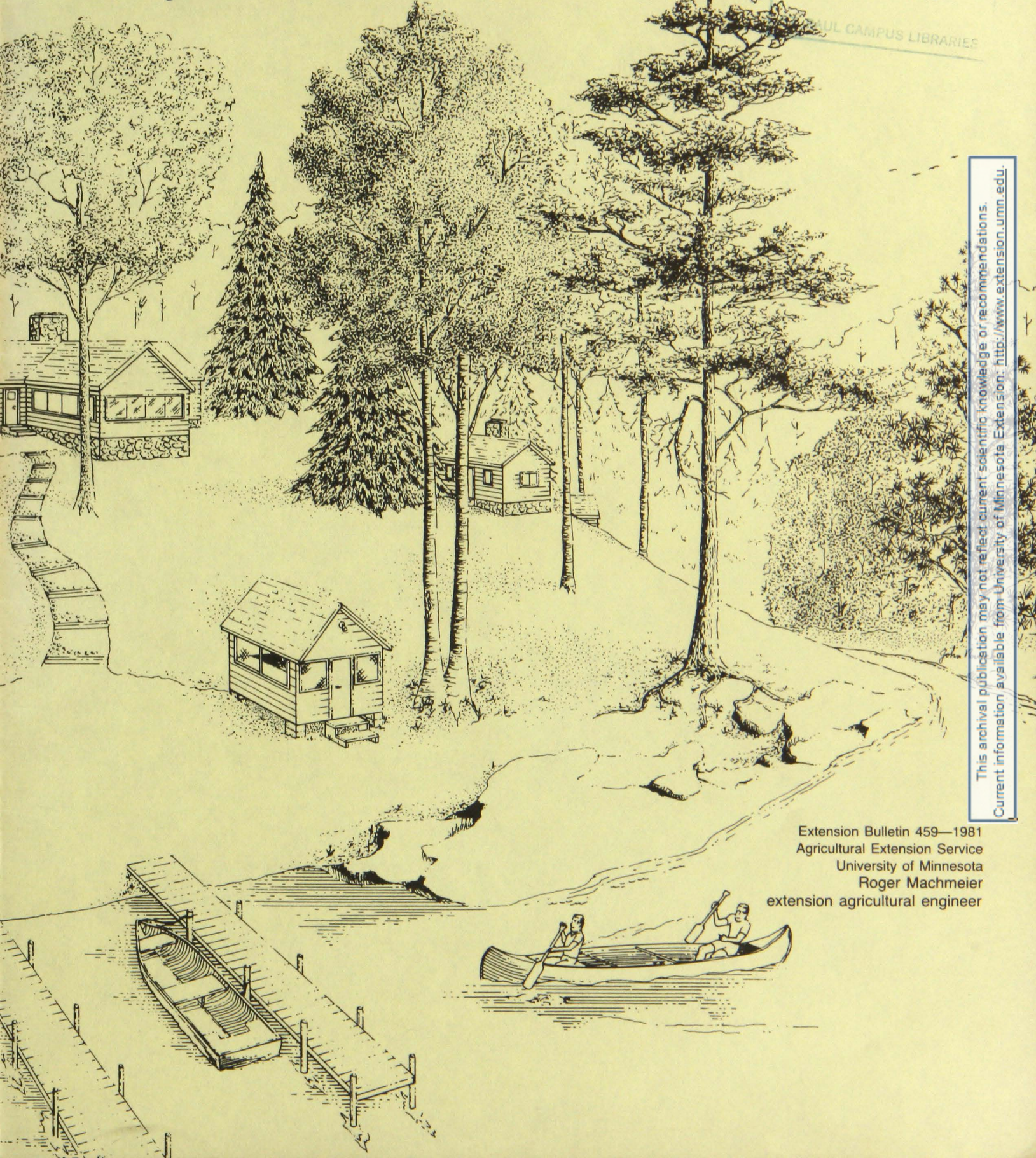


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2.1

Designing Sewage Treatment Systems for Resorts

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Designing Sewage Treatment Systems for Resorts

Contents	page
Introduction	3
Estimating Sewage Flows	3
Sizing Septic Tanks	5
Types of Soil Treatment Units	5
Designing the Soil Treatment Unit	6
Drainfield Trenches With Drop Boxes	6
Collector Sewer	7
Pumping Stations	7
Example	8
Information for a Permit	13
Operation and Maintenance	13
Appendix A	14
Appendix B	14
Estimating Sewage Flows for _____ Resort	15

This publication replaces Extension Folder 290.

Resorts with modern accommodations such as this A-frame also must have modern and adequate sewage treatment systems. This publication provides the resorter with information on proper sewage treatment system design procedures.



Introduction

Proper sewage treatment is important, to protect the public health and our valuable water resources. Raw sewage or septic tank effluent contains disease-causing organisms and cannot be discharged to the ground surface or into surface waters. Sewage also contains nutrients which fertilize lakes and streams, causing algal blooms and excessive weed growths. Even if the sewage were disinfected to kill disease-causing organisms, nutrients still are present to fertilize lakes and streams.

Equally important is the fact that a resort operator needs a dependable sewage treatment system to insure the function and quality of the resort. Few things detract more from a guest's opinion of a resort than backed-up toilets or open septic tanks and cesspools and the attendant disarray and inconvenience.

A proper sewage treatment system will function effectively and require minimum repair and maintenance. Required maintenance can be performed during an off-season or during minimum occupancy. An adequate sewage treatment system will not generate odors or inconvenience guests. However, proven guidelines must be followed in the design, installation, and maintenance of the sewage treatment system.

Resort sewage treatment systems are regulated by the Minnesota Department of Health. In some areas the Department of Health has delegated its authority to the county. Check with your local zoning office and the district sanitarian of the Minnesota Department of Health to find out how resort sewage system permits are handled in your county. Then proceed with the design of your system. To design your sewage system you will need the following information:

- a) source and amount of sewage flows
- b) nature of sewage flow; i.e., from restaurant, house-keeping cabin, campground, etc.
- c) areas available for the installation of drainfield trenches (taking into consideration setback distances from lake, water supply well, buildings, as well as plans for expansion of facilities)
- d) evaluation of soil texture and percolation rate
- e) relative elevations of the sources of sewage and where suitable soil is located (if sewage source elevation is lower than soil treatment area elevation, a pumping station will be required)
- f) the location, size, and condition of existing sewage treatment facilities if some will continue to be used as part of the total sewage system

Estimating Sewage Flows

Be sure the sewage treatment system handles only sewage wastes. Water from basement footing drains, roof drains, or other surface drains must not be allowed to enter the system.

Install water-conserving plumbing fixtures. Fine spray shower heads, low-water-use flush toilets, insulated hot water pipes, spring loaded faucets, urinals, and many other water-conserving techniques can be used without inconveniencing your guests. Be sure there are no leaky faucets or toilet valves. You can increase the efficiency and life of your sewage treatment system by minimizing water use.

