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Rural Sewage Disposal for Individual Homes

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Some of the material in this publication is adapted from "Manual of Septic-Tank Practice," U. S. Department of Health, Education, and Welfare.

Rural Sewage Disposal

This circular has been prepared to aid and assist residents of South Dakota rural areas in providing sanitary and safe disposal for sewage and wastewater from homes.

In recent years there has been a great increase in the demand of rural families for modern homes. This is due in large measure through extension of electric and water supply service to rural areas.

Use of individual septic tank systems as a substitute for community sewers for disposal of wastes in urban areas is not recommended. Public sewers should be provided for urban areas and sewage should be treated so its discharge into natural watercourses will not be detrimental to humans, animals, plant life or aquatic growth.

The septic-tank system may provide sewage treatment and disposal for small groups of homes or for many types of establishments where larger quantities of sewage are involved than are discharged from an individual home. Lack of competent sanitary engineering advice in the development of such systems generally will lead to failures, excessive costs and a multitude of troubles.

This circular cannot present all of the results of experience gained in the design and operation of septic tank systems. The soundest advice available to anyone contemplating such a system is to obtain competent sanitary engineering consultation from an engineer licensed to practice in South Dakota. Plans and specifications for all installations should be submitted to the Division of Sanitary Engineering, State Health Department, Pierre, S. D., for review and approval prior to construction. Advice for wastewater treatment facilities for institutions, recreational areas and other establishments without access to public wastewater facilities may be obtained also from the State Department of Health.

Rural Wastewater Disposal

A sanitary wastewater disposal system is necessary to dispose of human excreta from rural homes and developments where public sewers are not available. Proper disposal of wastes is a major factor in maintaining a healthful environment in rural areas. Many communicable diseases are spread through fecal contamination of human food and water by man, various birds, animals and insects. All human wastes should be disposed of to prevent contamination of water and food.

Connection to an adequate public wastewater disposal system is the most satisfactory method of disposing of wastewater. Every effort should be made, therefore, to secure public sewer extensions, particularly in areas near organized municipalities. When numerous residences are to be served and a public sewer is not available, consideration should be given to construction of a community wastewater collection system and treatment plant. Information on development of com-

munity systems is available from the State Department of Health.

Wastes must be disposed of so that:

1. Water supplies will not be contaminated.
2. Public health hazards will not be created by allowing wastes to serve as breeding places for insects, rodents, and other possible carriers which may come in contact with food and drinking water.
3. A health hazard will not be created by allowing wastes to be accessible to children.
4. State or local regulations governing water pollution and wastewater disposal will not be violated.
5. Waters used for recreational purposes will not be polluted.
6. A nuisance resulting from obnoxious odors or unsightliness will not be caused.

Along with a safe and adequate pressure water system and adequate plumbing, a sanitary wastewater disposal system will make housework easier and provide greater comfort and convenience for the rural family. Good planning will insure the most satisfactory installation for the rural home and one which will function properly for many years.

Sewage Flows

Systems are generally designed on the basis of a sewage flow of 50 gallons per person per day or 100 gallons per bedroom. Judgment must be used in estimating present and future usage of the system. The usual design method is to use the number of bedrooms with at least two persons per bedroom. If more than two persons occupy a bedroom, or if other rooms are used for sleeping, take these factors into consideration in designing the system.

All wastes from the household, including those from the laundry, bath, and kitchen, should discharge into one system. A grease trap for kitchen wastes is not necessary. Discharge from a garbage grinder should never be passed through a grease trap but should be run directly into the septic tank. Recommended septic tank capacities are sufficient to handle the grease normally discharged from a home.

Waste brines from household water softener units have no adverse effect on the action of the septic tank, but may slightly shorten the life of a disposal field installed in certain clay-type soils. Under normal conditions, these brine wastes may be directed to the sewage disposal system.

Roof drains, foundation drains, and drainage from other sources producing large amounts of clear water should not be piped into the septic tank or absorption area. Drainage from garage floors or other sources of oily wastes should not be discharged directly into the system. Provide a grease and sand trap for such wastes prior to discharge into the septic tank.

