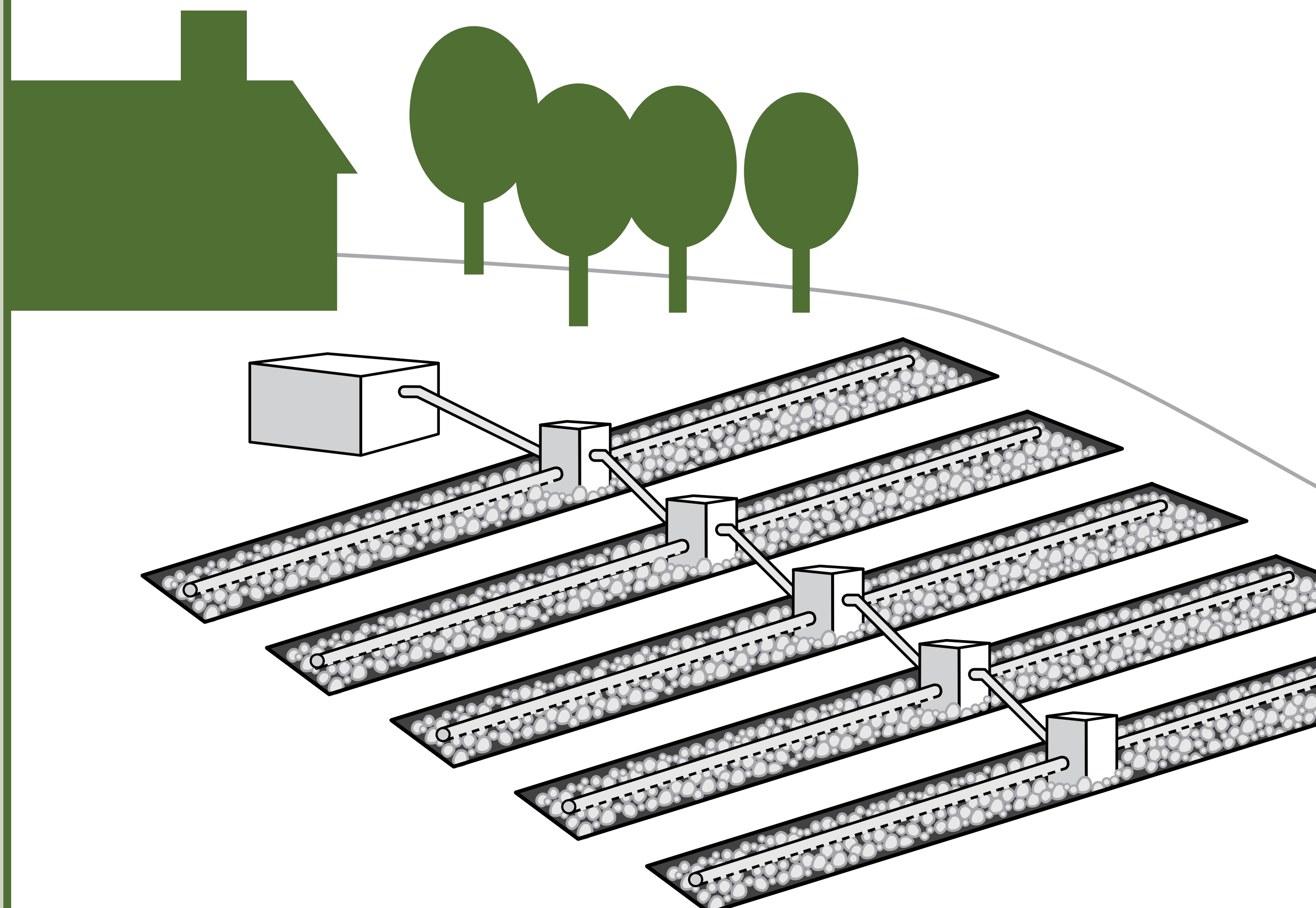
Bulletin 939

Septic Tank–Soil Treatment Systems

for Ohio Rural Homes



THE OHIO STATE UNIVERSITY EXTENSION

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Septic Tank–Soil Treatment Systems for Ohio Rural Homes

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Protecting public health and water quality is the goal of an onsite wastewater treatment system. Many treatment technologies are available to meet this goal. The selection of an appropriate technology is dictated by the site and soil conditions.

Natural soil is an ideal medium for treating wastewater. Natural processes that occur in unsaturated soil remove pathogens and recycle nutrients and organic matter that can degrade surface and groundwater quality. Complete treatment of wastewater requires deep, permeable, and unsaturated soil. In Ohio's soils, complete treatment can be accomplished in 4 feet of soil depth. Unfortunately, soils this deep in Ohio are uncommon. Most of Ohio's naturally occurring soils range from 1 to 3 feet deep. Soil survey data indicate that only 6.4% of Ohio's land area has soils more than 4 feet deep. Where these deep permeable soils exist, wastewater can be treated completely, easily, and inexpensively through natural processes.

This bulletin describes the design and maintenance of septic tank–soil treatment systems for individual homes. Permits for wastewater treatment systems serving 1-, 2-, or 3-family dwellings are issued by the local health department. Some health departments will permit septic tank–leach field systems to be installed on sites with shallow soils to a limiting condition. It is important to note that while legally permitted in Ohio, systems constructed on shallow soils may provide organic matter and bacteria removal, but they do not remove all pathogens and nutrients from wastewater.