To design your sewage treatment system you must measure or estimate sewage flow rates. A water meter provides the most accurate measurement of total sewage flow. As soon as you consider the installation or repair of your sewage treatment system, install a water



Many resorts have cabins located near the lake for guest accessibility and the view. In the area shown, the water table is within 2 feet of the ground surface. A pumping station should be used to transfer sewage to an area with more suitable soil.

meter and take readings at about the same time each day for at least a month. Consider the water meter a permanent installation, and use water meter readings to determine whether sewage flow rates exceed the sewage system's design capacity.

In addition to measuring the total sewage flow, you will have to estimate the amount generated at each location. If you have a meal-serving facility, also install a water meter there. The success of your sewage system design depends upon an accurate value for the amount of sewage generated. Also record the number of registered guests, restaurant patrons, and staff—including family members.

When a sewage treatment system is designed without water meter readings, an estimate must be made of the amount of sewage generated. Average figures are presented in Appendix A, but water use at your resort may be above or below the average. You also will have to estimate the number of guest days, meals served, etc. If you overestimate the sewage volume, the sewage treatment system will be oversized. Aside from the additional cost, oversizing is not necessarily bad and will provide for some expanded use of your facility. Underestimating the sewage volume will result in an

inadequately sized sewage treatment system which may lead to sewage surfacing, plumbing back-ups, and other 'failures' of the system. These 'failures' would not necessarily be due to either improper design or installation but rather to a low estimate of the sewage volume.

When estimating sewage flows, estimate the maximum daily, the maximum weekly, the maximum monthly, and the total annual. The maximum daily sewage flow is used to determine the minimum liquid volume for septic tanks.

The purpose of the septic tank is to separate solids from liquids. If the flow through the tank is too fast, proper separation cannot take place. Thus, the maximum daily sewage flow is used to select the proper septic tank size. For a given maximum daily sewage flow, the same size tank is needed to separate sewage solids regardless of the number of days per year sewage is discharged into the tank.

A properly sized soil treatment unit can handle variations in daily flow rates. Thus, an average daily sewage flow rate is used to size the soil treatment unit. For resort facilities which are open year 'round, the average daily sewage flow rate can be estimated by dividing the monthly flow rate by 30.

For seasonal resort facilities, the average daily sewage flow is estimated by dividing the total annual sewage flow by 365. Even though sewage is generated more rapidly when the resort is open, the soil treatment unit will be able to treat the sewage easily at the faster rate. It takes 12 to 18 months of continuous use before the rate of sewage flow into the soil slows down to the long-term acceptance rate which is used to design year 'round sewage treatment systems. For a seasonal facility, the soil treatment unit can dry out and recover its initial treatment capacity when no sewage is being generated.

What is a seasonal use facility? WPC-40 (6 MCAR 4.8040) of the Minnesota Pollution Control Agency defines seasonal use, "where a commercial establishment is occupied or used for less than 180 days per year and less than 120 days consecutively."

Table 1 on page 10 provides an example of how sewage flows can be estimated for a resort. A copy of this form with blank spaces for you to fill-in is provided on page 15. The estimated flow in Appendix A together with your estimate of number of guests and the type of resort facilities can be used to estimate sewage flows from your resort. Be conservative and estimate high on the use of your facilities and the amount of sewage generated.

Sizing Septic Tanks

The liquid volume of the septic tank depends on the maximum daily sewage flow rate. Never install a new septic tank smaller than 750 gallons of liquid capacity. For flows up to 1,500 gpd (gallons per day) the liquid volume of the septic tank should be 1.5 times the maximum daily sewage flow rate. For flows greater than 1,500 gpd, the minimum liquid volume should be 1,125 gallons plus 75 percent of the maximum daily sewage flow rate. However, for wastes from a restaurant or meal-serving facility, it is recommended to multiply the daily sewage flow by 2 and to use a compartmented septic tank or, preferably, multiple tanks in series to provide cooling for grease coagulation.

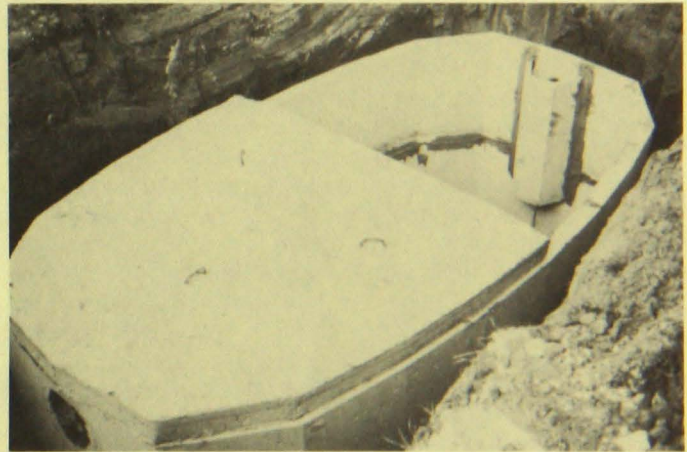
Experience with grease traps in restaurants has shown they usually are ineffective because of lack of maintenance. Also, with modern, high-temperature dishwashers, the wastewater is not cool enough for grease to coagulate in the trap. Therefore, provide additional storage volume in the septic tanks for the grease after it has coagulated. Also, minimize the amount of grease that goes into the sewage system.

Carefully consider whether you want to use a garbage grinder for kitchen wastes. The tendency with a garbage grinder is to deposit non-decomposable wastes such as bones, coffee grounds, and plastic products into the sewage system. Experience has shown that solids accumulate in the septic tank more than twice as fast when a garbage grinder is used. Also, the effluent discharging from the septic tank has more solids, which tend to plug the soil absorption system.

You can use one large septic tank for your resort. However, it is usually more suitable and economical to use a number of smaller septic tanks at the various

locations where sewage is generated. Precast concrete or fiberglass septic tanks of suitable quality usually are the most economical and commonly are available in the following sizes: 750, 1,000, 1,250, 1,500, and 2,000 gallons. A single large tank will need to be made of reinforced poured concrete or reinforced concrete block walls. The cover must be reinforced and strong enough to withstand expected surface loads. Experienced labor is required to construct a large septic tank in place. Also, the collector sewer will need to be more carefully designed and constructed to transport raw sewage than to transport septic tank effluent.

In addition to the septic tank volume for sludge storage, the tanks should have an additional volume above the outlet to provide for floating scum storage. This additional volume should be equal to 20 percent of the liquid volume. Refer to Extension Bulletin 304, *Town and Country Sewage Treatment*, for details on tank construction, baffles, manhole access, inspection pipes, and similar information.



Precast concrete septic tanks often are used in resort systems. The photo shows a 1,500-gallon tank with a two-piece cover and concrete baffles. Be sure baffles are cast with high quality, dense concrete.

Types of Soil Treatment Units

The three types of soil treatment units used in Minnesota are drainfield trenches, seepage beds, and seepage pits. Of these three, the drainfield trench does the best job of treating sewage and provides the longest service life.

Drainfield trenches, which are 2 to 3 feet wide, should be located in a grassy area where evaporation and plant use will assist in treating the sewage during summer months. The trees do not need to be removed, and the lawn can be used for other purposes. The layout of trenches is flexible. The drainfield area can be on a slope, but individual trenches must follow contours if located on sloping ground.