House Sewer

The house sewer is that part of the horizontal piping extending from the foundation wall of the building to the septic tank. It should be constructed of 6-inch diameter, tight-jointed pipe of cast iron, vitrified clay, asbestos cement, plastic, concrete, or bituminous pressed fiber. Any portion of the sewer line with-

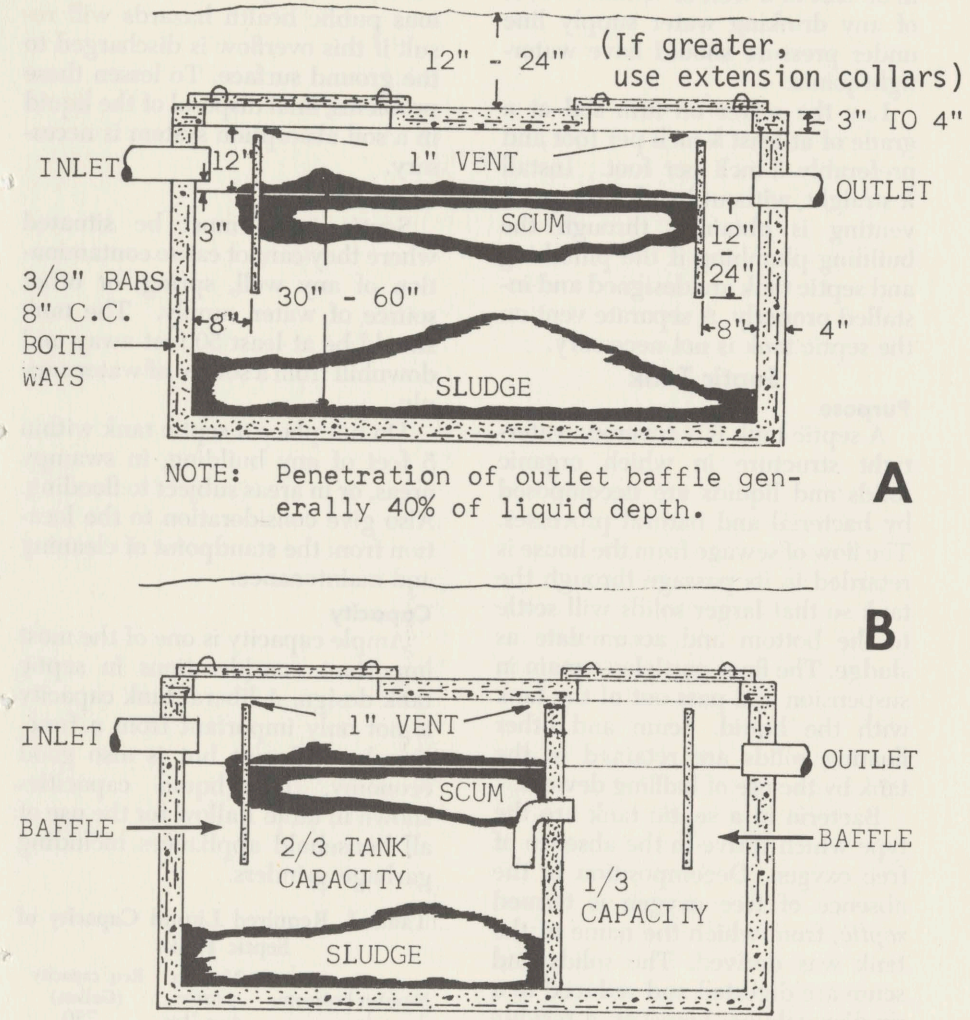


Figure 1—Typical concrete septic tanks.

A—Longitudinal section of a single compartment septic tank. Baffles shown are pre-cast concrete plank 2 inches thick. Baffles may also be of 4-inch cast-iron soil pipe, or sanitary tee branches, or 4-inch vitrified clay, or concrete tee branches, or vented elbows.

B—Longitudinal section of a two-compartment septic tank. Inlet and outlet fittings should be proportioned as for a single tank. The same allowance for space above the liquid level should be made as for single tanks.

in 50 feet of a well or within 10 feet of any drinking water supply line under pressure should have watertight joints.

Lay the sewer on firm soil at a grade of at least ⅛-inch per foot and preferably ¼-inch per foot. Install it straight, without bends. Adequate venting is obtained through the building plumbing if the plumbing and septic tank are designed and installed properly. A separate vent on the septic tank is not necessary.

Septic Tank

Purpose

A septic tank is a covered, watertight structure in which organic solids and liquids are decomposed by bacterial and natural processes. The flow of sewage from the house is retarded in its passage through the tank so that larger solids will settle to the bottom and accumulate as sludge. The finer particles remain in suspension and pass out of the tank with the liquid. Scum and other floating solids are retained in the tank by the use of baffling devices.

Bacteria in a septic tank are the type which thrive in the absence of free oxygen. Decomposition in the absence of free oxygen is termed *septic*, from which the name of the tank was derived. The solids and scum are digested and reduced to a smaller volume; however, a residue of inert solid material will remain. Space must be provided in the tank to store this residue between cleanings.

A septic tank does not provide complete sewage treatment. The overflow from the septic tank will contain large numbers of harmful bacteria and organic matter in a finely divided state or in solution. Foul odors, unsightly conditions, and serious public health hazards will result if this overflow is discharged to the ground surface. To lessen these problems, final disposal of the liquid in a soil absorption system is necessary.

