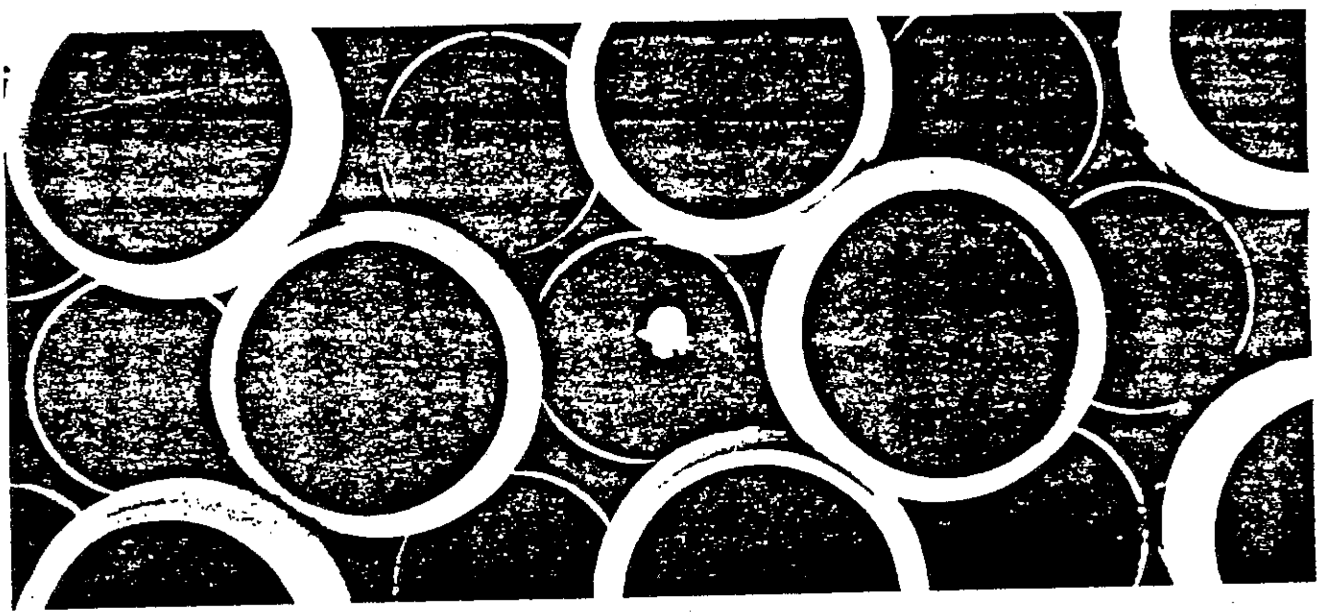
Design and Installation of Mound Systems for Waste Treatment



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Design and Installation of Mound Systems for Waste Treatment

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Introduction

Many sites under consideration for development in North Carolina are not suitable for on-site sewage disposal by conventional septic systems. Among these sites are some which do have enough depth and area of usable soil to provide safe disposal via mound systems. Mounds are not a panacea for all the unsuitable soils of North Carolina, but they are useful for some specific conditions where conventional systems have frequently failed.

This manual specifies the procedures and materials to be used for successful siting, design, installation and maintenance of residential mound systems. Use of proper materials and techniques is critical to the success of the mound, as well as to all other ground-absorption systems. Many engineers, sanitarians, contractors and designers are unfamiliar with mound construction, and these instructions are designed as an aid to them. Although those who design, build and use septic systems can benefit from this report, it must always be used in cooperation with the local health department. The local health department must first approve a site, and then assign waste flow and soil loading rates.

This manual covers design and installation of small mound systems suitable for homes and small businesses. Principles are similar for larger commercial and institutional systems, but the special requirements of those systems are not addressed.

CHAPTER 1

What Is A Mound System?

A soil-absorption system must serve two purposes: 1) keep untreated effluent below the surface, and 2) purify the effluent before it reaches ground or surface water. The system works best when the distribution area is not saturated with water or effluent, allowing efficient aerobic bacteria to treat the wastes.

There are several conditions which frequently hinder the performance of soil-absorption systems. Clogging of the soil can occur from localized overloading during use or from the mechanical sealing of the soil-trench interface during construction. This clogging can cause effluent to break through to the surface, especially in fine-textured soils. Anaerobic conditions caused by continuous saturation due to overloading or a high water table retard treatment, increasing the potential for pollution. Shallow soils are not thick enough to purify the effluent.

The mound system combines several improvements to help overcome these problems. These are:

- no construction in the natural soil
- treatment of effluent in fill material
- uniform distribution of effluent
- dosing and resting cycles

Dosing the effluent into a mound of fill material increases the separation distance to any restrictive horizon or seasonally high water table. The effluent is at least partially treated before it reaches the natural soil, reducing the load on the soil and the potential for clogging. Problems of local overloading are decreased when effluent is distributed over the entire absorption area. Dosing and resting cycles help maintain aerobic conditions in the mound, improving treatment.

A mound is a pressure-dosed, above-ground soil filter for treating domestic wastewater (Figure 1). It consists of:

- two-compartment septic tank
- pumping chamber
- submersible effluent pump and level controls
- high-water alarm and level switch
- supply manifold
- perforated distribution laterals
- mound fill
- gravel
- topsoil cap
- natural soil
- grass cover

When septic tank effluent rises to the level of the upper pump control, the pump turns on and effluent moves through the supply manifold and distribution laterals. These laterals are PVC pipes containing small holes (1/8-inch to 1/4-inch) spaced 2.5 feet to four feet apart. Under low pressure [0.7 to two pounds per square inch (psi)] supplied by the pump, septic tank effluent flows through the holes and into the mound. The effluent moves downward through the mound by gravity and is partially treated by the time it reaches the natural soil. The mound is sand to sandy loam in texture and provides an aerobic zone for effective treatment.

The pump turns off when the effluent level falls to the low-water pump control. The level controls are set so that the effluent is pumped four to eight times daily with resting periods in between to allow aerobic treatment of effluent. If the pump or level controls should fail, the effluent would rise to the level of the alarm control. The alarm would turn on, signaling the homeowner of failure.

CHAPTER 2

Site and Soil Requirements for Mound Systems

A mound system, like any other soil-absorption system, should be located on the best soil on the lot.

Space requirements

The basal area of most residential mounds occupies from 1,000 to 5,000 square feet, depending on the soil permeability, mound shape and design waste load. In addition, a 25-foot wide exclusion area around the mound base should be set aside. This area can be used for future repair or replacement of the mound. The mound and exclusion area as well as the septic tank and pumping chamber must meet setback requirements from wells, property lines, building foundations, etc., as specified in local or state regulations [10 NCAC 10A. 1912 (a)]. Although it is not possible to integrate the site, soil and setback requirements into a general lot size requirement, undeveloped lots smaller than three quarters of an acre may not be acceptable for a mound system. Before approving a potential site for a mound, the exact space requirements should be calculated (Chapter 3) to ensure that there is enough usable soil on the lot.