For information on the soil's ability to treat wastewater and Ohio's soil depths check Ohio State University Extension Bulletin 896, *Suitability of Ohio Soils for Treating Wastewater*. This bulletin is useful in planning for the use of onsite wastewater treatment systems. This and other publications on onsite wastewater treatment can be obtained through local OSU Extension offices or found at http://setll.osu.edu.

Where should a soil treatment system be used in Ohio?

Soil treats wastewater when applied to a soil that is deep, permeable, and unsaturated. A minimum of 4 feet of soil depth from the trench bottom to a limiting layer may be needed to ensure that the pollutants are removed. Limiting conditions include:

- Ground water
- Seasonal high water tables
- Dense, compacted layers
- Bedrock
- Sand and gravel

A soil treatment system must be positioned in the landscape along the land contour. Required horizontal separation distances from drinking water wells and property lines and other resources or boundaries are found in the Ohio Administrative Code. Soil treatment systems that are long and narrow insure that water can infiltrate and move away from the site without backing up or ponding.

How do soil treatment systems work?

Soil treatment systems, described in this bulletin, accept septic tank effluent. In the septic tank, solids settle out and are retained to minimize soil clogging. Research has shown that two tanks in series or one tank with two compartments retain a higher percentage of solids than a similarly sized single compartment tank. Septic tank effluent filters can also enhance solids removal by the septic tank. Table 1 presents recommended septic tank size.

Septic tank effluent is distributed beneath the soil surface through a series of trenches. Soil treatment systems usually rely on gravity to distribute the wastewater. Wastewater quickly flows out of the pipes buried in a layer of gravel or a chamber beneath the ground surface. The bottom of the trench actually distributes the wastewater, so the trench bottom must be level.

Since all of the wastewater is applied where the perforated pipe first enters a trench, only a small area of the trench is used to accept and treat the wastewater. Eventually, the small area is overloaded and the soil clogs with solid particles and biological growth, sometimes called a biomat. The wastewater must then move along the trench to infiltrate. Over the years, wastewater continues to "creep" down the trench as illustrated in figure 1.

Once a clogging layer covers the entire bottom of the trench, the entire trench will be utilized. A simple inspection port at the end of each trench enables an inspector to check for ponding. Without management, the wastewater will continue to pond in the trench and may begin to surface in the yard or back up in the house. A series of green stripes in a yard above the trenches is a sign that wastewater is ponding and action should be taken before the system completely fails.

Research conducted at Penn State University (1981) shows that by simply resting a clogged trench, the infiltration capacity can be restored in about one year. All soil treatment systems should be designed and installed with three features for maintenance.

1. Inspection ports at the end of each trench to check for ponding.
2. A device to divert wastewater away from a clogged trench to allow it to rest for at least one year.
3. Extra trenches to accept wastewater for at least one year while the clogged trenches are being restored.

Table 1. Septic tank size. Tanks should have two compartments or use two tanks in series.

Number of Bedrooms	Tank Size (Gallons)
1	1000
2	1000
3	1500
4	2000
5	2000

Table 2. Estimated septic tank pumping frequency.

Tank Size (Gallons)	Household Size (Number of People)									
	1	2	3	4	5	6	7	8	9	10
500	5.8	2.6	1.5	1.0	0.7	0.4	0.3	0.2	0.1	-
750	9.1	4.2	2.6	1.8	1.3	1.0	0.7	0.6	0.4	0.3
1000	12.4	5.9	3.7	2.6	2.0	1.5	1.2	1.0	0.8	0.7
1250	15.6	7.5	4.8	3.4	2.6	2.0	1.7	1.4	1.2	1.0
1500	18.9	9.1	5.9	4.2	3.3	2.6	2.1	1.8	1.5	1.3
1750	22.1	10.7	6.9	5.0	3.9	3.1	2.6	2.2	1.9	1.6
2000	25.4	12.4	8.0	5.9	4.5	3.7	3.1	2.6	2.2	2.0

Note: More frequent pumping needed if garbage disposal is used.