Location

Septic tanks must be situated where they cannot cause contamination of any well, spring, or other source of water supply. The tank should be at least 50 feet away and downhill from a source of water supply.

Do not place a septic tank within 5 feet of any building, in swampy areas, or in areas subject to flooding. Also give consideration to the location from the standpoint of cleaning and maintenance.

Capacity

Ample capacity is one of the most important considerations in septic tank design. A liberal tank capacity is not only important from a functional standpoint but is also good economy. The liquid capacities shown in table 1 allow for the use of all household appliances including garbage grinders.

Table 1. Required Liquid Capacity of Septic Tanks

Number bedrooms	Number persons	Req. capacity (Gallon)
2 or less	4 or less	750
3	6	900
4*	8	1,000

*For each additional bedroom, add 200 gallons.

Design and Construction

Septic tanks should be watertight and constructed of corrosive-resistant materials such as concrete, coated metal, or heavyweight concrete blocks. Properly cured precast or cast-in-place reinforced concrete

tanks are universally acceptable. Prefabricated, coated metal tanks should meet Commercial Standard 177-62 of the U. S. Department of Commerce and be labeled with the Underwriters Laboratories seal. The interior of concrete block tanks should be surfaced with two ¼-inch coats of portland cement sand plaster.

Other features of properly designed and constructed septic tanks are:

- Shape of a septic tank is relatively unimportant. Generally, the length of rectangular tanks should be approximately twice the width. Circular and cylindrical tanks function as well as rectangular tanks.
- A single compartment tank will give satisfactory performance. However, a two-compartment tank with the first compartment equal to one-half to two-thirds of the total volume, provides better suspended solids removal which may be especially valuable for protection of the soil absorption system.
- Liquid depth may range between 30 inches and 60 inches.
- Provide for at least a 12-inch space between the liquid surface and the top of the tank.
- Provide an access manhole or removable cover at each end of the tank.
- The bottom of the inlet pipe should enter the tank about 3 inches above the liquid level.
- A vented inlet tee or baffle extending at least 6 inches below the liquid level is required.
- An outlet tee or baffle should extend 12 to 24 inches below the liquid level depending on the depth of the tank, or to at least 40% of liquid depth.
- Place precast tanks on a bedding of sand or pea gravel.

Typical concrete septic tanks are shown in figure 1, A and B.

Operation and Maintenance

Clean septic tanks periodically to prevent excessive accumulations of scum and sludge. If either sludge or scum approaches the bottom of the outlet device too closely, solids will be scoured into the disposal field and clog the system. When a disposal field is clogged in this manner, it is not only necessary to clean the tank, but it also may be necessary to construct a new disposal field. Septic tanks of the size recommended should give 2 to 3 years of satisfactory operation before cleaning becomes necessary. However, tanks should be inspected at least once a year.

A septic tank is usually cleaned by pumping the contents into a tank truck. Individuals who conduct a business of cleaning septic tanks are located in most areas. South Dakota law requires that these persons be licensed by the State Department of Health. All properly licensed operators are issued an annual license card which the homeowner should request to see before contracting for services. The law includes no provisions for regulating charges, and it is therefore strongly recommended that a lump sum contract price be agreed upon before any work is done. Arrangements based on costs

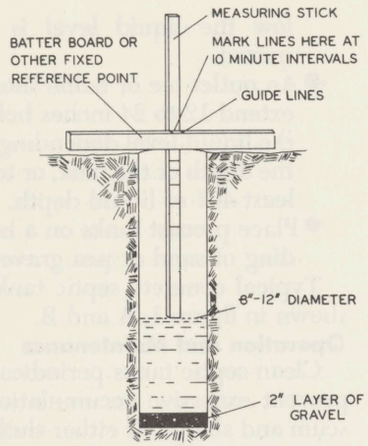


Figure 2—Soil percolation test.