Soil requirements

A suitable mound site requires a minimum depth of 12 inches of natural soil to any restrictive horizon such as a hardpan, restrictive saprolite, bedrock, or to the seasonally high water table. The soil must be of suitable or provisionally suitable texture, structure and permeability as defined in state regulations (10 NCAC 10A. 1920).

Topography and location

Mounds built on slopes require special dosing and installation procedures (Chapter 9). Slopes greater than 10 percent are not suitable for mounds. The mound and tanks should not be located in a depression or drainage area. Surface and subsurface water must be intercepted and diverted away from all components of the mound system. The distribution lines should be located at a higher elevation than the pumping tank. This prevents the gravity flow or inadvertent siphoning of effluent to the mound. If the topography does not allow for such placement, then the system must be modified (pg. 11) to ensure that effluent will not leave the pumping tank when the pump is turned off.

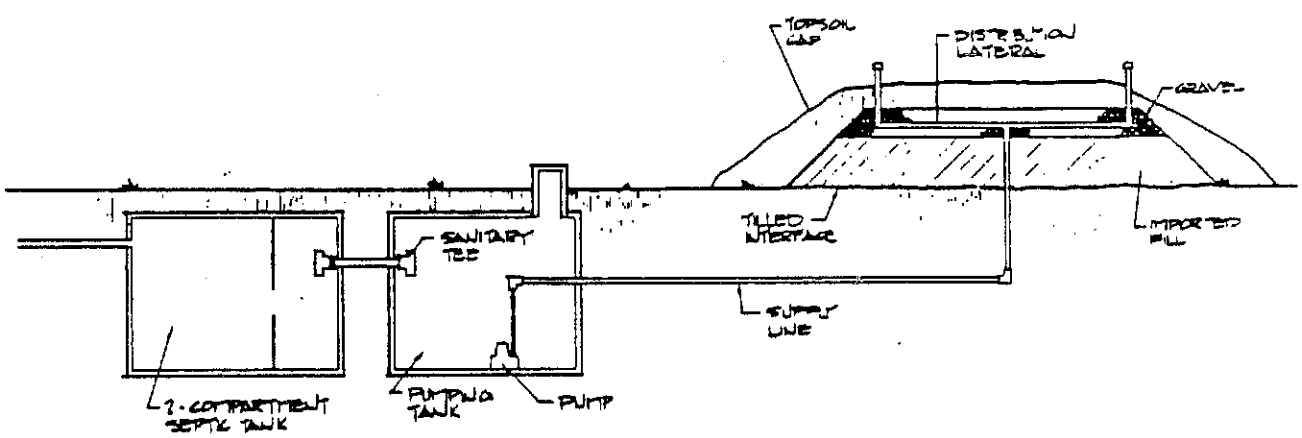

Figure 1. Components of a mound system

CHAPTER 3

Layout of a Mound

The next three chapters are a step-by-step procedure for designing a mound system. There is no one mound system that fits all sites—each must be designed individually. Special procedures for designing mounds on sloping lots are covered in Chapter 9.

Laying out a mound system involves calculating its size and shape, and choosing its location. Each site must be inspected and each layout approved by the local health department to ensure that adequate space is available for the mound, tanks and repair area, and that all setback requirements are met.

Distribution area

The dimensions of both the distribution area (top of mound) and the base of the mound must be calculated. The area of the distribution network depends on the daily wastewater flow and the absorptive capacity (loading rate) of the fill.

Step 1. Determine the daily wastewater flow. For residential systems, the estimated flow is 150 gallons per day (gpd) for each bedroom (BR) in the house.

Example:

For a 3-bedroom house:
Flow = 150 gpd/BR x 3 BR = 450 gpd

Step 2. Calculate the loading rate of the fill. Determine the texture of the fill to be used, and find the wastewater-loading rate using Table 1.

Table 1. Recommended loading rates for fill material for mound systems

USDA Soil Texture	Maximum Loading Rate
	gpd/ft²
Sand	1.0
Loamy sand	0.8
Sandy loam	0.6

Example:

For a loamy sand fill:
Loading rate = 0.8 gpd/ft²

Step 3. Compute the area of the distribution network where area = flow/loading rate.

Example:

Using flow and loading rate calculated above:
Area = 450 gpd/0.8 gpd per ft²
= 563 ft²
Round off to 600 ft²

Step 4. Determine the dimensions of the distribution area. The width of the distribution network should be about 15 feet for ease of construction. The length is the area divided by the width.

Example:

For a 600 ft² distribution area, set the width at 15 ft.
Length = area/width
= 600 ft²/15 ft
= 40 ft
Dimensions are 15 ft x 40 ft

Basal area

The size of the mound base depends on (1) the daily waste flow and loading rate of the soil, and (2) the geometry of the mound. Calculate the basal areas from both sets of requirements. The larger of the two values is the minimum basal area that will meet all requirements.

Step 1. Compute the basal area needed to meet the waste-loading requirements. The daily waste flow is calculated the same as above. The loading rate is found from the texture of the most restrictive horizon in the upper 12 inches of the soil profile (Table 2).

Example:

For a soil that is a sandy clay loam:
Waste flow = 450 gpd
Loading rate = 0.5 gpd/ft²
Basal area = 450 gpd/0.5 gpd/ft²
= 900 ft²

Table 2. Recommended loading rates for mound systems based on soil texture and estimated permeability

USDA Soil Texture	Estimated Permeability	Maximum Loading Rate*
	min/in.	*gpd/ft²*
Sand, loamy sand	20	0.8-1.0
Sandy loam, silt loam	20-40	0.8-0.6
Sandy clay loam, clay loam	40-60	0.6-0.4
Silty clay loam, sandy clay	60-90	0.4-0.2
Silty clay, clay	90-120	0.2-0.1
Massive clay	>120	not suitable

*These loading rates should be used only for calculating the size of mound systems—not for other types of systems.

To protect against erosion, the mound geometry must be designed so that the sides are not too steep. These sides (called sideslopes) should be no steeper than three to one. That is for every one foot of vertical drop, three feet of horizontal distance is required (Figure 2). The basal area required to meet geometric criteria is the area needed to accomodate the distribution area and to stabilize mound sideslopes.

This basal area is calculated in three steps. First, the height of the mound fill is chosen. Then, the sideslope length is calculated using: $S = 3 \times H$, where S is the sideslope length and H is the fill height. Finally, the sideslope lengths are added to the distribution area dimensions to get the basal dimensions.

