydrogen sulfide gases are produced in a septic tank. They are both toxic and explosive. Hydrogen sulfide gas is quite deceptive. It can have a very strong odor one moment, but after exposure, the odor may not be noticed.

Inspection Process

As sewage enters a septic tank, the rate of flow is reduced and heavy solids settle, forming sludge. Grease and other light solids rise to the surface, forming a scum. The sludge and scum (Figure 10.11) are retained and break down while the clarified effluent (liquid) is discharged to the absorption field.

Sludge eventually accumulates in the bottom of all septic tanks. The buildup is slower in warm climates than in colder climates. The only way to determine the sludge

Problem	Possible Cause(s)	Remedies
Wastewater backs up into the building or plumbing fixtures sluggish or do not drain well.	Excess water entering the septic tank system, plumbing installed improperly, roots clogging the system, plumbing lines blocked, pump failure, absorption field damaged or crushed by vehicular traffic.	Fix leaks, stop using garbage disposal, clean septic tank and inspect pumps, replace broken pipes, seal pipe connections, avoid planting willow trees close to system lines. Do not allow vehicles to drive over or park over lines. Contact local health department for guidance.
Wastewater surfaces in the yard.	Excess water entering the septic tank system, system blockage, improper system elevations, undersized soil treatment system, pump failure, absorption field damaged or crushed by vehicular traffic.	Fix leaks, clean septic tank and check pumps, make sure distribution box is free of debris and functioning properly, fence off area until problem is fixed, call in experts. Contact local health department for guidance.
Sewage odors indoors.	Sewage surfacing in yard, improper plumbing, sewage backing up in the building, trap under sink dried out, roof vent pipe frozen shut.	Repair plumbing, clean septic tank and check pumps, replace water in drain pipes, thaw vent pipe. Contact local health department for guidance.
Sewage odors outdoors.	Source other than owner's system, sewage surfacing in yard, manhole or inspection pipes damaged or partially removed, downdraft from vent pipes on roof.	Clean tank and check pumps, replace damaged inspection port covers, replace or repair absorption field. Contact local health department for guidance.
Contaminated drinking water or surface water.	System too close to a well, water table or fractured bedrock; cesspool or dry well being used; improper well construction; broken water supply or wastewater lines. Improperly located wells must be sealed in strict accordance with state and local codes.	Abandon well and locate a new one far and upslope from the septic system, fix all broken lines, stop using cesspool or drywell. Contact local health department for guidance.
Distribution pipes and soil treatment system freeze in winter.	Improper construction, check valve in lift station not working, heavy equipment traffic compacting soil in area, low flow rate, lack of use.	Examine check valve, keep heavy equipment such as cars off area, increase water usage, have friend run water while away on vacation, operate septic tank as a holding tank, do not use antifreeze. Contact local health department for guidance.

Table 10.4. Septic Tank System Troubleshooting

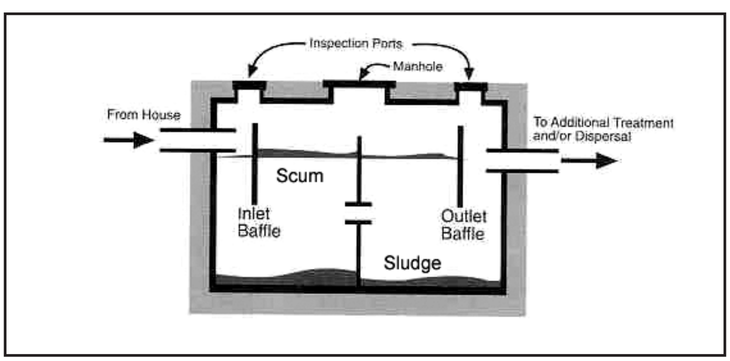

Figure 10.11. Sludge and Scum in Multicompartment Septic Tank [13]

depth is to measure the sludge with a probe inserted through an inspection port in the tank's lid. Do not put this job off until the tank fills and the toilet overflows. If this happens, damage to the absorption field could occur and be expensive to repair.

Scum Measurement

The floating scum thickness can be measured with a probe. The scum thickness and the vertical distance from the bottom of the scum to the bottom of the inlet can also be measured. If the bottom of the scum gets within 3 inches of the outlet, scum and grease can enter the absorption field. If grease gets into the absorption field, percolation is impaired and the field can fail. If the scum is near the bottom of the tee, the septic tank needs to be cleaned out. The scum thickness can best be measured through the large inspection port. Scum should never be closer than 3 inches to the bottom of the baffle. The scum thickness is observed by breaking through it with a probe, usually a pole.

Sludge Measurement

To measure sludge, make a sludge-measuring stick using a long pole with at least 3 feet of white cloth (e.g., an old towel) on the end. Lower the measuring stick into the tank, behind the outlet baffle to avoid scum particles, until it touches the tank bottom. It is best to pump each tank every 2 to 3 years. Annual checking of sludge level is recommended. The sludge level must never be allowed to rise within 6 inches of the bottom of the outlet baffle. In two-compartment tanks, be sure to check both compartments. When a septic tank is pumped, there is no need to deliberately leave any residual solids. Enough will remain after pumping to restart the biologic processes.

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