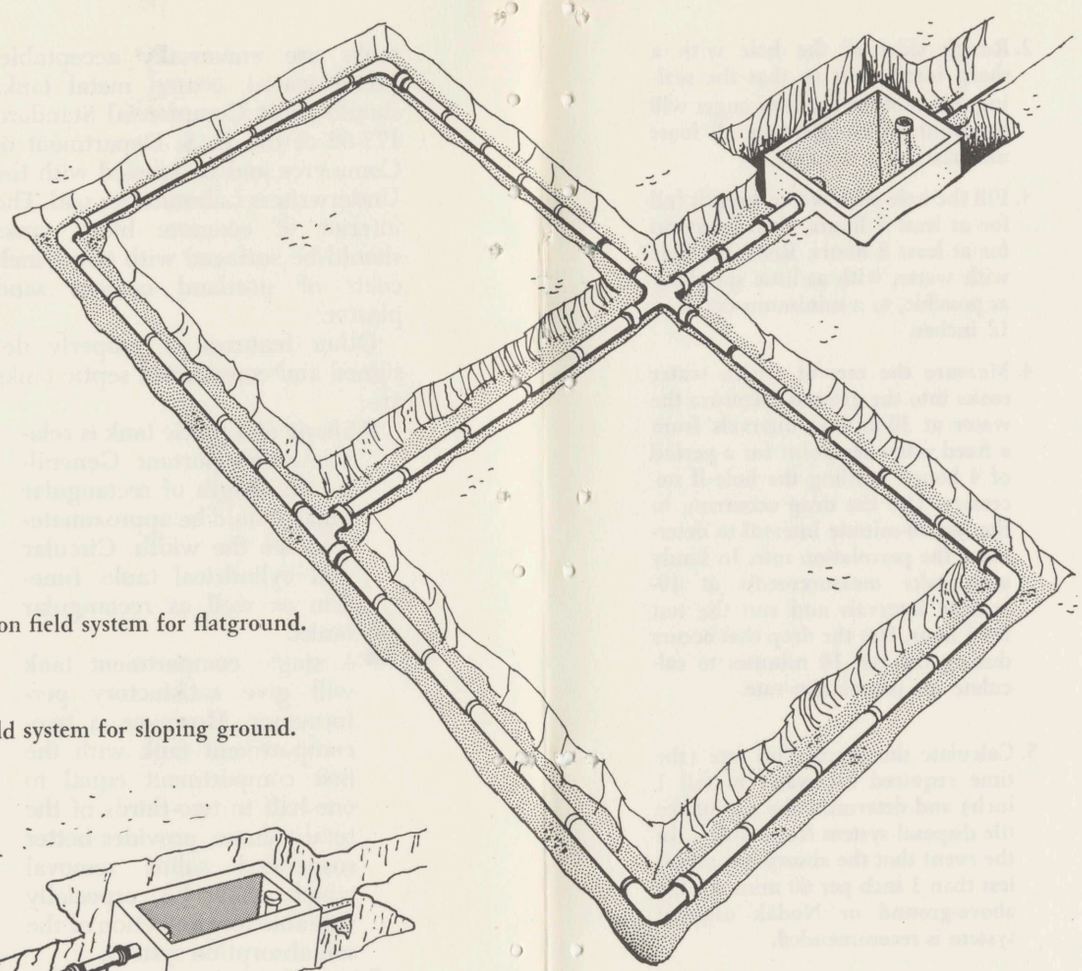
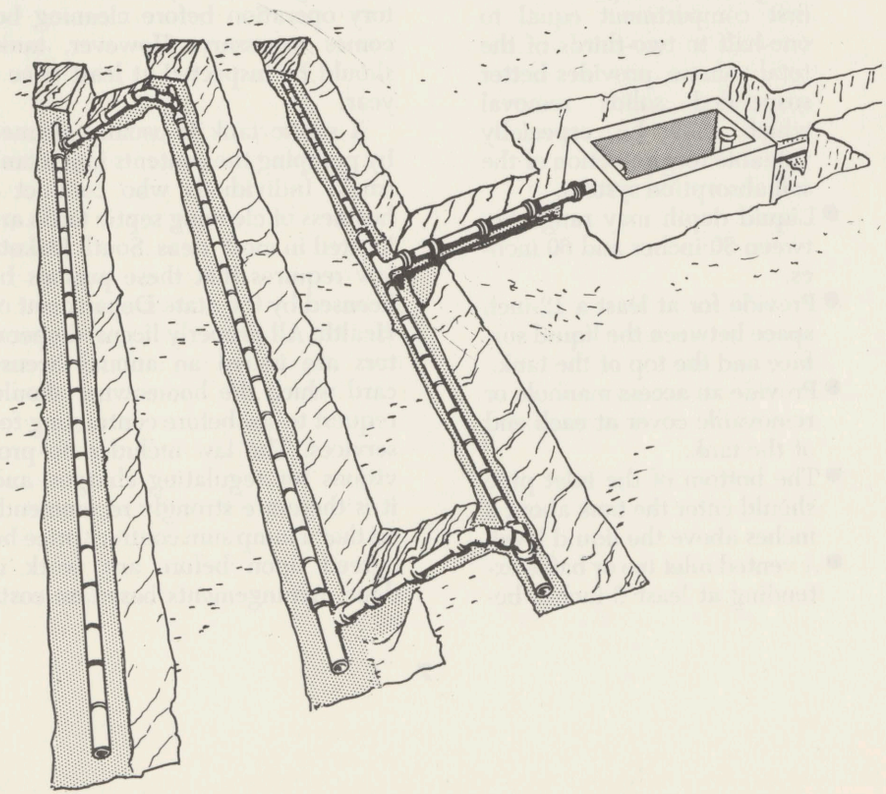


Figure 3. Closed or continuous absorption field system for flatground.