Step 2. Select depth of mound fill. A fill depth of two feet is usually recommended for adequate treatment of effluent. See Chapter 5 for more discussion of fill requirements.

Step 3. Calculate sideslope length.

Example:

For mound with 2 ft of fill:
S = 3 x 2 ft
S = 6 ft

Step 4. Calculate basal area needed to meet geometric requirements.

Example:

For a 15 ft x 40 ft mound with 6 ft sideslopes: (see Figure 3).
Length = 40 ft + 6 ft + 6 ft = 52 ft
Width = 15 ft + 6 ft + 6 ft = 27 ft
Basal area = 52 ft x 27 ft = 1404 ft²

Step 5. Select the larger of the two basal areas.

Example:

Soil requirements = 900 ft²
Sideslope requirements = 1400 ft²
Use 1400 ft² as basal area.

Size of septic and pumping tanks

Septic tank volume is determined according to state and local regulations, and is the same as for a conventional system. The pumping tank should accommodate at least twice the volume (V) of the daily waste flow to provide one day of emergency storage.

Example:

For a 450 gpd waste flow:
V pump tank = 450 gal x 2
= 900 gal

Location of system

The mound should be located on the best available soil on the lot. All setback requirements from wells, lot lines and waterways must be observed. The exact location of the tanks as well as landscaping and drainage improvements must be noted. Space must be reserved for repair or replacement. The best way to do this is to leave a 25-foot buffer around the mound which would include the repair area. All setbacks are measured from the edge of this buffer. A detailed sketch of the system should be made and filed with other information on the system (Figure 4).

Landscaping and drainage

All landscaping and site drainage to be done before and after mound installation must be recorded in detail on the improvements permit.