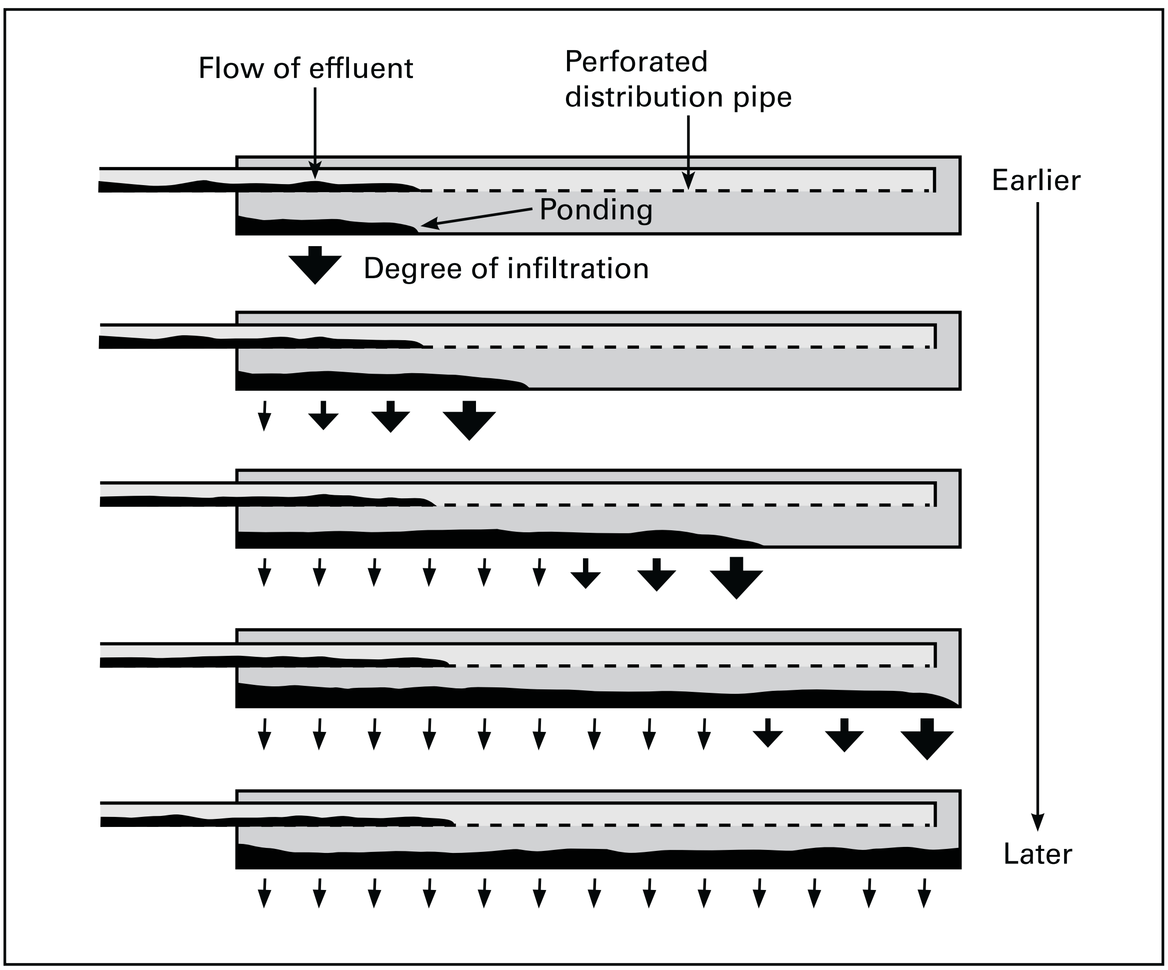

Figure 1. Progression of clogging along bottom in trench system (After: Two Remedies for Failing Septic Systems. Penn State Extension Special Circular SC302).

How are soil treatment systems designed?

Since the soil is treating the wastewater, designing a system relies on detailed information from a site and soil evaluation. Details on how evaluations are conducted are presented in OSU Extension Bulletin 905, *Soil and Site Evaluation for Onsite Wastewater Treatment*.

The following pages describe the design process and show an example for a three-bedroom home.

Step 1. Evaluate site location for a soil treatment system.

A soil treatment system is proposed for a three-bedroom residence. On a site with deep, permeable soil, locate the contour of the lot in the system area. Mark the horizontal separation distances to property lines, structures, wells, and other important landscape features. Stake out and outline, with paint, the trench locations so that they run parallel to the contour. The trenches should be far enough apart to operate excavation equipment between the trenches. Six feet is a typical separation distance. Note that the distance between the trenches may vary as they are sited along the contour.

A summary of the soil and site information is given below. Confirm the soil and site description prior to designing a leaching trench system for the site.

1. **Soil profile**

A 0–14 inches:	**Very dark brown (10YR 2/2) silt loam; moderate, fine granular structure; friable when moist, slightly acid.**
B 14–66 inches	**Very dark grayish brown (10YR 3/2) silt loam; moderate, medium, subangular blocky structure, firm when moist; many coatings of organic matter on ped faces; slightly acid.**
C 66 inches	**Brown (10 YR 5/3) gravel and sand; loose; calcareous.**

2. **Site slope is 0–3%**
3. **The area available is 160 feet along the contour and 50 feet along the slope. Three medium-sized trees are in the proposed absorption area.**
4. **Depth to limiting condition is 66 inches due to a sand and gravel layer.**