Seepage beds require less lawn area but have much less sidewall absorption area than trenches. Beds can't be located on slopes greater than 6 percent. Since seepage beds are wider than 3 feet, they may require tree removal. Improper construction practices can

smear or seal the bottom of the bed during construction and destroy the soil's ability to absorb effluent.

Seepage pits, often called dry wells and incorrectly called cesspools, are the least desirable soil treatment unit. The sewage effluent is placed too deep for proper filtration and often contributes to well contamination and lake eutrophication. There is no evaporation or use of effluent by plants. Seepage pits are not allowed if the soil is suitable for the installation of drainfield trenches or elevated seepage beds. Seepage pits must never be located in coarse, sandy soil that has a percolation rate faster than 0.1 minute per inch, because such soil cannot do an adequate job of filtration.

Designing the Soil Treatment Unit

The size of the soil treatment unit for your resort depends upon the average daily sewage flow and the soil texture. Appendix B presents drainfield trench and seepage bed bottom areas required to treat an average daily sewage flow of 100 gallons per day with various soil percolation rates.

The total soil treatment unit can be, but does not necessarily need to be, located at a single place. Trenches can be located near the source of sewage if the soil is suitable and if setback distances from shoreland, buildings, wells, property lines, etc. can be maintained. If not, effluent from some or all septic tanks can flow through a 4-inch sewer pipe to a watertight pumping tank of adequate size, from which it can be pumped to a soil treatment unit in a more suitable location, often at a higher elevation.

Carefully evaluate the soils in the locations proposed for the soil treatment units. Use Soil Conservation Service soil survey information if available. Look for mottled soil as evidence of seasonally saturated soil. *Never* install a drainfield trench where mottled soil is closer than 3 feet to the bottom of the trench. Refer to Extension Folder 522, *Locating On-Site Home Sewage Treatment Systems*, for soil evaluation procedures and Extension Folder 261, *How to Run a Percolation Test*, for percolation testing procedures.

Drainfield Trenches With Drop Boxes

Individual drainfield trenches connected by drop boxes are the most desirable soil treatment unit and are explained in detail in Extension Bulletin 304, *Town and Country Sewage Treatment*. With this method, effluent is distributed in a way that provides maximum effective use of all the soil treatment area and automatic resting with variable rates of sewage generation.

Septic tank effluent either flows by gravity or is pumped into the first drop box of the soil treatment unit. One outlet of the drop box connects to a watertight pipe leading to the drop box located at the head end of the next trench of the soil treatment unit. The second outlet should be located so the bottom of the outlet is at the top of the distribution pipe in the first trench. Thus, all of the treatment area of the first trench, bottom and sidewalls, is in contact with and is treating sewage



The drop box in the foreground directs effluent into the 4-inch pipe and the drainfield trench. Drop box distribution is especially effective for resorts, where sewage flow rate varies. Drop boxes allow the soil treatment unit to be easily expanded.

effluent. A drop box is installed at the head end of each drainfield trench.

The bottom of each individual drainfield trench must be level throughout its length. Also, it is desirable that trenches follow ground contours as closely as possible to maintain uniform depth. Trenches should not be excavated close enough to trees to cause serious root damage. But it is not necessary to remove trees from the drainfield trench area, because trees will use effluent. Tree roots will not plug drainfield trenches.

Shallow trenches do a much better job of treating sewage than deep ones. The ideal trench excavation depth is 24 inches. Set a drop box at the head end of each trench. Place 12 inches of clean rock, 3/4 inch to 2 1/2 inches in diameter, in the bottom of the excavation. Connect the trench distribution pipe to the drop box, laying the pipe on the rock. Then place rock around the pipe and to a depth of 2 inches over the top of the pipe. Cover the rock with 3 to 4 inches of loose hay or straw, and cover this with a layer of red rosin paper (untreated building paper). Cover the paper with 6 to 12 inches of top soil, mounding it to allow for settling. Establish a grass cover as soon as possible.

Proper construction procedures must be followed for the drainfield trenches. No matter how accurate your sewage flow estimate or how adequate your design, poor construction practices will lead to premature failure of the sewage system, possibly during the first year. Ask your local zoning administrator for a list of licensed installers. Also ask your zoning administrator or Department of Health sanitarian to inspect your sewage system *as it is being installed*.

As little as 6 inches of soil backfill over the trench rock is enough to prevent freezing, even during Minne-

sota's winters. But you must have a good grass cover and allow snow to accumulate naturally. Snow compacted by pedestrians, snowmobiles, or other vehicles will allow frost to penetrate down to the drainfield trenches, regardless of amount of soil cover.

Collector Sewer

The collector sewer line for raw sewage to a single septic tank or for septic tank effluent to a pumping station usually can be 4 inches in diameter. Plastic pipe is widely used but should be of suitable strength and quality. Also, all joints should be watertight to prevent infiltration or to prevent root penetration. It is a good idea to install a cleanout every 50 feet or so along the collector sewer line. The cleanout (as shown in figure 1) allows the sewer to be cleaned in case of obstruction. The cleanouts are more likely to be necessary on a collector line carrying raw sewage than on a line carrying septic tank effluent.

The grade or slope of the collector sewer which carries raw sewage should be no less than 1 inch in 8 feet and no more than 1 inch in 4 feet to properly transport the sewage solids. If the slope is too flat, the solids will tend to settle out because of the slow flow. If the slope is too steep, the liquids will tend to flow away from the solids, leaving them in the pipe.

There are no limits as far as the slope of a pipe carrying effluent is concerned, except that the pipe must have a downward slope and this slope must be uniform. In other words, there can be no low spots in the pipe. There is no maximum grade for a pipe carrying septic tank effluent.



A 4-inch plastic pipe with cleanouts every 100 feet will collect effluent from the septic tanks serving individual cabins. The effluent will flow to a pumping station (figure 2) for transfer to the soil treatment unit.

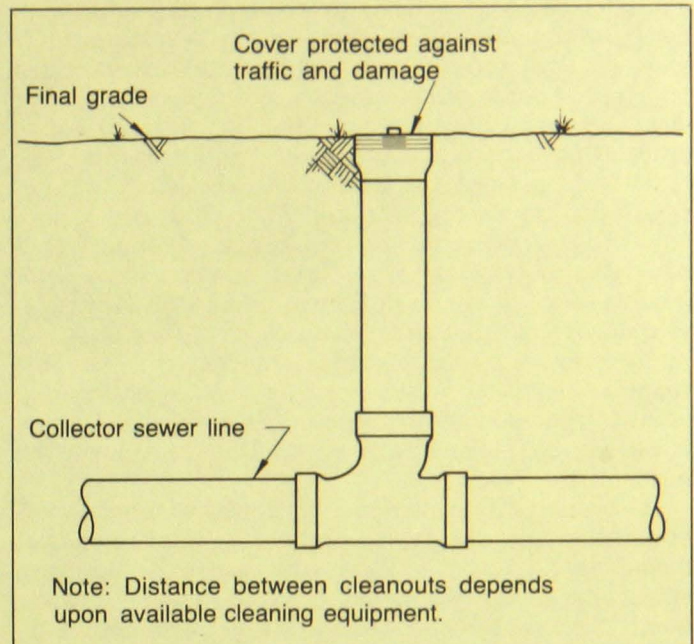


Figure 1. Cleanout for sewer line

Pumping Stations

In many cases, the location of resort facilities requires that septic tank effluent be pumped to a location where the soil is suitable for the installation of the soil treatment system.