Figure 4. Serial absorption field system for sloping ground.



per pound, gallon, load, or hour should definitely be avoided.

Do not wash or disinfect septic tanks after pumping. A small residue of sludge should be left in the tank for seeding purposes.

Operation of septic tanks is not improved by addition of disinfectants or other chemicals. In general, addition of chemicals to a septic tank is not recommended. Some products on the market which claim to "clean" septic tanks, thereby eliminating the need for pumping sludge, contain sodium hydroxide (lye) or other caustic compounds. Such compounds may interfere with the biological action in the tank and eventually cause clogging of the soil disposal system although they sometimes provide temporary relief. Soaps, detergents, bleaches, drain cleaners, or other materials normally used in the household will not appreciably affect operation of a septic tank.

Over 1,000 products, many containing enzymes and other reportedly "magical" ingredients, have been placed on the market for use in septic tanks. Extravagant claims have been made for many of them. Properly controlled tests have indicated that a septic tank will operate equally as well without these products.

Tile Disposal System

Purpose

Final disposal of the effluent from septic tanks causes most of the difficulties with rural sewage disposal systems. A septic tank system, to give satisfactory service, must have an adequate final disposal system.

Effluent from a septic tank will have the appearance of water but it will not be pure. The final disposition of effluent into upper soil layers exposes it to action of aerobic bacteria. These bacteria, unlike those within the septic tank, live or are active only in the presence of oxygen. They are not sufficiently active in saturated soil or much more than 3-5 feet below the surface of the ground to be of use in treatment of effluent. Shallow tile disposal systems take advantage of the action of these bacteria, which tend to purify the effluent as it percolates through

the top layers of soil. Effluent discharged deep into the soil does not receive the benefit of this purifying action.

Suitability of Soil

The first step in design of a subsurface sewage disposal system is to determine if the soil is suitable for absorption of septic tank effluent and, if so, how much tile field is required. This data is acquired by conducting percolation tests of the site. Time required for percolation tests varies with different types of soil. The bottom of the tile field should be at least 2 feet above ground water and 5 feet above rock or impervious soil strata.

After preliminary test borings indicate that the subsoil appears suitable, make percolation tests in the proposed disposal field. Make at least two percolation tests in separate test holes. Follow this procedure in performing a soil percolation test (also see figure 2):

1. Dig or bore a hole with vertical sides having an 8- to 12-inch diameter. Depth of the test hole should be 6 inches below the proposed tile trench bottom.
2. Rough sides of the hole with a sharp instrument so that the sealing action of the spade or auger will be counteracted. Remove all loose material from the hole.
3. Fill the hole with water, keep it full for at least 4 hours, then let stand for at least 8 hours. Refill the hole with water, with as little splashing as possible, to a minimum depth of 12 inches.
4. Measure the rate at which water soaks into the ground. Measure the water at 30-minute intervals from a fixed reference point for a period of 4 hours, refilling the hole if necessary. Use the drop occurring in the last 30-minute interval to determine the percolation rate. In sandy soils, take measurements at 10-minute intervals and run the test for 1 hour. Use the drop that occurs during the last 10 minutes to calculate the percolation rate.
5. Calculate the percolation rate (the time required for water to fall 1 inch) and determine the size of the tile disposal system from table 2. In the event that the absorption rate is less than 1 inch per 60 minutes, the above-ground or Nodak disposal system is recommended.

Table 2. Absorption Area Requirements for Private Residences (Provides for garbage grinder and automatic washing machines)

Percolation rate (time required for water to fall 1 inch, in minutes)	Required absorption area, in sq. ft. per bedroom* standard trench†	Percolation rate (time required for water to fall 1 inch, in minutes)	Required absorption area in sq. ft. per bedroom* standard trench†
1 OR LESS	70	10	165
2	85	15	190
3	100	30	250
4	115	45	300
5	125	60‡	330

*In every case, sufficient area should be provided for at least 3 bedrooms.
†Absorption area for standard trench is figured as trench bottom area.
‡Unsuitable for absorption systems if over 60.