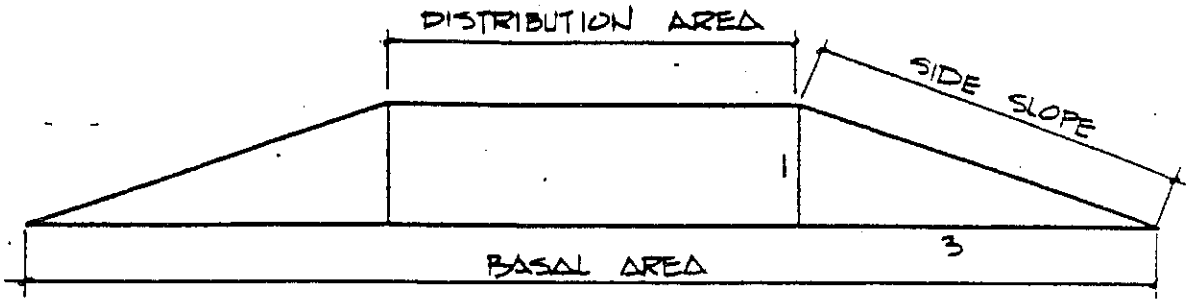

Figure 2. Cross section of mound fill

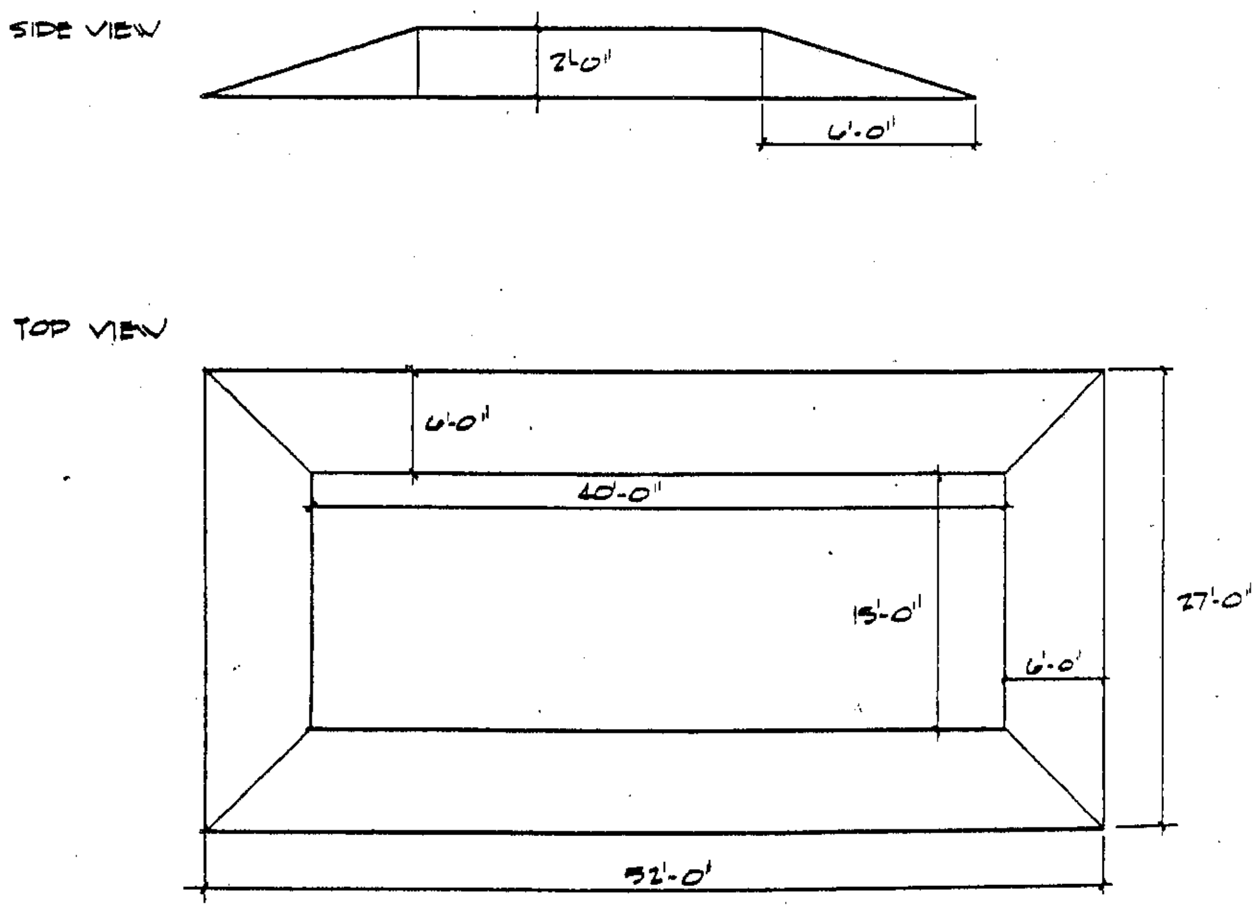

Figure 3. Basal area needed to meet geometric requirements for example system

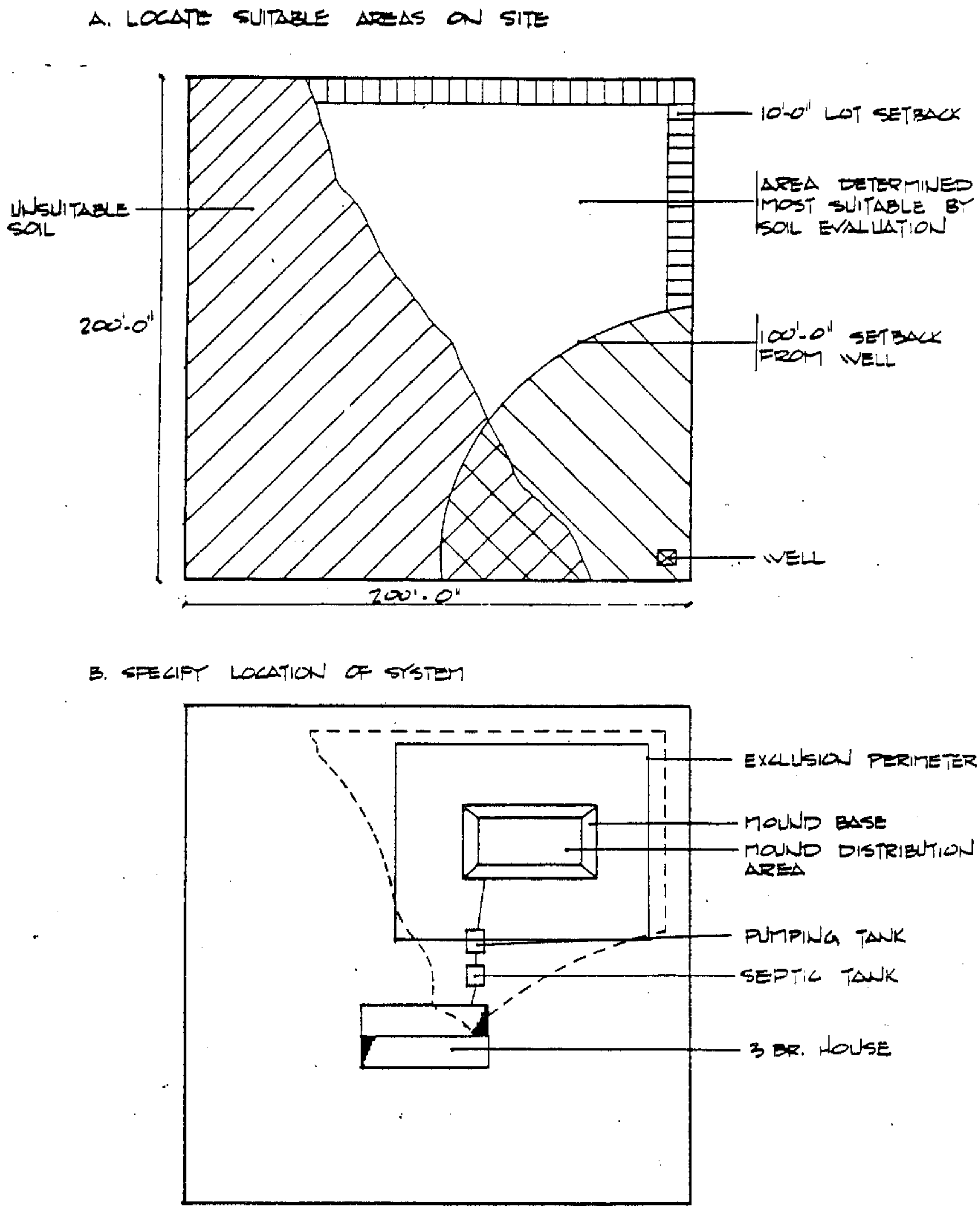

Figure 4. Layout of example system

CHAPTER 4

Fill, Topsoil, and Gravel

The fill forms the treatment area of the mound, while the topsoil protects the mound. It is important not to underestimate the amounts of these materials needed.

Volume of fill

The cross section of the mound is a trapezoid. The volume of fill is calculated as the area of this trapezoid times the length of the mound base (Figure 5).

The formula for the volume is:

$V = [(A+B)/2] \times H \times L$ where
A = width of distribution area
B = width of base
H = height of fill
L = length of base

Step 1. Compute volume of fill.

Example:

For the example mound see Figure 6, where:
$A = 15$ ft
$B = 27$ ft
$H = 2$ ft
$L = 52$ ft
$V = [(15 \text{ ft} + 27 \text{ ft})/2] \times 2 \text{ ft} \times 52 \text{ ft}$
$= 2200 \text{ ft}^3$

Step 2. Convert volume to cubic yards.

Example:

$2200 \text{ ft}^3/27 \text{ ft}^3 \text{ per yd}^3 = 81 \text{ yd}^3$

Volume of topsoil

The mound is covered with six inches of topsoil. This is about one-third the volume of the fill.

Example:

$V \text{ topsoil} = \frac{1}{3} V \text{ fill}$
$= \frac{1}{3} (81 \text{ yd}^3)$
$= 27 \text{ yd}^3$

Volume of gravel

The quantity of gravel needed will depend on how it is placed on the mound. If the gravel is moved using a front-end loader, the easiest method is to cover the entire distribution network with gravel. If the gravel is to be moved by wheelbarrow, it is easiest to place the gravel only in bands around each distribution line. Calculations for both methods are shown below.

Step 1. Calculate gravel required for the entire distribution area. For every 100 square feet of distribution area to be covered six inches deep, allow 2.5 yards (3.3 tons) of gravel.

Example:

For a 600 ft^2 distribution area:
$V \text{ gravel} = (600 \text{ ft}^2/100 \text{ ft}^2) \times 2.5 \text{ yd}^3$
$= 15 \text{ yd}^3$

Step 2. Calculate gravel required for distribution lines only. Gravel is placed in bands 18 inches wide by six inches deep. Half as much gravel is needed as for the entire distribution area.