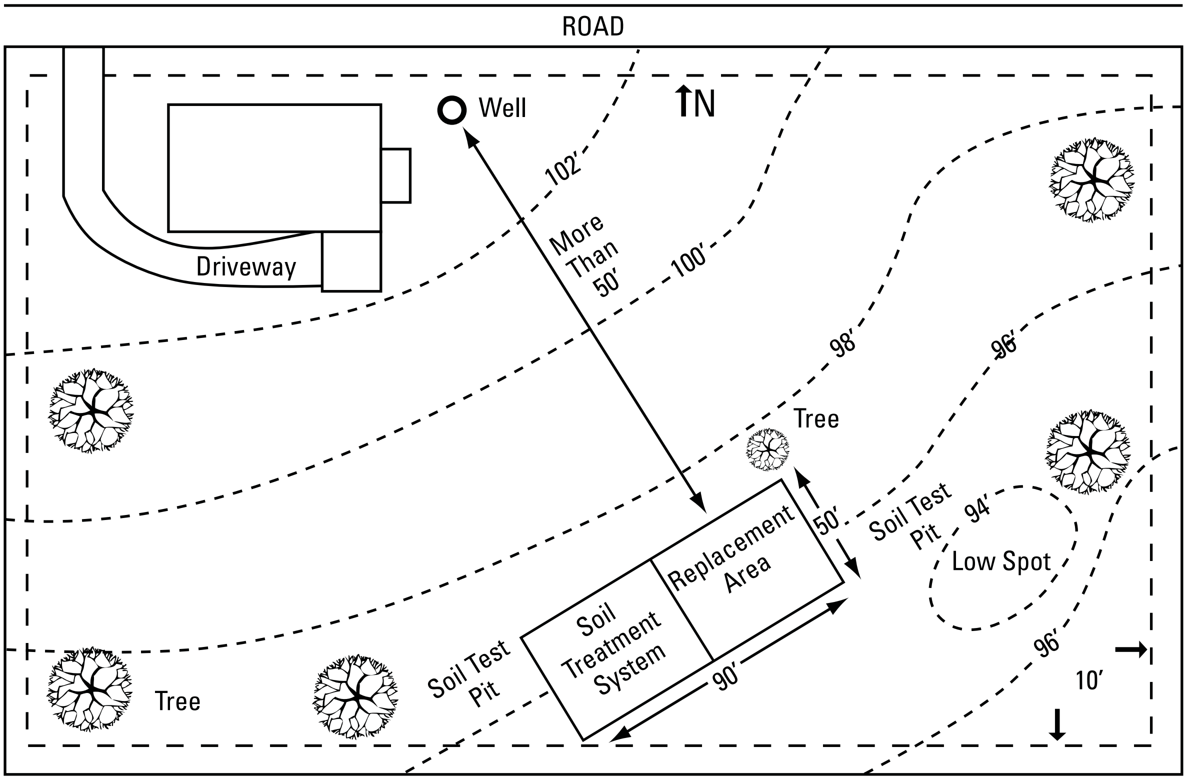

Figure 2. Draft of layout plan with site of proposed soil treatment system.

Step 2. Determine design wastewater volume.

In Ohio, the daily wastewater design volume for single-family residences is 120 gallons/bedroom/day. Design volumes need to be adjusted for homes with extra water-using fixtures or high water-consuming lifestyles.

Design wastewater volume:

For a three-bedroom residence, design wastewater volume is
120 gallons/bedroom/day x 3 bedrooms = 360 gallons/day

Step 3. Select linear loading rate.

Selection of the linear loading rate is a very important step in designing any soil treatment system. The linear loading rate estimates the contribution of water from the trenches to the landscape hydrology. In other words, the linear loading rate estimates how water will move from the trenches downslope as it disperses into the soil profile. The nature of the limiting condition impacts how the water moves through the landscape. The nature of the limiting condition is identified as a part of the soil and site evaluation conducted by a qualified professional.

The linear loading rate is the volume of water the landscape can safely accept each day for each foot of trench length along the contour. It is presented as gallons per day per linear foot (gpd/lf). Using table 3, find the nature of the limiting condition and select the corresponding linear loading rate. The space limited value is a less conservative value and should be used only if limited suitable area is available.

Table 3. Linear loading rate for different limiting conditions with at least 3 foot separation distance (After Converse and Tyler, 1990).

Nature of Limiting Condition	Linear Loading Rate Range (gpd/linear ft)		
	Conservative Value		Space-limited Value
Solid Bedrock	3	to	4
Inpermeable layer	3	to	4
Seasonal high water table	3	to	4
Semipermeable layer	5	to	6
Fractured compacted till	5	to	6
Creviced or fractured bedrock	8	to	10
Sand and/or gravel layer	8	to	10

Linear loading rate:

The soil evaluation revealed a limiting condition as a sand and gravel layer. The corresponding linear loading rate from table 3 is 8 gpd/lf.

Step 4. Select the soil infiltration area loading rate.

The wastewater moves down through the soil from the trench bottom by gravity. Therefore, the soil infiltration area is the total area of the trench bottoms (trench length X trench width X number of trenches). The rate at which the daily application of wastewater safely infiltrates into the soil at the trench bottom is the soil infiltration area loading rate. This rate is estimated from the characteristics of the soil at the soil depth where the trench bottom will be located and is presented as gallons per day per square foot (gpd/ft^2).

Since the most permeable and well-aerated soil is near the surface, trenches should be as shallow as possible. Commonly, trench bottoms are positioned at 18-inch depth. They should never be deeper than 3 feet.

Table 4. Estimated soil infiltration area loading rate for different soil characteristics (After Converse and Tyler, 1990).

Soil Morphological Conditions	Soil Infiltration Area Rate (gpd/ft^2)
A. Gravelly coarse sand or coarser	0.0 (Limiting condition)
B. Consistence stronger than firm or hard or cemented	0.0 (Limiting condition)
C. Texture sandy clay, clay or silty clay of high clay content and structure massive or weak, or silt loam and massive structure.	0.0 (Limiting condition)
D. Texture sandy clay loam, clay loam or silty clay loam and structure massive.	0.0 (Limiting condition)
E. Texture sandy clay, clay or silty clay of low clay content and structure moderate or strong	0.2
F. Texture sandy clay loam, clay loam or silty clay loam and structure weak.	0.2
G. Texture sandy clay loam, clay loam or silty clay loam and structure strong or moderate.	0.4
H. Texture sandy loam, loam or silt loam and structure weak.	0.4
I. Texture sandy loam, loam or silt loam and structure moderate or strong.	0.6
J. Texture fine sand, very fine sand, loamy sand or loamy very fine sand.	0.6
K. Coarse sand with single grain structure.	0.8

Soil infiltration area loading rate:

The trenches for this proposed system will be 18 inches deep. The soil at that depth is sandy loam texture; moderate structure; friable consistence. From table 4, the soil infiltration area loading rate is 0.6 gpd/ft^2.