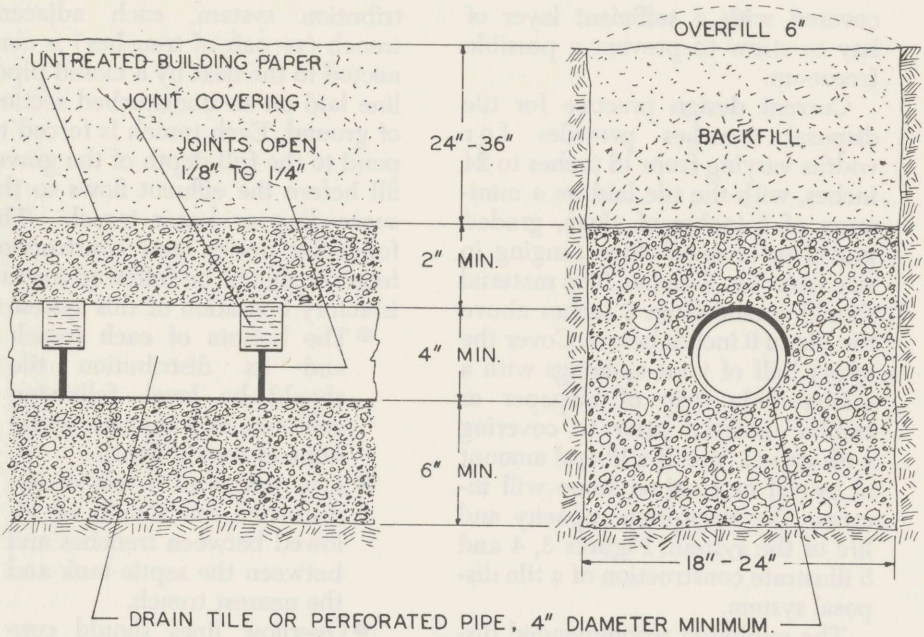


Figure 5. Cross section of absorption trench.

Location

Keep all subsurface absorption systems 100 feet from any water-supply well, 50 feet from any stream or watercourse, 20 feet from dwellings, and 5 feet from property lines. Do not construct tile fields in the vicinity of large trees or under driveways. Slopes to the south or east are preferable but not essential.

Consideration should be given to the ground contour in the absorption system area. The usual procedure is to dig trenches parallel to the contour, resulting in more uniform trench depth.

Construction

An absorption field or subsurface tile disposal system is usually constructed of 12-inch lengths of 4-inch open-joint drain tile, or perforated asphalt-impregnated fiber pipe, or perforated plastic pipe. It is placed so that flow from the septic tank will be distributed with reasonable uniformity.

Preferably, individual laterals should not be over 60 feet long, with a maximum length of 100 feet. More and shorter laterals are preferred because if something happens to disturb one line, most of the field will still be serviceable.

Construct trench bottom and tile distribution lines at a grade of 2 to 4 inches per 100 feet.

Depth of the absorption field trenches should be 30 to 48 inches in South Dakota. Freezing rarely occurs in a carefully constructed system kept in continuous operation. However, should the absorption field be constructed late in the year so that soil does not have ample opportunity to compact properly, it is recommended that the trenches be

covered with a sufficient layer of hay or straw to prevent a possible freeze-up.

Current design practice for tile disposal trenches provides for widths varying from 18 inches to 24 inches, with the tile laid on a minimum of 6 inches of clean, graded gravel or crushed stone ranging in size from ½ to 2 inches. The material should extend from 2 inches above the tile to 6 inches below. Cover the upper half of joint openings with a 4-inch wide strip of tarpaper or similar material prior to covering with gravel. Use of a liberal amount of gravel or crushed stone will increase the absorption capacity and life of the system. Figures 3, 4 and 5 illustrate construction of a tile disposal system.

The minimum recommended distance between tile disposal trenches is 6 feet.

Closed or Continuous System

In flat locations, where ground surface slope does not exceed 6 inches in any direction within the area of the absorption field, the disposal lines may be arranged in a closed or continuous system as shown in figure 3. In this system, open-jointed tile or perforated pipe is used throughout the field and the entire trench length is counted in the effective absorption area. Because of the relatively flat grade and interconnecting lines, the effluent will distribute satisfactorily.

Serial Distribution System

In situations where ground slope exceeds 6 inches in any direction in the area of the absorption field, serial distribution of the effluent is recommended. This arrangement is shown in figure 4. In the serial distribution system, each adjacent trench (or pair of trenches) is connected to the next by a closed pipeline laid on an undisturbed section of ground. Each trench is forced to pond to the full depth of the gravel fill before the effluent flows to the succeeding or lower trench. The following design and construction features should be followed for satisfactory operation of this system:

- The bottom of each trench and its distribution tile should be level, following contours to minimize variations in trench depth.
- A minimum of 6 feet of undisturbed soil should be allowed between trenches and between the septic tank and the nearest trench.
- Overflow lines should connect the trenches in such a manner that a trench will be filled with effluent to the depth of the gravel before effluent flows to the next lower trench. This may be done (see figure 4) by placing the overflow pipe invert at the top of the gravel fill.
- The overflow lines should be 4-inch, tight-joint sewer pipe, connecting directly to distribution lines in adjacent trenches. The trench for an overflow line, at the point where it leaves an absorption trench, should be dug no deeper than the top of the gravel fill in the absorption trench to assure that the overflow line will rest on undisturbed soil.
- The overflow line from an absorption trench should be as

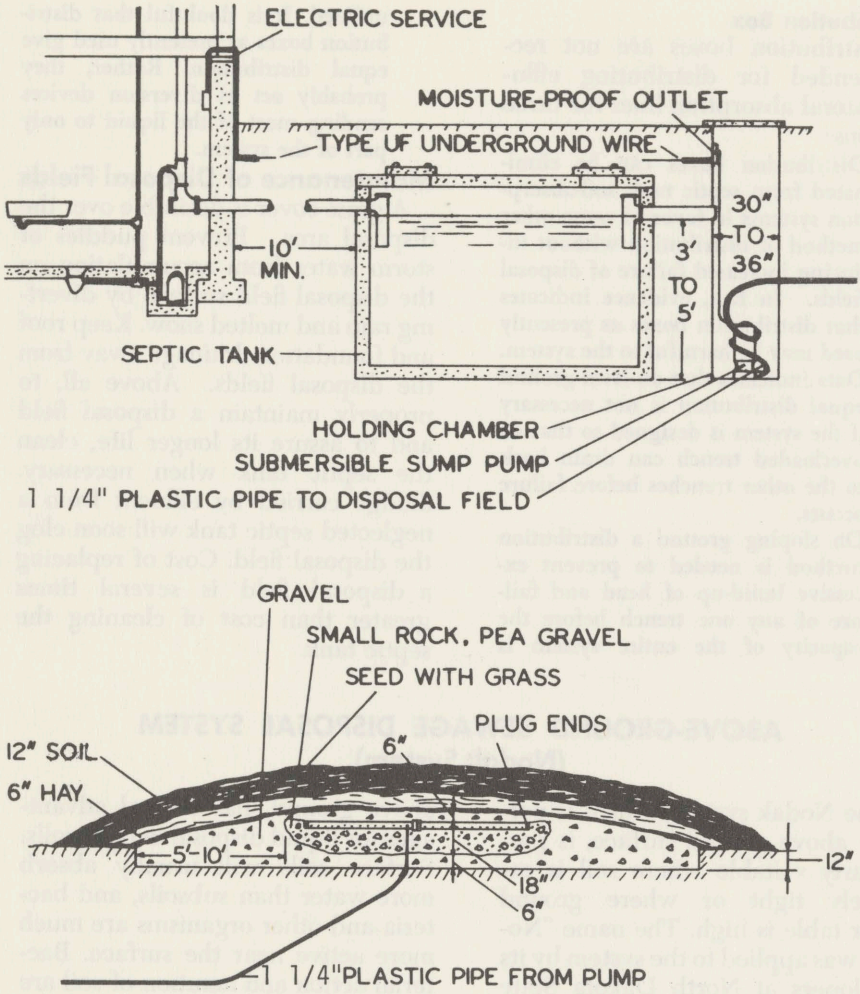


Figure 6. Above-ground disposal system.

far as practical from the inlet to that trench to prevent short circuiting of the effluent.

- The invert of the first overflow line should be at least 4 inches lower than the invert of the septic tank outlet.
- All other features should match those for subsurface absorption fields generally.

Distribution Box

Distribution boxes are not recommended for distributing effluent lateral absorption lines for three reasons:

1. Distribution boxes can be eliminated from septic tank soil-absorption systems in favor of some other method of distribution without inducing increased failure of disposal fields. In fact, evidence indicates that distribution boxes as presently used may be harmful to the system.
2. Data indicates that on level ground equal distribution is not necessary if the system is designed so that an overloaded trench can drain back to the other trenches before failure occurs.
3. On sloping ground a distribution method is needed to prevent excessive build-up of head and failure of any one trench before the capacity of the entire system is utilized. It is doubtful that distribution boxes as presently used give equal distribution. Rather, they probably act as diversion devices sending most of the liquid to only part of the system.

Maintenance of Disposal Fields

A grass cover is desirable over the disposal area. Prevent puddles of storm water from accumulating on the disposal field surface by diverting rain and melted snow. Keep roof and foundation drainage away from the disposal fields. Above all, to properly maintain a disposal field and to assure its longer life, clean the septic tank when necessary. Sludge carried by effluent from a neglected septic tank will soon clog the disposal field. Cost of replacing a disposal field is several times greater than cost of cleaning the septic tank.