Example:

For a 600 ft^2 distribution area:
$V \text{ gravel} = 15 \text{ yd}^3/2$
$= 7.5 \text{ yd}^3$

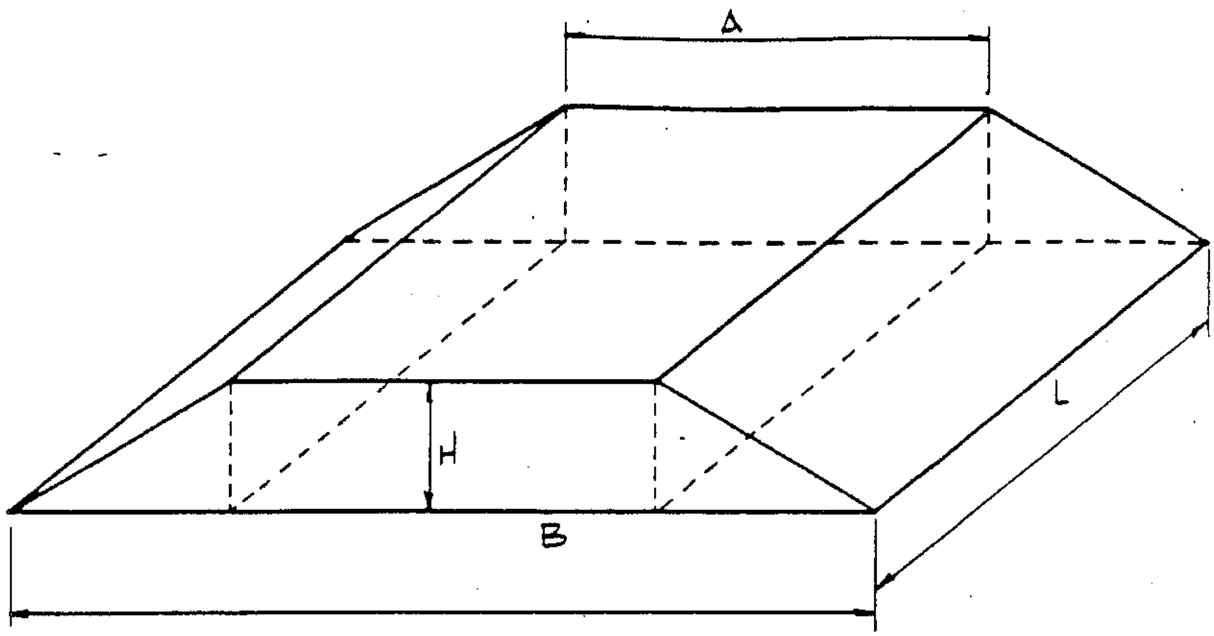

Figure 5. Mound fill dimensions

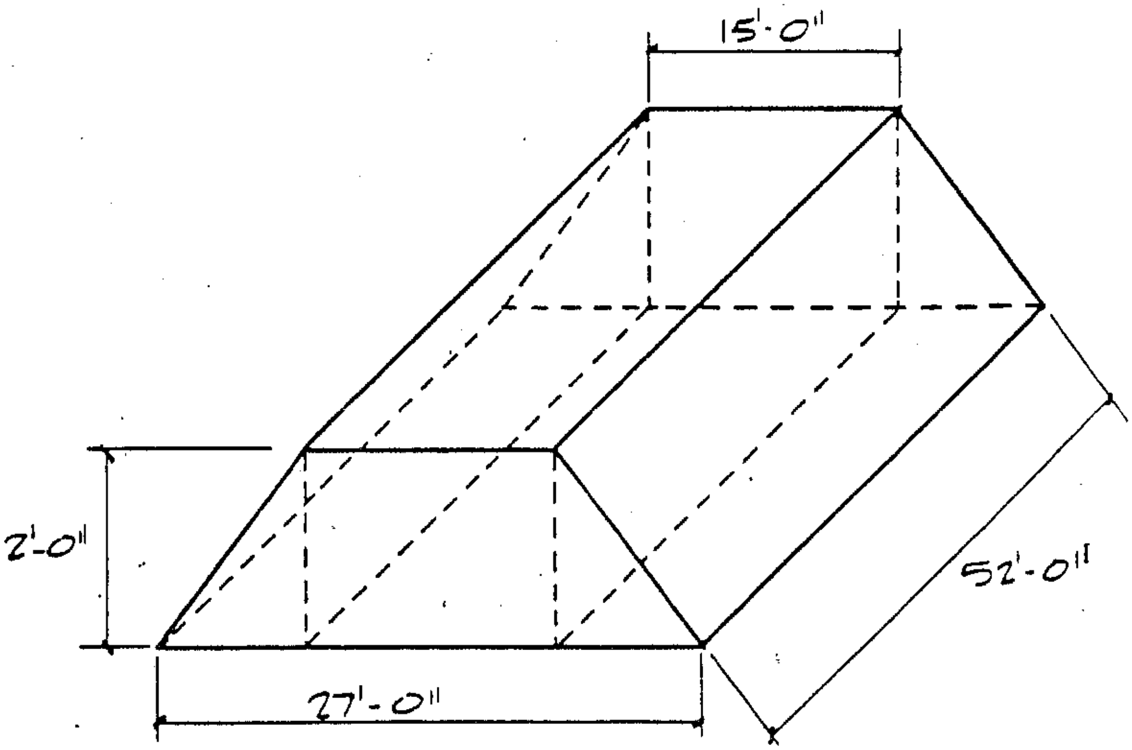

Figure 6. Mound fill dimensions for example system

CHAPTER 5

Dosing and Distribution System Design

The purpose of low-pressure dosing is to spread effluent evenly over the mound absorption area.

Distribution network

The distribution network is a system of perforated PVC pipes laid over the absorption area. They are usually spaced three feet apart, and are set back at least 1.5 feet from the sides and ends of the distribution area.

Step 1. Determine the number of distribution lines. Divide the width of the distribution area by the line spacing. Ignore any remainder from the division. This will give the number of lines that will meet the 1.5-foot setback limits from the edge of the distribution area.
Number of lines = width/line spacing

Example:

For a 15-ft wide distribution area with 3-ft line spacing:
Number of lines = 15 ft/3 ft
= 5

Step 2. Calculate the length of each distribution line. Subtract the 1.5-foot setback requirement from each end of the distribution area to find the length of the distribution lines.
Line length = distribution area length − 2 (1.5 ft)

Example:

For a 40-foot long distribution area:
Line length = 40 ft − 2(1.5 ft)
= 37 ft

Step 3. Determine the total length of lines.
Total length = number of lines x line length

Example:

For five 37-foot lines:
Total length = 5 x 37 ft
= 185 ft

Step 4. Draw a sketch of the distribution network and save for reference.

Dosing rate

The dosing rate depends on the total length of the distribution lines, the size and number of holes in the lines, and the pressure head supplied by the pump. Holes must be at least ⅛-inch in diameter and can be spaced from 2.5 feet to four feet apart. Pressure head is best set between two and four feet (0.9 to 1.7 psi). Lower pressures do not provide uniform delivery of effluent. Higher pressures cause local scouring of the gravel and mound fill. Suggested starting values for design calculations are a 5/32-inch hole diameter, three-foot hole spacing and three feet of pressure head.