Whenever possible, pump septic tank effluent rather than raw sewage. A septic tank will retain solids that are troublesome to pump. Even though you ask your guests not to deposit materials such as sanitary napkins and disposable diapers in the sewage system, occasionally these materials will plug a raw sewage pump. Your sewage system will be much more maintenance-free if all sewage flows through a septic tank before pumping.

If you must pump raw sewage, consult with a qualified pump company representative. A grinder pump for raw sewage requires periodic maintenance and replacement of the grinding mechanism. A sewage ejector pump must be properly selected for the pumping situation. The discharge pipe from the pump must have a large enough diameter to provide the proper flow velocity to transport the raw sewage solids.

Specifications for a pump are based on two factors, the discharge head and the discharge flow rate. Both must be specified to accurately define the pumping requirement. For most resorts, a pump capacity in the range of 20 to 25 gallons per minute will be adequate. Part of the discharge head will be the elevation difference between the liquid level in the pumping tank when the pump shuts off and the point where the sewage is discharged into the first drop box of the drainfield trench system. Measure this elevation distance accurately, since visual estimates of elevation differences are usually incorrect. Add about 10 feet to the elevation difference to allow for pipe friction losses, and use this

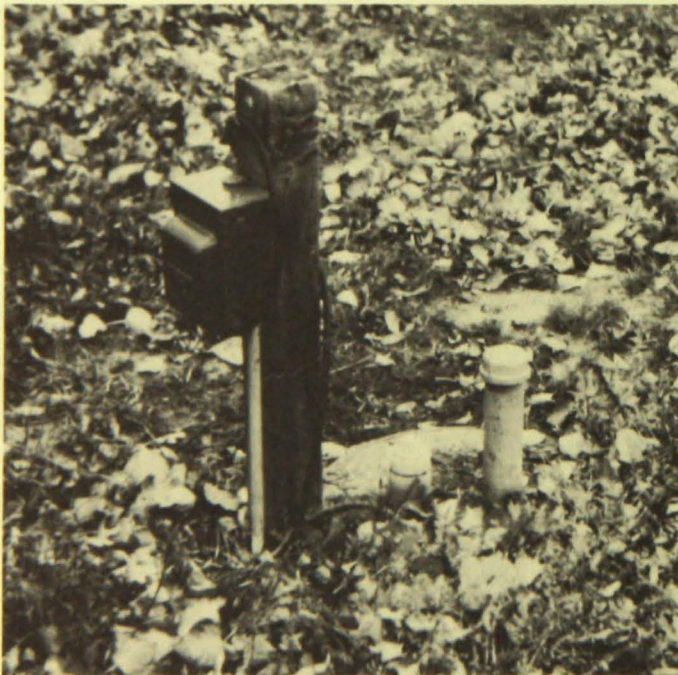
value to specify the discharge head of the pump. A 1/2-horsepower submersible sump pump is adequate for most resorts. Sump pumps are available in standard and high head models. Select the pump according to discharge head requirements. It is a good idea not to pump at a rate faster than about 50 gallons per minute (3,000 gallons per hour) so that effluent can flow out of the first drop box without any back pressure.

If most or all of the resort sewage is pumped, it is advisable to install dual pumps so that guests are not inconvenienced by pump failure. Install an alarm device on the pump control to warn of failure of either pump to operate. Also, install another alarm device on a separate electrical circuit to warn of failure of the pump circuit. If these two warning devices are utilized, there is little danger of the pump station failing to serve the needs of the resort.

Use manually-controlled sump pumps which operate with a separate switch. Experience has shown that models with a switch built into the case of the pump are subject to a high frequency of repair and/or replacement. A manually-operated pump together with a separate liquid level control has proven to be the most dependable and trouble-free.

Be sure no electrical connections or electro-mechanical devices are located in the pumping tank itself or in the manhole. The humid atmosphere and corrosive gases soon would make these devices inoperative. All electrical connections inside the tank should be soldered and covered with a waterproof connector.

The pump should be constructed of noncorrosive materials. Cast iron- or bronze-fitted pumps with stainless steel fasteners often are used for pumping sewage.



Pump station controls should be above ground in a weatherproof enclosure or a building. Never locate controls in the tank or manhole because corrosive gases and humidity will quickly make them inoperable.

The pumping station must be a watertight tank(s) with a 24-inch manhole access. However, be sure the manhole cover cannot be removed easily by your guests. The pump-out capacity of the tank should be 10 to 20 percent of the daily flow into the tank. If dual pumps are not used, a reserve tank capacity of 25 percent of the average daily sewage flow should be provided to allow time to replace the pump.

A pumping station with alternative dual pumps is shown in figure 2. The pump shut-off level should be above the top of the pump case to provide adequate pump cooling at all times. The pumps should be placed on concrete blocks above the floor of the pumping tank. The pump-out quantity is usually about one-tenth of the average daily sewage flow. Start level for the pumps is determined by using the number of gallons per foot of depth contained in the tank together with the desired number of gallons for the pump-out quantity. The procedure for calculating the pump-out depth is explained in Extension Bulletin 304, *Town and Country Sewage Treatment*.

A pump cycle counter can be a valuable accessory to the system. This electrical device advances a counter each time the pump runs. The number of pump cycles multiplied by the pump-out quantity can provide an accurate measure of the amount of effluent delivered to the soil treatment unit. Compare this quantity to the quantity estimated for design purposes.

The discharge line from the pump to the first drop box can be 2-inch diameter plastic if the distance does not exceed about 500 feet. For longer distances, the friction loss should be calculated to determine if a larger diameter pipe would be advisable. For assistance in calculating pipe sizes and pump requirements, contact your zoning office, a qualified pump company representative, or an extension agricultural engineer.