Step 5. Determine absorption area length.

Absorption area length = Design wastewater volume / Linear loading rate

Determine absorption area length:

Absorption area length = Design wastewater volume / Linear loading rate
Absorption area length = 360 gpd / 8 gpd/lf
Absorption area length = 45 feet

Dark green stripes in the lawn over the trenches indicate ponding in trenches. In an older system (10 years +) it may indicate the need to rest the trenches to restore treatment capacity. In a new system (less than 5 years) it may indicate poor design or construction.

Step 6. Determine absorption area width.

The absorption area width is the total width of the trench bases.
Absorption area width = Linear loading rate / soil infiltration area loading rate

Determine absorption area width:

Absorption area width = Linear loading rate / soil infiltration area loading rate
Absorption area width = 8 gpd/lf / 0.6 gpd/ft^2
Absorption area width = 13.3 feet

Cleaning the effluent filter in the septic tank is an important maintenance activity. A spray bottle filled with water and one drop of dishwashing liquid works well to clean the filter. It only takes a few minutes to remove the filter, spray down the filter over the tank opening, and replace the cleaned filter.

Step 7. Determine number of trenches.

Select a trench width that is convenient to install. Trenches on steeper slopes should be narrow to minimize the depth difference from one side of the trench to the other. A common trench width is 18 inches wide. Trenches should be 3 feet wide or less to maintain aerobic conditions.

Number of trenches = absorption area width / trench width

NOTE: This is the number of trenches needed for system operation. At least half as many additional trenches will be required for system maintenance when clogging eventually occurs. Diversion devices redirecting the flow from each trench will also be needed. The extra trenches will receive wastewater for about one year, allowing the clogged trenches to rest and restore naturally. Following the rest period, wastewater is directed back into the original system.

Drop boxes can be used to distribute the wastewater into trenches in a soil treatment system.

Determine the number of trenches:

Select trench width of 3 feet wide, since the lot has little slope.

Number of trenches = absorption area width / trench width

Number of trenches = 13.3 feet / 3 feet
Number of trenches = 4.4 or 5 trenches (round up to the next whole number)

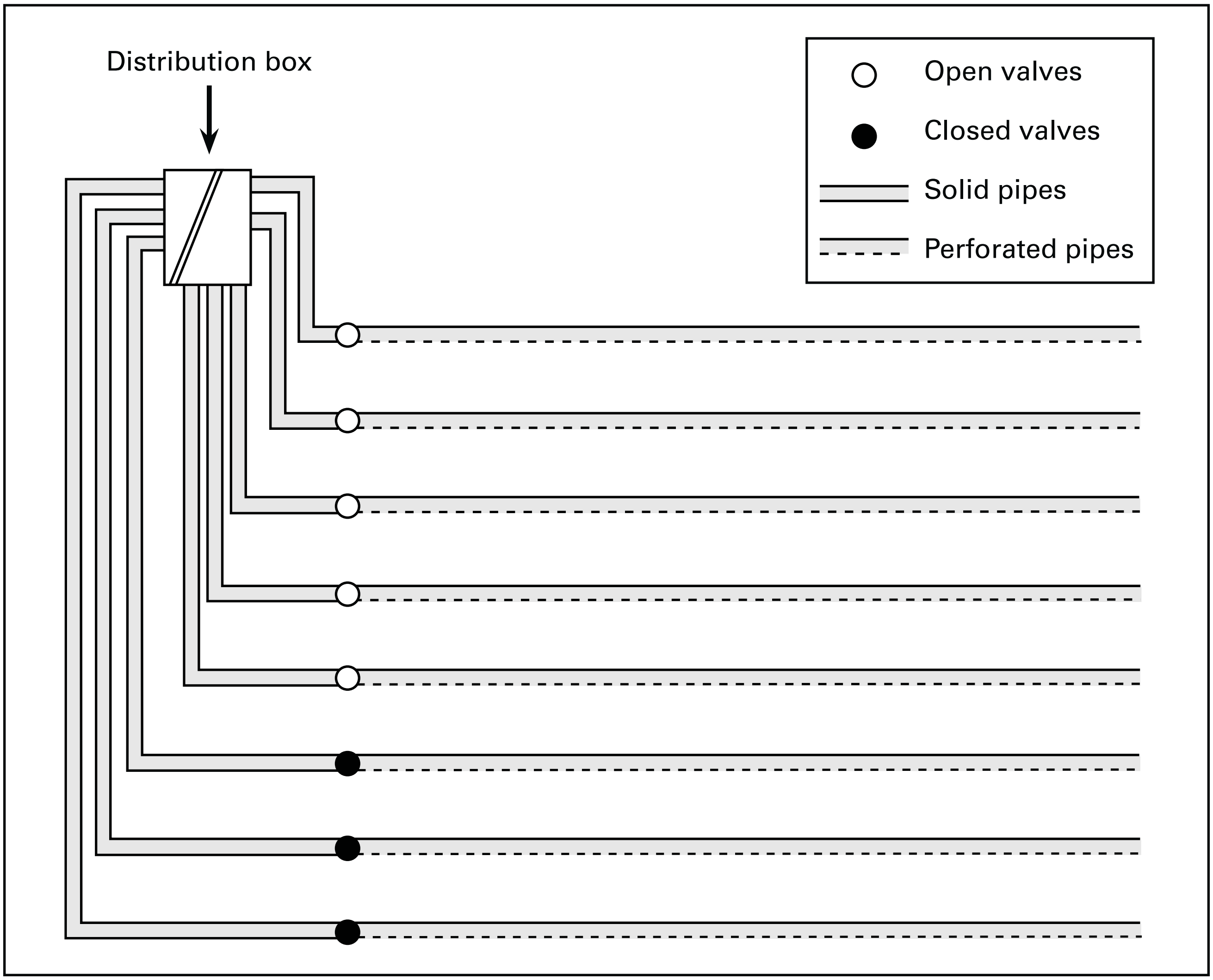

Figure 3. Wastewater distribution in soil treatment system using a distribution box. Shows valves that can be opened to divert wastewater to trench and closed to rest trench.