Table 3. Flow rate as a function of pressure head and hole diameter in drilled PVC pipe.

Pressure Head		Hole diameter (in.)				
		3/32	1/8	5/32	3/16	7/32
		Flow rate (gpm)				
ft	*psi*					
1	0.43	0.10	0.18	0.29	0.42	0.56
2	0.87	0.15	0.26	0.41	0.59	0.80
3	1.30	0.18	0.32	0.50	0.72	0.98
4	1.73	0.21	0.37	0.58	0.83	1.13
5	2.16	0.23	0.41	0.64	0.94	1.26

Step 1. Calculate number (no.) of holes.
No. holes = length of line/hole spacing

Example:

For a system with 3-ft hole spacing and five 37-ft lines:
No. holes/line = 37 ft/3 ft per hole
= 12 holes/line
Total holes = 12 holes/line x 5 lines
= 60 holes

Step 2. Determine the flow rate per hole. This is calculated from the hole size and pressure head using Table 3.

Example:

For 3-ft pressure head and 5/32-in. holes:
Flow rate = 0.50 gal per minute (gpm) (Table 3)

Step 3. Calculate total dosing rate.

Example:

Flow rate/hole = 0.50 gpm
Flow rate/line = 0.50 x 12 holes = 6.0 gpm
Total flow rate = 0.50 x 60 holes = 30 gpm

When the mound is located downhill from the pump, a ¼-inch siphon-breaker hole must be drilled in the supply line in the pumping tank. This hole will prevent inadvertent siphoning of the contents of the pump tank into the field. An extra two gallons per minute must be added to the pumping rate to compensate for flow through the siphon-breaker hole.

Example:

For a system with 30 gpm flow rate and a siphon-breaker hole:
Total flow rate = 30 gpm + 2 gpm = 32 gpm

Table 4. Friction loss per 100 feet of PVC pipe.

Flow	Pipe diameter (in.) 1	1¼	1½	2	3	4
gpm	*Friction loss (ft)*					
1	0.07					
2	0.28	0.07				
3	0.60	0.16	0.07			
4	1.01	0.25	0.12			
5	1.52	0.39	0.18			
6	2.14	0.55	0.25	0.07		
7	2.89	0.76	0.36	0.10		
8	3.63	0.97	0.46	0.14		
9	4.57	1.21	0.58	0.17		
10	5.50	1.46	0.70	0.21		
11		1.77	0.84	0.25		
12		2.09	1.01	0.30		
13		2.42	1.17	0.35		
14		2.74	1.33	0.39		
15		3.06	1.45	0.44	0.07	
16		3.49	1.65	0.50	0.08	
17		3.93	1.86	0.56	0.09	
18		4.37	2.07	0.62	0.10	
19		4.81	2.28	0.68	0.11	
20		5.23	2.46	0.74	0.12	
25			3.75	1.10	0.16	
30			5.22	1.54	0.23	
35				2.05	0.30	0.07
40				2.62	0.39	0.09
45				3.27	0.48	0.12
50				3.98	0.58	0.16
60					0.81	0.21
70					1.08	0.28
80					1.38	0.37
90					1.73	0.46
100					2.09	0.55

Pump selection

The pump must have enough power to pump effluent at the calculated flow rate against the total head (resistance) encountered in the distribution system. The total head is the amount of work the pump must do to overcome elevation (gravity) and friction in the system at the specified pressure and flow rate. Total head = elevation head + pressure head + friction head.

Elevation head is the difference in elevation from the pump to the end of the manifold. Remember that the pump will be four to five feet below ground level in the pumping chamber.

Pressure head is the pressure required for even distribution and is usually specified between two and four feet.

Friction head is the loss of pressure due to friction as the effluent moves down the pipes. Pipe friction is estimated using Table 4. When estimating pipe friction, use the length of the supply manifold, but not the lateral lines. Add 20 percent to the pipe friction estimate to account for friction losses in joints and fittings. Note that friction loss varies with pumping rate as well as with pipe length and diameter.