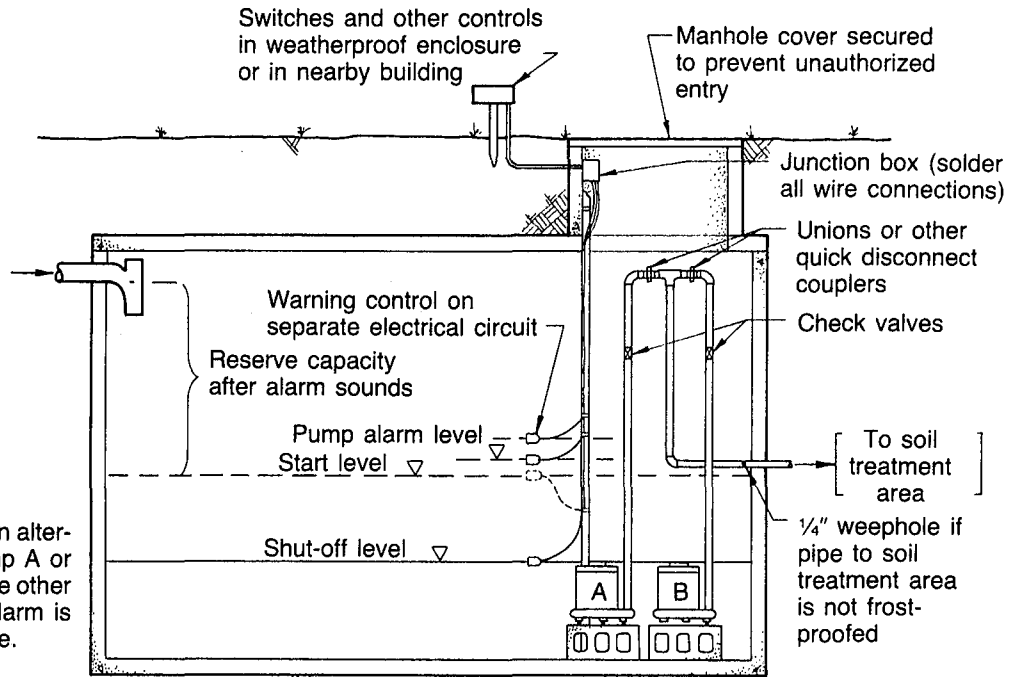
Example

An example is presented to show how to estimate sewage flows, size septic tanks, and size drainfield trenches for the resort shown in figure 3. Cabins 1, 2, 3, and 10 are housekeeping, and cabins 4, 5, 6, 7, 8, and 9 are American plan. The lodge has rooms for eight guests, a restaurant, bar, resort laundry facility, and the family residence. A 20-site campground also is part of the resort.

The guest capacity of the cabins is listed on table 1, which is used to estimate sewage flows. From Appendix A, guests in a housekeeping cabin use 60 gpd (gallons per day) and motel guests (American plan) use 50 gpd. The maximum daily sewage flow is obtained by multiplying the guest capacity by the estimated sewage flow per guest. These values are calculated and entered in the first column.

The lodge serves 200 meals maximum per day. These are the American plan guests plus some guests from the housekeeping cabins and some campers. Estimating a sewage flow of 5 gallons per meal served, this is a total of 1,000 gpd. The bar has 20 seats, and the estimated sewage flow is 5 gallons per seat for a total of 100 gpd.

Figure 2. Pumping station with dual pumps



Note: Pumps A and B operate on alternate cycles. If either pump A or pump B fails to operate, the other pump operates and an alarm is actuated to warn of failure.

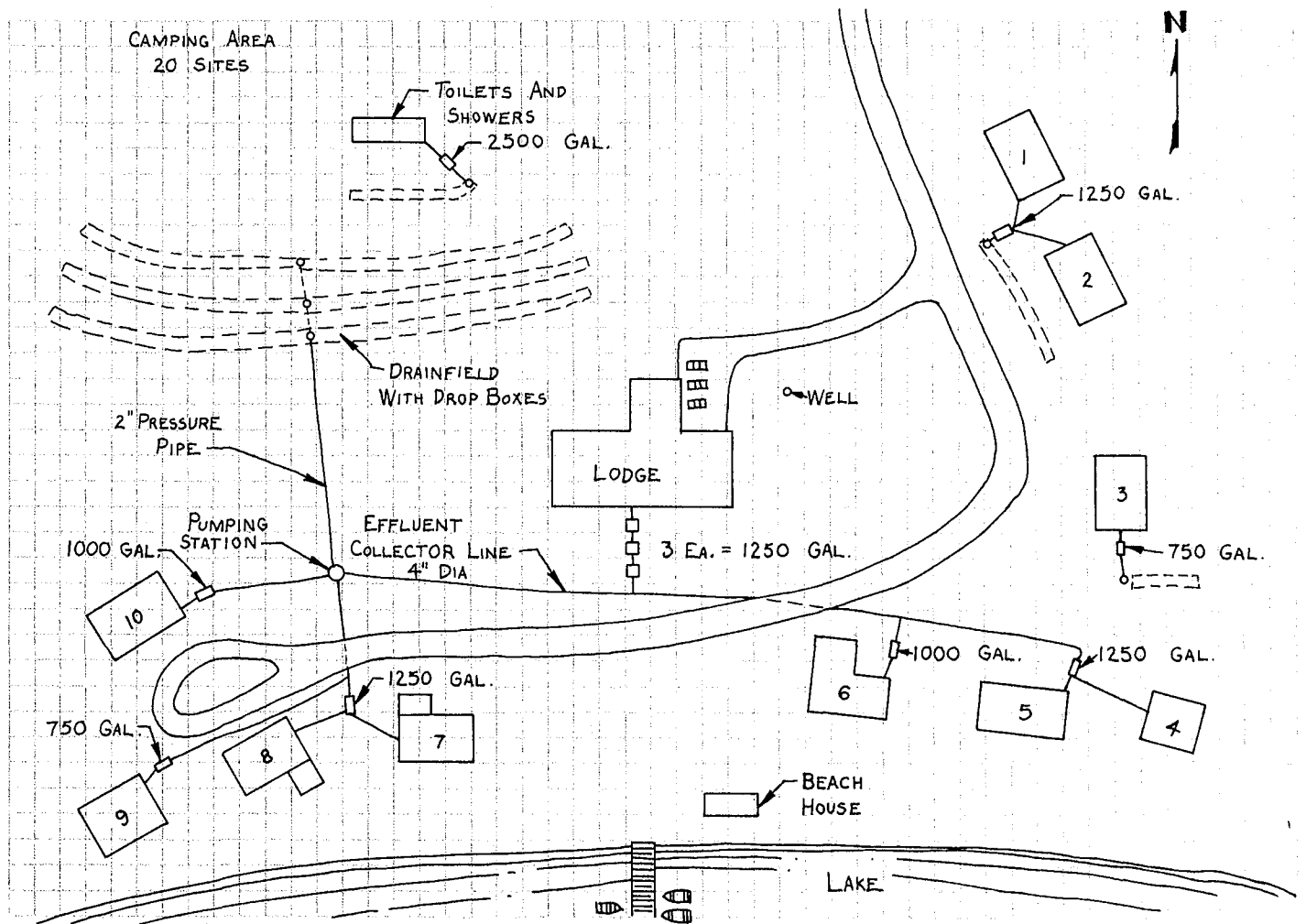


Figure 3. Sketch of resort with sewage system

Public toilets are located in the lodge, but the estimates of sewage flow for meals served and the bar include toilet wastes, so no extra sewage flow will be added for the toilets.

Each of the eight lodge guests is estimated to use 50 gallons per day for a total of 400 gpd.

The resort laundry washes five loads per day at the maximum. Guests are not allowed to use the laundry. The specification on the automatic laundry shows a water use of 75 gallons per load.

The family of four lives in part of the lodge and maintains a year 'round residence. Even though they

eat meals in the restaurant during the season, a sewage flow of 75 gallons per family member or 300 gpd will be estimated.