Overall system dimensions:

5 trenches, 3 feet wide, each at least 45 feet long.
Trenches are parallel to the contour and are 6 feet apart to allow for the easy movement of equipment during system construction.

Three additional trenches will be installed to allow for absorption area resting.

Check placement of trench system on lot:

Note: since the area available for the system is 160 feet long along the contour the trenches can be longer, still leaving space for a replacement area.

An alternative design is with trenches 75 feet long and 3 feet wide. The longer trenches, in effect, lower the design linear loading rate.

Design linear loading rate = Wastewater design loading rate / system length
Design linear loading rate = 360 gpd/75 ft = 4.8 gpd/ft

Absorption area width = Linear loading rate / soil absorption area loading rate
Absorption area width = 4.8 gpd/lf / 0.6 gpd/ft^2 = 8 feet

Number of trenches = Absorption area width / trench width
Number of trenches = 8 feet / 3 feet = 3 trenches

Remember two additional trenches will be needed with a diversion device to allow for absorption area resting.

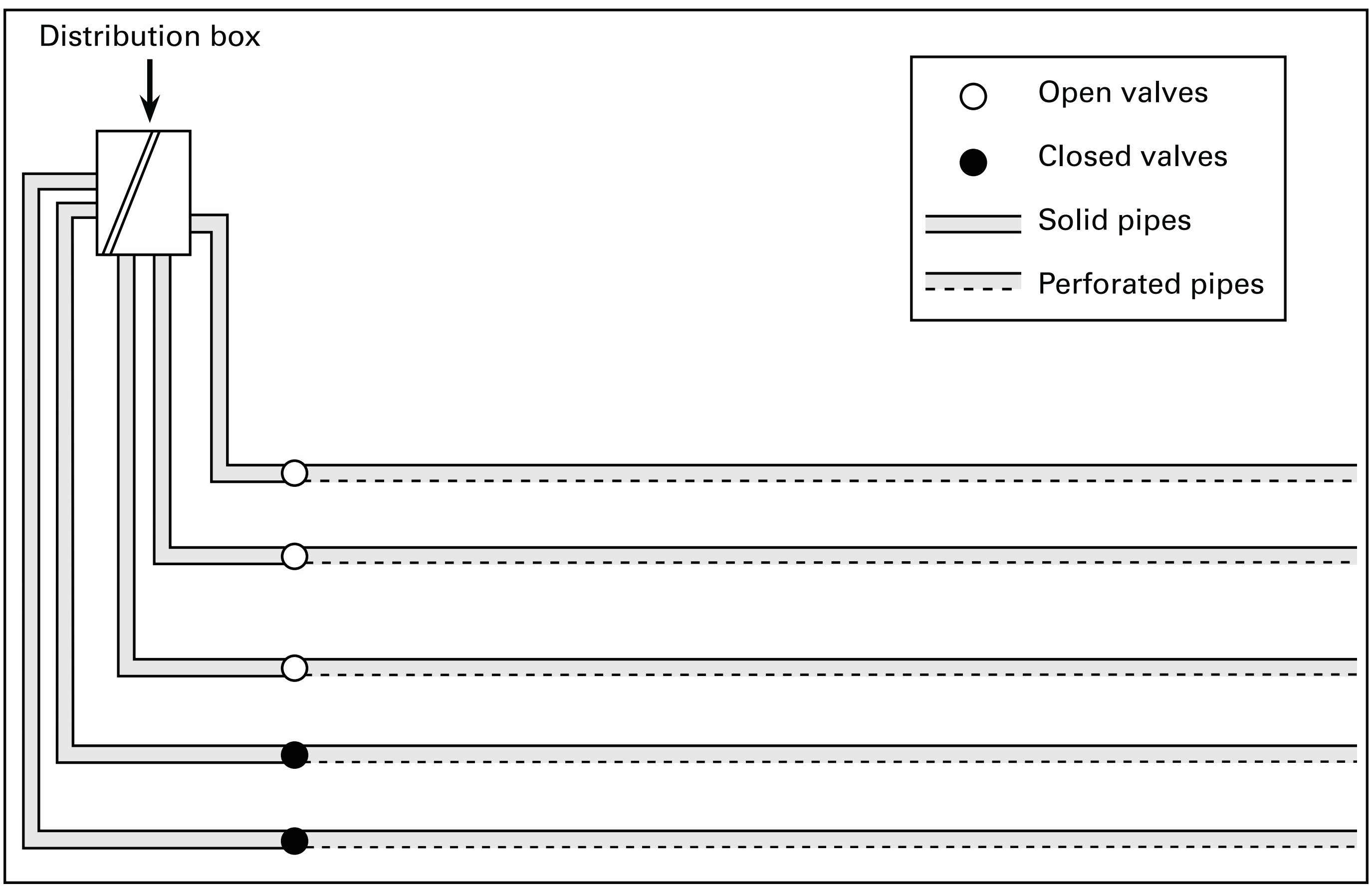

Figure 4. Wastewater distribution in soil treatment system using a distribution box. The system has longer and fewer trenches.