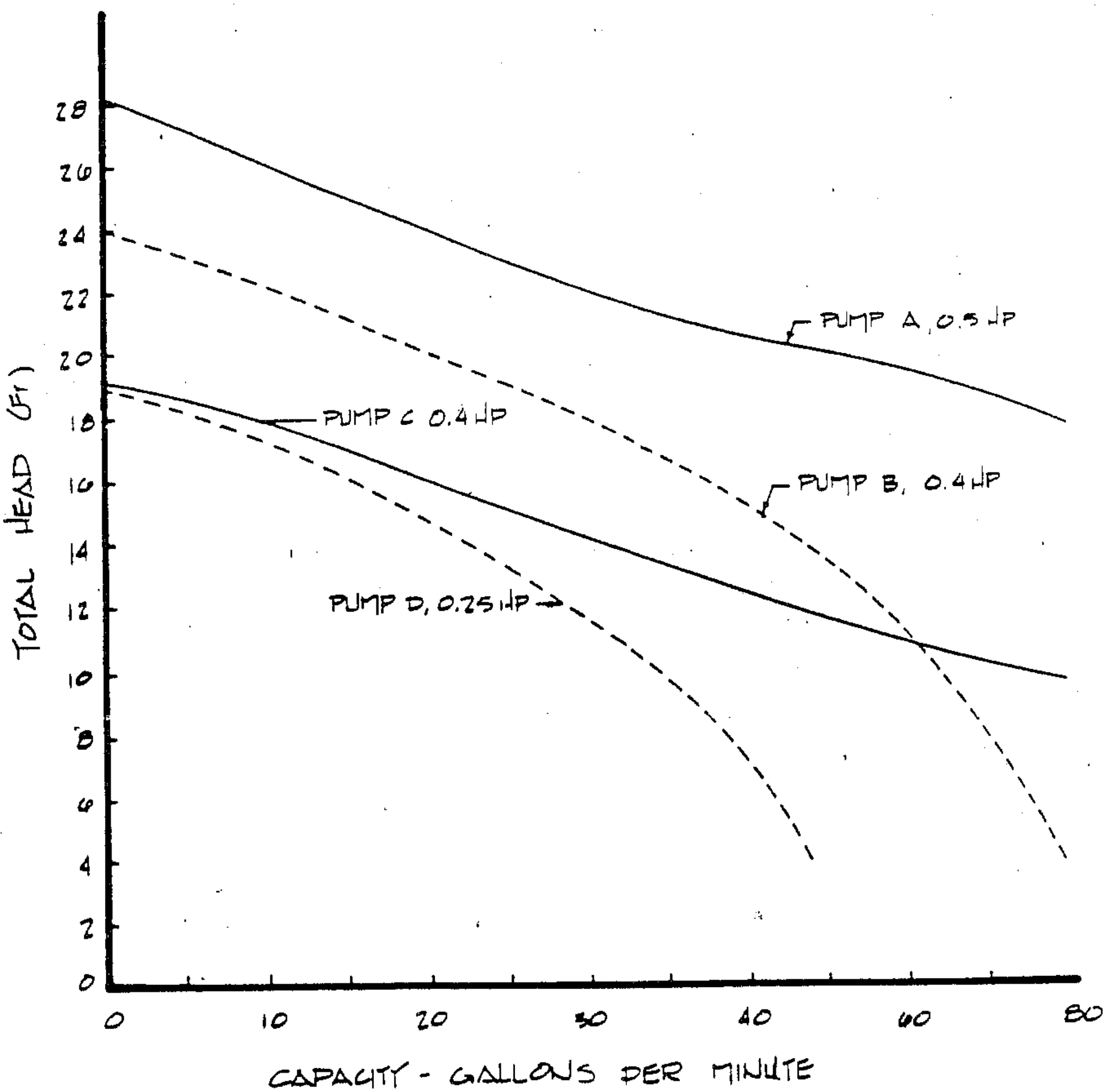

Figure 7. Examples of performance curves (capacity vs. total head) for four submersible effluent pumps

The total head must be calculated to select the proper size pump.

Step 1. Compute friction head.
Friction head = 1.2 x pipe friction

Example:
For a 50-ft supply line with 1½-in. diameter and 30 gpm pumping rate:
Pipe friction = (50 ft/100 ft) x 5.2 ft of head
= 2.6 ft
Friction head = 1.2 x 2.6 ft
= 3.1 ft

Step 2. Calculate total head.

Example:
For system with:
7-ft elevation head from pump to end of lines,
3-ft pressure head,
3.1-ft friction head,
Total head = 7 ft + 3 ft + 3.1 ft
= 13.1 ft

The system will require a pump with a capacity of 30 gallons per minute against 13 feet of head. It is always necessary to specify the total head when selecting a pump. The head and flow requirements are checked against the performance curve provided by the pump manufacturer. Examples of performance curves are shown in Figure 7. It is important to use the performance curve for the specific brand and size of pump to be used. Performance curves vary among brands.

Step 3. Select a pump of proper capacity. Consult the appropriate performance curve. The system requirements of flow and total head (30 gallons per minute at 13 feet) intersect at a point which must fall below the performance curve. If the point falls above the curve, then the pump is too small for the system.

Example:
See Figure 8. This point falls below the curve; therefore, the pump is adequate.

When the chosen pump is too small, there are several options:

- Select a larger pump.
- Reduce the total head requirement by reducing the pressure head (two feet is the minimum). This has a large effect because a lower pressure head will also lower the flow rate and friction head.

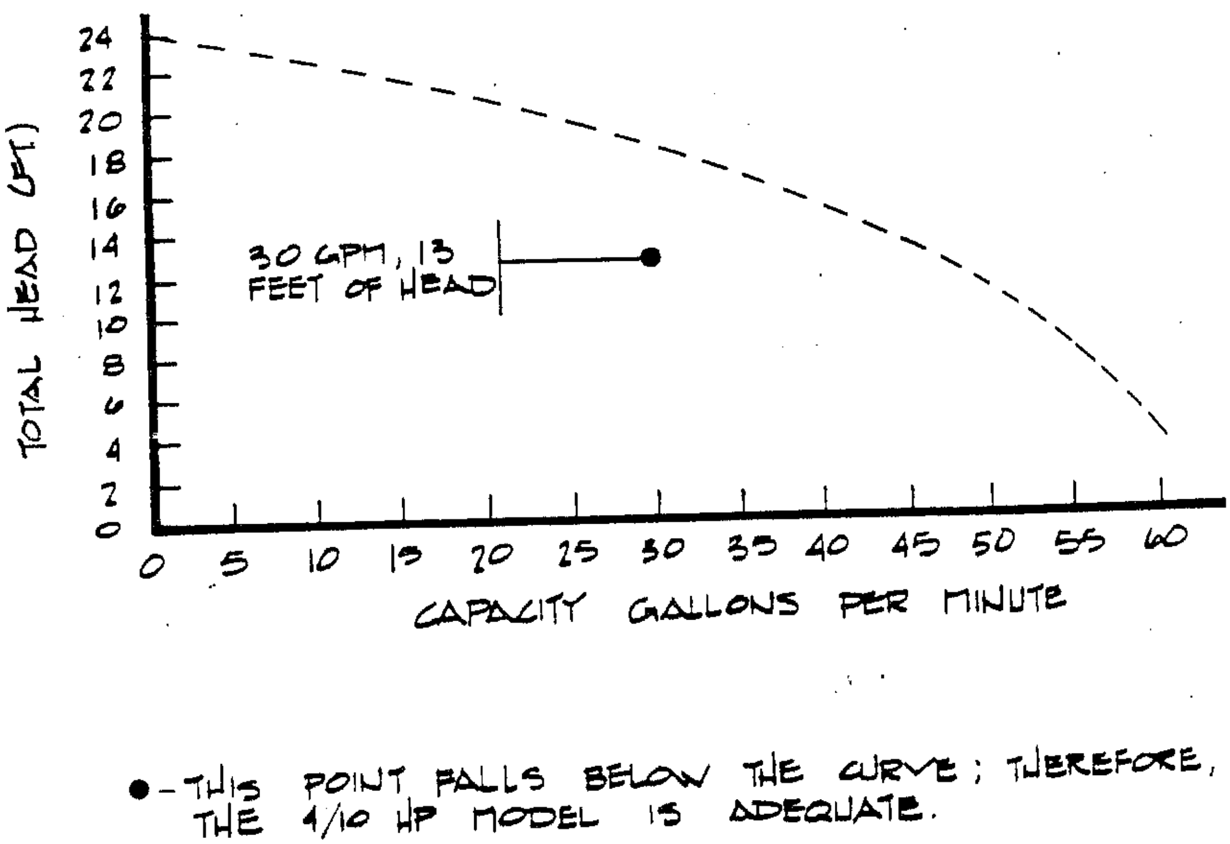

Figure 8. Comparing pump requirements to performance curve

- Reduce the friction head loss by using a larger diameter supply manifold (two inches is a practical maximum for residential systems).
- Reduce the flow rate by using a smaller hole size (⅛-inch is the minimum) or by increasing hole spacing.
- Raise the pump by placing more blocks underneath it.

A combination of choices can be made. The goal is to design a system that works properly for the lowest possible price. A larger pump is an easy solution, but will be more expensive than one of the other options. For most residential systems a 0.3 to 0.4 horsepower pump will be adequate with judicious selection of the other parameters.