The 20-site campground is strictly seasonal. A sewage flow of about 75 gpd per site is assumed for a maximum daily flow of 1,500 gallons. There may be other sewage sources such as staff residences, sanitary dump station, fish cleaning house, etc. Estimates of sewage flow will have to be made for each source of sewage.

Table 1. Estimating sewage flows

Source of sewage		Maximum daily	Maximum weekly	Maximum monthly	Total annual
Cabin number or name	Guest capacity				
<u>1</u>	<u>6</u> × <u>60</u> = <u>360</u>	<u>360</u>	<u>2520</u>	<u>7560</u>	<u>22680*</u>
<u>2</u>	<u>8</u> × <u>60</u> = <u>480</u>	<u>480</u>	<u>3360</u>	<u>10800</u>	<u>32400*</u>
<u>3</u>	<u>4</u> × <u>60</u> = <u>240</u>	<u>240</u>	<u>1680</u>	<u>5040</u>	<u>15120*</u>
<u>4</u>	<u>4</u> × <u>50</u> = <u>200</u>	<u>200</u>	<u>1400</u>	<u>5600</u>	
<u>5</u>	<u>10</u> × <u>50</u> = <u>500</u>	<u>500</u>	<u>3500</u>	<u>14000</u>	
<u>6</u>	<u>12</u> × <u>50</u> = <u>600</u>	<u>600</u>	<u>4200</u>	<u>16800</u>	
<u>7</u>	<u>8</u> × <u>50</u> = <u>400</u>	<u>400</u>	<u>2800</u>	<u>11200</u>	
<u>8</u>	<u>8</u> × <u>50</u> = <u>400</u>	<u>400</u>	<u>2800</u>	<u>11200</u>	
<u>9</u>	<u>6</u> × <u>50</u> = <u>300</u>	<u>300</u>	<u>2100</u>	<u>8400</u>	
<u>10</u>	<u>10</u> × <u>60</u> = <u>600</u>	<u>600</u>	<u>4200</u>	<u>12600</u>	<u>37800*</u>
Total Lodge:					
Restaurant					
<u>200</u> seats × <u>5</u> = <u>1000</u> meals		<u>1000</u>	<u>7000</u>	<u>24500</u>	
Bar and lounge					
<u>20</u> seats × <u>5</u> = <u>100</u>		<u>100</u>	<u>500</u>	<u>2000</u>	
Public toilets					
uses × =					
Rooms					
<u>8</u> guests × <u>50</u> = <u>400</u>		<u>400</u>	<u>2800</u>	<u>10000</u>	
Laundry					
<u>5</u> loads × <u>75</u> = <u>375</u>		<u>375</u>	<u>750</u>	<u>3000</u>	
Family residence:					
<u>4</u> people × <u>75</u> = <u>300</u>		<u>300</u>	<u>2100</u>	<u>8400</u>	
Total lodge		<u>2175</u>			
Campground:					
<u>20</u> sites × <u>75</u> = <u>1500</u>		<u>1500</u>	<u>10500</u>	<u>3200</u>	<u>96000*</u>
Other:					
Staff residences					
Sanitary dump station					
Fish cleaning house					
etc.					
Totals		<u>7755</u>	<u>52210</u>	<u>183100</u>	
Average daily sewage flow		<u>7755</u>	<u>7460</u>	<u>6105</u>	

*seasonal facilities

DETERMINING AVERAGE DAILY SEWAGE FLOWS

An example of estimating sewage flow is presented in table 1. The average daily sewage flow is used to size the soil treatment unit. For year 'round facilities, the monthly sewage flow is divided by 30, and for seasonal facilities the total annual flow is divided by 365.

An intermediate step in determining the maximum weekly flow is helpful in estimating sewage flows. For the cabins, the maximum daily flow is multiplied by 7 days to obtain the maximum weekly flow.

The same is true of the restaurant, as meals are served regularly during the week. A restaurant catering more to the general public might have a smaller number of meals served per day during the week than on weekend days.

The bar reflects weekend use, and the total weekly flow is estimated as 500 gallons even though the maximum daily flow is 100 gallons.

A busy week will have all the lodge guest rooms occupied, and the daily flow of 400 gallons is multiplied by 7 days for a total of 2,800 gallons.

The laundry is not used every day. Although a maximum of five loads might be washed in a single day, 10 loads would be the weekly maximum. Therefore, the maximum weekly flow for the laundry is 10 times 75 gallons per load or 750 gallons.

The 300 gpd estimated for the family residence will be multiplied by 7, as will the daily campground flow of 1,500 gallons. These values are 2,100 and 10,500 gallons and are entered in the 'maximum weekly' column of the table.

To estimate the maximum monthly flow, information must be available on the facilities and operation of the resort. In the example, experience has shown that the housekeeping cabins 1, 2, 3, and 10 rent last and are occupied an average of 3 weeks per month. For these cabins, the monthly flow rate is determined by multiplying the weekly flow rate by 3.

All American plan cabins are full during the peak season. The weekly sewage flows are multiplied by 4 to obtain the monthly flows.

The restaurant usually does not serve meals at the maximum weekly rate throughout a full month. The weekly sewage flow rate will be multiplied by 3.5 to obtain the monthly flow of 24,500 gallons. The bar and lounge tend to be used about the same each week during the busiest months, and the weekly flow of 500 gallons will be multiplied by 4.

The lodge guest rooms likely will not be occupied full time during the month, and the monthly maximum sewage flow is estimated as 10,000 gallons.

The laundry sewage flow will be about the same each week, and the weekly flow of 750 gallons will be multiplied by 4 to obtain 3,000 gallons.

The family residence sewage flow will be assumed to continue full time for a total of 8,400 gallons per month.

The campground normally is not totally full all month, and the monthly sewage flow rate is estimated as 32,000 gallons.

A blank form for you to estimate sewage flows from your resort is provided on page 15.

SEPTIC TANK SIZING

Septic tanks can be located at each point where sewage is generated, or several sources can be combined to flow into a separate tank. Maximum daily sewage flows are used to size the septic tanks, as shown in table 2.

Cabins 1 and 2 are located together, and their sewage can flow into a single tank. The maximum daily sewage flow of the two cabins is 840 gallons, which when multiplied by 1.5 results in 1,260 gallons of required tank capacity. A 1,250-gallon size is available from the local precast tank manufacturer, and this size will be selected.

Cabin 3 is located away from the other cabins and will have its own septic tank. Even though the sewage flow is only 240 gpd, which when multiplied by 1.5 is 360 gallons, a minimum size septic tank of 750 gallons must be selected.

Cabins 4 and 5 are American plan and have a combined daily sewage flow of 700 gallons. Multiplying 700 by 1.5 results in 1,050 gallons, and a 1,250-gallon septic tank will be selected.

Cabin 6 is for 12 American plan guests and has an estimated daily sewage flow of 600 gallons. A minimum size of 900 gallons (600 x 1.5) is required, and a 1,000-gallon tank will be selected.

Cabins 7 and 8 have a combined flow of 800 gpd and require a 1,200-gallon (800 x 1.5) septic tank. A 1,250-gallon tank will be selected.