ABOVE-GROUND SEWAGE DISPOSAL SYSTEM (Nodak System)

The Nodak system, which is partially above ground surface, is particularly suitable where soil is extremely tight or where ground water table is high. The name "Nodak" was applied to the system by its developers at North Dakota State University. Numerous installations of this type have been made in North Dakota and South Dakota, and reports indicate the system operates satisfactorily even under difficult soil and ground water conditions. The system may be used in any type of soil, and choice of disposal system becomes largely dependent on the relative costs of construction.

A shallow disposal field, partly above ground, has several advantages for liquid disposal in tight soils. Surface soils will usually absorb more water than subsoils, and bacteria and other organisms are much more active near the surface. Bacterial action and aeration of soil are important in decomposition of waste materials remaining in the overflow from the septic tank. Grass growing on the disposal bed will also use up part of the water by transpiration. If the disposal field does plug, it can be easily cleaned or replaced since it is shallow and readily accessible.

A conventional septic tank is required as a part of this system, as it is for all systems. The septic tank

overflow goes into a nearby holding chamber. An automatic submersible sump pump is installed in the holding chamber to pump the liquid to the final disposal field. Figure 6 shows a typical installation.

Holding Chamber

The holding chamber is usually built near the outlet of the septic tank. It should be of sufficient size to permit a man to work inside. A circular chamber should have an inside diameter of at least 30 inches. The chamber should extend from ground level to a depth about 3 feet to 5 feet below the septic tank outlet. Either concrete culverts, a poured concrete tank or a sealed concrete block chamber are all suitable construction materials.

Use extreme caution in entering a holding chamber which has been in use because of possible sewer gas accumulation. The chamber should be well ventilated, using a mechanical fan before entering. A second person should also be present to assist in any emergency.

Pump and Controls

A bronze or cast iron submersible sump pump is recommended. Do not use a standard open motor type sump pump. The submersible pump should be equipped with a dependable automatic water level switch.

Use underground Type UF wiring for the electric service to the sump pump. Provide a separate grounded circuit, properly fused. A moisture-proof convenience outlet in the holding chamber will permit easy removal of the pump.

Type and Size of Pipe

Flexible plastic pipe of 1¼-inch diameter is recommended between the pump and the final disposal field. Lay the pipe below frost level to prevent freezing, unless the pipe is placed so it will drain between pumping cycles. An extra length of plastic pipe in the holding chamber or a coupling in the discharge line will permit removal of the submersible pump from the chamber.

Disposal Field

Required size of the above-ground disposal field is shown in table 3.

Table 3. Required Size of Above-Ground Disposal Field

No. Bedrooms	No. Persons	Area Required (sq. ft.)	Dia. of Circular Field (ft.)
1	2	330	21
2	4	660	30
3	6	990	36
4	8	1320	41

The field can be round or rectangular and should have a completely flat bottom. Sink the disposal field about 1 foot into the ground to prevent seepage from around the edge.

A circular disposal field is illustrated in figure 6. Dimensions shown may be applied to all sizes of disposal fields. Construction of the disposal field will usually include the following steps (see also figure 6):

1. Excavate the bottom of the field to a depth of 1 foot. Make sure the bottom is flat.
2. Install the plastic pipe from the pumping chamber to a point at the center of the field.
3. Place 6 inches of coarse gravel on the bottom.
4. Provide a core of aggregate containing no sand, such as crushed rock, pea gravel, or small field stones (3 inches or less in diameter) to a depth of 18 inches above the gravel. The core extends

to within 5 or 10 feet of the outside edge of the field, depending on size of the field.

5. Install a 6-inch perforated distribution pipe horizontally so the top is level with the top of the core. The pipe should be slightly shorter than width of the core and plugged at both ends. For larger installations, a cross fitting with distributor pipes extending in four directions is recommended. The plastic pipe from the pump is connected to the distribution pipe or cross at the center with a tight connection using a suitable fitting.
6. Fill the remainder of the bed with coarse gravel to a depth of 6 inches above the distribution pipe.
7. Cover the entire bed with 6 to 12 inches of hay to serve as insulation and to keep the dirt cover out of the gravel and rock. Straw is not recommended.
8. Cover the entire bed with the soil excavated from the bed. This will provide a soil cover of about 12 inches.
9. Seed the bed with a short grass (such as bluegrass or crested wheatgrass) to prevent erosion and to improve appearance of the installation.

Operation and Maintenance

Little care is required of the above-ground sewage disposal system. Do not drive heavy equipment over the bed. Mow the grass periodically to prevent development of a heavy mat of dead material from developing on the field. Do not allow trees and shrubs to grow on the field, but they may be planted around the unit.

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