What about using drop boxes in soil treatment systems?

Another method of construction is to use drop boxes in every trench of a soil treatment system. Drop box systems use less pipe, since one pipe does not have to be installed and connected to the distribution box for each trench. This is called a sequential distribution system as shown in figure 6. In this system style, the first trench is completely ponded before water overflows and flows down into the second drop box.

The drop box also acts as both an inspection port and a diversion valve. If ponding occurs in a trench, water will pond in the drop box (figure 5). The outlets to the ponded trench can be capped off for one year to allow for resting and recovery.

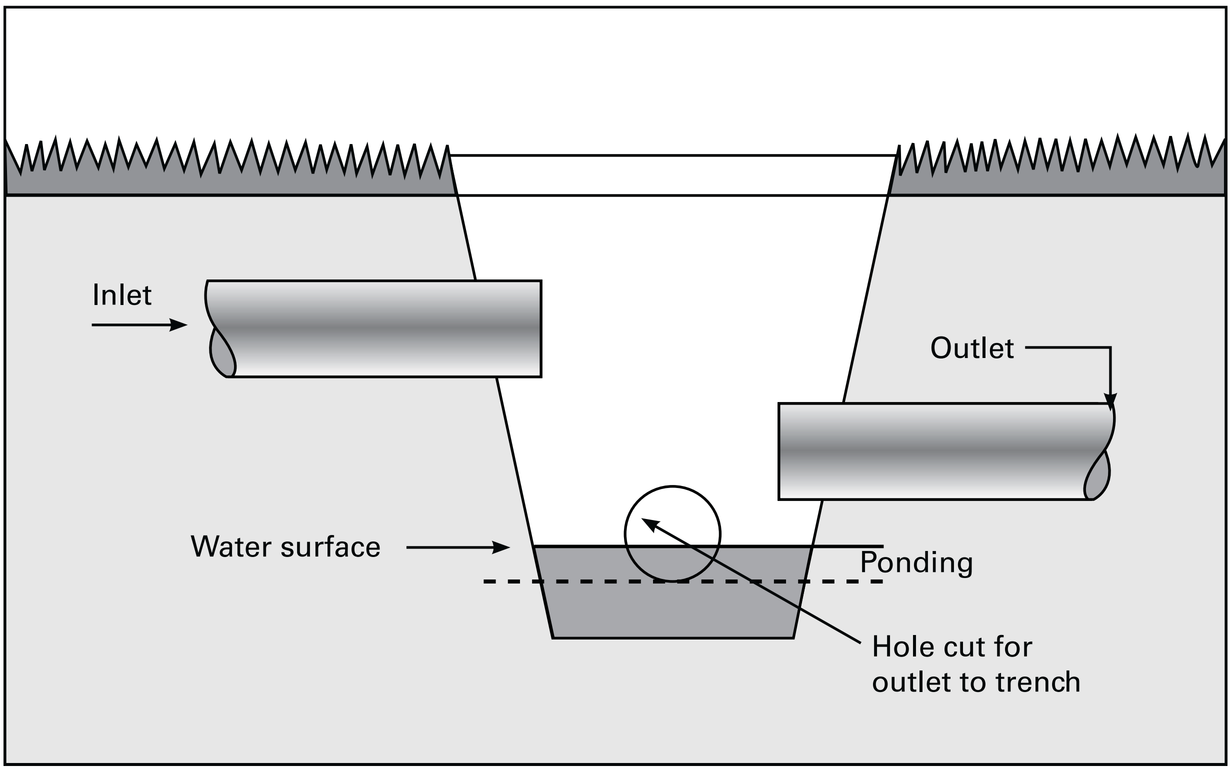

Figure 5. Example of a drop box. Inlet (high) and outlet (low) are shown. A hole is cut in the side at the appropriate elevation for the distribution pipe into trench. This illustrates ponding in trench.