Cabin 9 has an estimated daily sewage flow of 300 gallons and will require a minimum size septic tank of 750 gallons.

Cabin 10 will need a 1,000-gallon septic tank for the 600 gpd estimated sewage flow.

The total sewage flow of 2,175 gpd from the lodge includes the restaurant, bar, guest rooms, laundry, and family residence. For estimated sewage flows above 1,500 gpd, use the formula 1,125 gallons plus 0.75 times the daily flow. For the 2,175 gpd from the lodge, 1,000 gpd is from the restaurant and 1,175 gpd from the other facilities. To determine septic tank size, the restaurant flow of 1,000 gpd should be multiplied by 2 and the 1,175 gpd multiplied by 1.5 to obtain a total septic tank liquid volume of 3,762 gallons. Select three 1,250-gallon tanks and connect them in series for a total tank capacity of 3,750 gallons.

Table 2. Septic tank sizes

Source of sewage	Maximum daily flow, gallons	Minimum liquid volume, gallons	Selected size, gallons
Cabins 1 and 2	840	1260	1250
Cabin 3	240	750	750
Cabins 4 and 5	700	1050	1250
Cabin 6	600	900	1000
Cabins 7 and 8	800	1200	1250
Cabin 9	300	750	750
Cabin 10	600	900	1000
Lodge	2175	3762	3750
Campground	1500	2250	2500

The campground is estimated to generate 1,500 gallons of sewage per day from the central toilet and show buildings. In this case using either formula will result in a minimum tank size requirement of 2,250 gallons. Two 1,250-gallon tanks will be selected. However, a 1,250- and a 1,000-gallon tank in series also would provide the required liquid capacity.

SIZING THE SOIL TREATMENT UNIT

Parts of the facilities of the resort shown in figure 3 are seasonal, and part are open year 'round. Cabins 1, 2, 3, and 10 are not winterized and are rented only during the summer months. The same is true of the campground. The total annual sewage flow for these seasonal facilities is estimated to be three times the monthly flow as shown in table 1.

Adequate lawn area and suitable soil are present near cabins 1 and 2. The percolation rate of the soil is measured at 20 minutes per inch. The total annual flow of 22,680 gallons for cabin 1 is divided by 365 to obtain the average daily sewage flow to be used for sizing the soil treatment system, 62 gpd. Appendix B shows that 134 square feet of trench are required for 100 gpd, if 12 inches of rock are placed below the distribution pipe. Thus, for an average daily sewage flow of 62 gallons, the required trench bottom area is $62 \times 134/100 = 83$ square feet (see table 3).

Following the same procedure for cabin 2 results in a trench bottom area requirement of 119 square feet. The total trench bottom area for cabins 1 and 2 is $83 + 119 = 202$ square feet, which can be obtained with 67 feet of 3-foot-wide trench. Additional lawn area is available near cabins 1 and 2 to expand the system size if required at a later date.

Cabin 3 has an estimated annual sewage flow of 15,120 gallons or an average daily sewage flow of 41 gallons. The percolation rate of the soil is 35 minutes per inch, and, from Appendix B, 160 square feet of trench bottom are required for 100 gpd. The trench bottom area required for 41 gpd is $41 \times 160/100 = 66$ square feet. This is 22 feet of 3-foot-wide trench, which will be located near cabin 3.

Cabins 4, 5, 6, 7, 8, and 9 are rented all year. Therefore, the total monthly sewage flow of 67,200 gallons from these cabins is divided by 30 to obtain the average daily flow of 2,240 gallons. The septic tanks will connect to a sewage collector line leading to a pumping tank. Effluent will be pumped to a location where the percolation rate is 4 minutes per inch. With this soil, 66 square feet of trench bottom area is required to treat 100 gpd. A total of 1,480 square feet is required to treat 2,240 gpd ($2,240 \times 66/100$).

Cabin 10 is seasonal, but the septic tank effluent will flow to the pumping station. The total annual flow of 37,800 gallons divided by 365 results in an average daily flow of 104 gallons. A total of 69 square feet of trench bottom area is needed ($104 \times 66/100$).

The monthly sewage flow from the lodge facilities, including the family residence, is 47,900 gallons or an average daily sewage flow of 1,597 gallons. Since the effluent will be pumped to an area where the soil percolation rate is 4 minutes per inch, 1,054 square feet of trench bottom area is required for the lodge sewage wastes.

The total bottom area of the drainfield trenches which will receive pumped effluent is $1,480 + 69 + 1,054 = 2,603$ square feet. This is 868 lineal feet of 3-foot-wide trench having 12 inches of rock placed beneath the distribution pipe. The drainfield trench sys-

Table 3. Soil treatment area requirements*

Source of sewage	Maximum monthly sewage flow, gallons	Total annual sewage flow, gallons	Average daily sewage flow, gallons	Trench bottom area, sq. ft.
Cabin 1 (20 MPI)		22,680	62	83
Cabin 2 (20 MPI)		32,400	89	119
Cabin 3 (35 MPI)		15,120	41	66
Cabin 4	5,600			
Cabin 5	14,000			
Cabin 6	16,800			
Cabin 7	11,200			
Cabin 8	11,200			
Cabin 9	8,400			
Total (4 MPI)	67,200		2,240	1,480
Cabin 10 (4 MPI)	37,800		104	69
Lodge (4 MPI)	47,900		1,877	1,240
Campground (3 MPI)		96,000	263	175

*trenches using 12 inches of rock below the distribution pipe

tem should use drop boxes with the effluent pumped to the highest drop box. (Note that 2,603 is not the correct area for a seepage bed.)

The pumping station will receive 127,700 gallons per month (67,200 + 12,600 + 47,900) during the summer season. This is the sewage flow from cabins 4, 5, 6, 7, 8, 9, and 10 together with the lodge and is an average flow of 4,260 gallons per day. Assuming a pump-out capacity of approximately 10 percent of the average daily flow, about 500 gallons will be pumped to the drainfield per pump cycle. Dual pumps will be used on alternating cycles so that each pump will operate four to five times per day. This will provide for satisfactory pump life and also continuous operation of the sewage system in case one pump fails. Since dual pumps are used, relatively little reserve capacity need be provided in the pumping tank. In this case a 1,250-gallon septic tank will be used with the inlet near the top of the tank, resulting in another 20 percent of volume (reserved for scum storage in a septic tank), for a total volume of about 1,500 gallons. An alarm on an electrical circuit separate from the pumps will be installed to warn of electrical failure of the pump circuit. Since the lift is only 10 feet, two 1/3-horsepower submersible sump pumps, each of which discharges at a rate of 1,500 gallons per hour, will be used. A sequencing control will operate the pumps on alternate cycles.

The seasonal campground has an estimated annual sewage flow of 96,000 gallons for an average daily flow of 263 gallons. The soil has a percolation rate of 3 minutes per inch, and, from Appendix B, 66 square feet of trench bottom area is required for 100 gpd. Thus, 175 square feet of trench bottom area is needed for 263 gpd (263 x 66/100). This could be a separate drainfield trench, 3 feet wide and 90 feet long; or, if elevations are suitable, the septic tank effluent might flow by gravity to the large drainfield, which would need to be increased in size to provide for the added sewage.