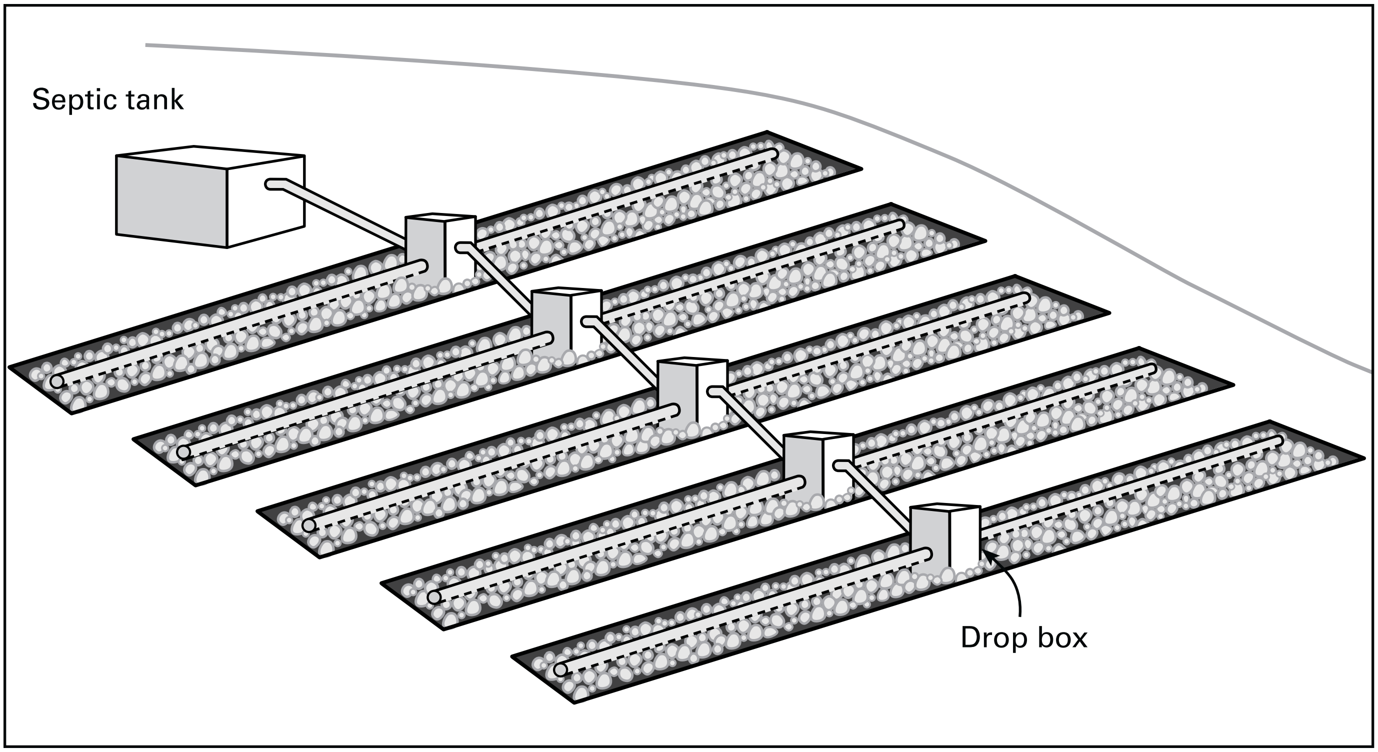

Figure 6. Drop boxes used in a soil treatment system.

How should a soil treatment system be maintained?

Annual inspection and regular maintenance is all that is required for a septic tank–soil treatment system. The steps for regular maintenance include:

1. Check for landscape changes on the lot that could impact the soil treatment system. Make sure:
    a. No soil compaction has occurred in the area of or just downslope of the treatment system. Do not site structures, pave, or park vehicles in the area.
    b. Excess water is diverted away from the soil treatment area. Watch for downspouts, roofing, or paving that direct runoff onto the area of the treatment system. Never connect foundation or downspout drains to any septic system.
2. Locate inspection ports at end of each trench, uncover if necessary and cut away grass.
3. Open port at end of each line and check for ponding.
    a. First 10 years: Ponding is not expected in the first few years of operation. If ponding is present at the end of trenches, start checking water use amounts and patterns. The system may be receiving greater than design flows. Either institute water conservation or expand the system to match actual water use.
    b. After a decade or more of use, ponding is likely to occur in some or all of the trenches. Divert wastewater away from ponded trenches to reserve trenches for at least one year to restore their infiltration capacity.
4. Open up septic tank, check condition of baffles, and clean off effluent filter.
5. Pump septic tank as needed. Regular pumping of a septic tank is required to restore the retention capacity of the septic tank to ensure proper functioning. Table 2 presents estimated septic tank pumping frequency.

In summary, septic tank–soil treatment systems can be simple to design and operate. In all cases, a qualified contractor is needed for installation. These installers pay careful attention to layout surveys, good job control and excavation planning, and provide as-built documentation of the installed system.

When properly sited, designed, installed, and operated, septic tank–soil treatment systems provide superior wastewater treatment at a low cost and eliminate the potential for wastewater discharge to streams. Unfortunately, in Ohio, few lots are found to be naturally suited for soil treatment systems, so their use will be limited. Other onsite wastewater treatment technologies are available, however, to match Ohio's diverse soil natural resource.

To find out more about onsite wastewater treatment systems, check the web site for the Ohio State University Soil Environment Technology Learning Lab (http://setll.osu.edu).

Other references

Slater, B., and K. Mancl. 2005. *Soil and Site Evaluation for Onsite Wastewater Treatment*. Ohio State University Extension Bulletin 905. The Ohio State University.

Mancl, K., and B. Slater. 2002. *Suitability of Ohio Soils for Treating Wastewater*. Ohio State University Extension Bulletin 896. The Ohio State University.

Mancl, K., and B. Slater. 2001. *Septic System Maintenance*. Ohio State University Extension Fact Sheet AEX 740. 4 pages.

Mancl, K. 2000. *Managing Septic Tank–Soil Absorption Systems*. Ohio State University Extension Fact Sheet AEX 752. 4 pages.

Makuch, J., and B. Sharpe. 1985. *Two Remedies for Failing Septic Systems*. Penn State University Extension Special Circular SC302.

Soil Treatment System Inspection and Maintenance Record

Owner ______________________________

Address ______________________________

County ______________________________

Permit No.		Site Plan
Permit Issued		
Date Installed		
Date Started		
Bedrooms		
Septic Tank Volume		
Number of Laterals		
Septic Tank Pumped Dates		

Inspection Date			
Inspector Name and Phone Number			
Lateral	Ponding/ Surfacing	Operating/ Resting	Inspection/ Port Cond.
1			
2			
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Comments:			

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Inspector Name and Phone Number			
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