A tabulation of the required soil treatment areas is presented in table 3.

Information for a Permit

To obtain a permit for a resort sewage treatment system, the following information will be required:

1. a sketch of the resort, roughly to scale, showing the relative locations of lodge, cabins, lake, water supply well, and other facilities (similar to the example in figure 3)
2. amount and source of sewage wastes, either estimated or measured by meter
3. size and location of all septic tanks
4. size and location of pumping station, if required
5. size and location of soil treatment unit(s)
6. specifications on trench construction, effluent collector lines, pumping stations, drop boxes, and similar items

Specifications mentioned in point #6 also are needed for the contractor and helpful if presented to the local zoning office and the Minnesota Department of Health. Such specifications can be developed by referring to this

publication and to Extension Bulletin 304, *Town and Country Sewage Treatment*. Your local zoning office and local septic system installer may also provide valuable assistance.

Operation and Maintenance

Now that you have a properly designed and installed sewage treatment system approved by all of the government agencies involved, many years of successful sewage treatment should result if you provide adequate maintenance. Septic tanks are really settling tanks in which bacterial action takes place. The amount of accumulated solids, sludge on the bottom and scum on the top, depends upon the nature of the raw sewage and how much sewage flows into the tank. For example, a septic tank serving a resort cabin which has minimum housekeeping facilities and is open seasonally would likely accumulate very few solids. Such a tank may not need pumping for removal of the accumulated solids more often than every 5 or 10 years. However, it is excellent preventive maintenance to check the septic tank annually to determine the rate of solids accumulation. Keeping a record of each septic tank, its location, and service record is helpful information to assure the continuing successful operation of your sewage maintenance system.

A septic tank which receives the sewage wastes from a restaurant will experience a much more rapid accumulation of solids. For restaurants it is a good idea to utilize septic tanks in series to provide cooling and coagulation of cooking fats. Thus, the first septic tank will experience the fastest accumulation of sludge in the bottom, and the second or third tank may accumulate more floating scum in the form of coagulated cooking fats. In any event, the solids accumulation in each of the tanks should be periodically measured and removed as necessary. Refer to Extension Bulletin 304, *Town and Country Sewage Treatment*, for more details on septic tank maintenance.

The question often is asked whether septic tanks for a seasonal resort should be pumped in the fall. An empty concrete tank underground will experience greater forces from the frozen soil around it, and the soil will likely freeze to greater depths if the tank is empty. Thus, it is better for the physical strength of the tank to leave the liquid in the tank during the winter months. However, local road restrictions on load limits often mean that the septic tanks cannot be pumped in the spring prior to the resort opening. Possibly the best compromise would be to have the tanks pumped near the end of the resort season and then add enough sewage or water to fill them prior to closing down for the winter.

If there is a pump station in your sewage treatment system, this should periodically be checked to be sure it is operating properly. The amount of checking depends upon how many safety controls or warning devices were installed. A pump station with alternating dual pumps with an alarm mechanism together with another alarm mechanism on a separate electrical circuit likely will need very little inspection, since any failure of this



An inspection well at the end of each drainfield trench allows you to quickly evaluate whether sewage effluent is flowing into the trench. The inspection well can be 4-inch plastic, extending to the ground surface and capped.

system will automatically be reported. A pump station with a single pump and another standby pump located in a maintenance building should be checked periodically. The alarm circuit and alarm mechanism should be checked to see that it is operative in the case of pump failure. The standby pump also should be kept in operating condition and available for instant replacement should the operating pump fail. Some resort owners delegate this responsibility to a sewage system contractor or local pump dealer who is available on 24-hour call during the resort season.

The soil absorption system requires very little maintenance. Access to drop boxes or the use of inspection wells at the end of each drainfield trench provide information as to how much of the soil treatment system is being utilized. It is a good idea to make an inspection of liquid levels in the various drainfield trenches late in the resort season during some weekend when the resort is occupied to near maximum capacity. An evaluation of the soil absorption system at this time will give an indication of the capacity being utilized and the additional capacity available.

Keep a record of the information which you have collected on your sewage treatment system. It also is advisable to have a record of the size and location of all parts of the sewage treatment system. With this information you will be able to easily locate the various parts of the system and determine if the system requires servicing.

A properly designed, installed, and maintained sewage treatment system should provide trouble-free service and protection of our ground and surface waters.

Appendix A. Estimates of sewage flows

Event	Gallons of sewage
Housekeeping cabins	60 per guest
Motels and hotels (assume 2 persons per room)	
With private bath	50 per guest
Without private bath	40 per guest
Add for laundry	10 per guest
Add for kitchenettes	10 per guest
Restaurants, including toilet and kitchen wastes	
24 hours	40 per seat
18 hours	30 per seat
12 hours	20 per seat
Each meal served	5 per seat
Boarding house (with food service)	50 per guest
Add for kitchen waste for nonresident boarders	10 per guest
Travel trailer parks	
With individual waste and sewer hookups	100 per space
With central toilet and showers	75 per space
Sanitary dump station (per site without sewer hookup)	10 per site
Mobile home parks	225 per space
or	75 per person
Picnic parks	
Toilet wastes only	5 per person
Beaches with bath houses, showers, lavatories, toilets	10 per person
Single-family dwellings (use 2 persons per bedroom)	75 per person
Multiple family dwellings or apartments	75 per person
Children's camps, central toilet and bath,	50 per child
Day camps, no meals served	10 per camper

Appendix B. Drainfield trench and seepage bed bottom areas for a sewage flow of 100 gallons per day

Percolation rate, minutes per inch ^a	Seepage bed bottom area, square feet	Drainfield trench bottom area, square feet		
		Inches of rock below the distribution pipe		
		12	18	24
Faster than 0.1	Use alternative system design for adequate sewage treatment ^b			
0.1 to 5	83	66	55	50
6 to 15	127	102	84	76
16 to 30	167	134	110	100
31 to 45	200	160	132	120
46 to 60	220	176	145	132
Slower than 60	Use alternative system design for adequate sewage treatment ^b			

^aFor procedure on percolation testing see Extension Folder 261, *How to Run a Percolation Test*.

^bFor alternative soil treatment units see Extension Bulletin 304, *Town and Country Sewage Treatment*.

Estimating sewage flows for _____ Resort

Source of sewage		Maximum daily	Maximum weekly	Maximum monthly	Total annual
Cabin number or name	Guest capacity				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
_____	_____ x _____ = _____				
Total					
Lodge:					
Restaurant					
_____ seats	x _____ = _____				
_____ meals	x _____ = _____				
Bar and lounge					
_____ seats	x _____ = _____				
Public toilets					
_____ uses	x _____ = _____				
Rooms					
_____ guests	x _____ = _____				
Laundry					
_____ loads	x _____ = _____				
Family residence:					
_____ people	x _____ = _____				
Total lodge					
Campground:					
_____ sites	x _____ = _____				
Other:					
Staff residences					
Sanitary dump station					
Fish cleaning house					
etc.					
Totals					
Average daily sewage flow					

*seasonal facilities (denote with an asterisk on form)

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