Dosing volume

Dosing volume is the amount of effluent pumped to the absorption field each time the pump runs. The dosing volume must be large enough to provide adequate distribution in the field and adequate resting time between doses, yet small enough to avoid overloading. The minimum dose to provide adequate distribution depends on the size of the supply and lateral network.

Step 1. Calculate minimum dosing volume.
V dose = V supply + 5 (V laterals)
The minimum volume is the sum of the supply-line volume and five times the volume of the lateral lines. The volume of the lines is calculated using Table 5.

Table 5. Storage capacity per 100 feet of PVC pipe.

	Storage Capacity	
Pipe Diameter	160 psi	Schedule 40
in.	*gal/100 ft*	
1	5.8	4.1
1¼	9.0	6.4
1½	12.5	9.2
2	19.4	16.2
3	42.0	36.7

Example:

1) Supply line = 50 ft of 1½-inch pipe
V supply = (50 ft/100 ft) (12.5 gal)
= 6.2 gal

2) Lateral lines = 185 ft of 1¼-inch pipe
V lateral = (185 ft/100 ft) (9.0 gal)
= 16.6 gal

3) V dosing = 6.2 gal + 5 (16.6 gal)
= 89 gal

Dosing four to eight times per day provides adequate resting time. For a 450 gallon-per-day design, this would be a range of 56 to 112 gallons per dose. Doses which are much larger may cause effluent to seep from the base of the mound.

Step 2. Select dosing volume.

Example:

Selecting 90 gal/dose would give five doses per day. This volume is larger than the minimum in Step 1. If water use is less than 450 gpd, dosing will occur less frequently, providing longer resting periods between doses.

Step 3. Compute the depth of effluent pumped per dose. In order to set the pump controls to deliver the proper dose, the depth of effluent to be pumped from the tank for each dose must be calculated. The computation is done using the following equation:

Dosing depth = (V dose/V tank) x liquid depth of tank.

Example:

For a 900-gal pumping tank; 4-ft liquid depth (bottom of tank to outlet tee); 90-gal dose:
Dosing depth = (90 gal/900 gal) x 4 ft
= 0.4 ft = 5 in.

The float control switch for the pump should be set for a five-inch drawdown to provide automatic doses of 90 gallons.

Check-valve calculation

Any effluent which remains in the supply and laterals lines of a properly sited system will drain back to the pumping chamber when the pump shuts off. If this volume is too large, it can cause overuse of the pump and excessive consumption of electricity. A check valve may be needed to prevent this return flow to the pumping chamber, especially on a large system with a long pumping distance. Check valves should be avoided if possible because they may malfunction when used for septic-tank effluent. In general, a check valve should only be used if the total storage volume of the pipes is greater than one fourth of the total daily waste flow.

Step 1. Calculate storage volume.
V storage = V supply + V laterals

Example:

V storage = 6.2 gal + 16.6 gal
= 22.8 gal

Step 2. Compare to ¼ daily waste flow.

Example:

450 gal x ¼ = 112 gal
22.8 gal < 112 gal
No check valve needed.

CHAPTER 6
Equipment Specifications

All necessary equipment and tools should be clearly listed so they can be obtained prior to building a mound. To prepare this list, first consolidate the design specifications onto a single worksheet (Appendix 1). A copy of this worksheet along with an accurate sketch including drainage and landscaping requirements (Figure 4) should be filed for every system which is installed. Using this sheet, prepare a list of materials (Appendix 2). Be sure that the materials meet the requirements discussed below. A sketch of the distribution lines (Figure 9) and the pump system (Figure 10) are useful for counting the fittings.

Septic tank and pumping chamber

As noted earlier, a mound system has two separate tanks—a septic tank and a pumping chamber. If a conventional septic system is being replaced by a mound, the existing septic tank can be used (after being pumped out), and only one additional tank installed.

The septic tank receives wastewater directly from the house. It is sized according to state and local regulations for conventional systems (10 NCAC 10A .1907). The septic tank must be a two-compartment design for maximum solids retention. It is very important that the septic tank and pumping chamber are watertight. One-piece tanks are best. When using two-piece tanks, the tongue-in-groove joint must be carefully sealed with asphalt-rope mastic.

Effluent from the two-compartment septic tank flows by gravity through a four-inch, solid PVC pipe to the pumping chamber. The pumping chamber should have a liquid capacity of at least two times the daily wasteflow from the house and can be a single-compartment design.

Both the septic tank and pumping chamber must be provided with above-ground concrete or masonry (or their equivalent) manhole risers to provide easy access for clean-out and pump service. The riser should be placed over the primary chamber of the septic tank and above the pump-access hole in the pumping chamber. Risers should be wide enough to accommodate the existing lids on the tanks, should extend at least six inches above the finished grade of the site and should also be covered with a concrete lid. Standard well tiles can be used for the risers, provided that the inside diameter is larger than the access hole in the tank. All joints must be sealed to prevent the infiltration of surface runoff and groundwater to the tanks.

Pipe and fittings

All pipes and fittings in a mound system should be made of PVC plastic. PVC is lightweight, easy to use and resists corrosion. All joints must be sealed with an appropriate PVC-solvent cement. The supply manifold from the pumping chamber to the mound is usually 1½-inch or two-inch PVC, depending on the specifications of the system (Chapter 5). A bushing or reducer may be needed to adapt the pump to the supply manifold. There should always be a threaded PVC union above the pump to allow easy removal or replacement. Lateral lines are usually made of 1¼-inch PVC. Appropriate holes in the laterals are drilled on site (Chapter 7).

PVC pipe may be of thin-wall (160 psi) or Schedule 40 specifications, but must be of the straight-length variety. Thin-wall (160 psi) PVC is usually cheaper than Schedule 40. A globe or gate valve for final pressure adjustment is installed in the supply manifold inside the pumping chamber. The valve should be made of PVC or bronze, whichever is cheaper. All other tees, elbows, caps and reducers in the distribution system should be made of PVC. The end of each lateral line is equipped with a capped "turn-up" that provides aboveground access for clean-out or back-flushing (Figure 9). Using 45-degree elbows rather than 90-degree elbows for the turn-ups will make clean-out easier to do. Galvanized caps may be used if PVC is not available.

In the few instances where a check valve is necessary (Chapter 5), it should also be installed with threaded fittings in the pump chamber to provide easy access for maintenance.

Pump, float controls and alarm systems

A good quality, submersible effluent pump must be used in mound systems. An expensive grinder pump is not required because the septic-tank effluent will be relatively free of solid material. A septic-tank effluent pump or a submersible sump pump that will not be corroded by sewage should be used in the pumping chamber. Pumps with

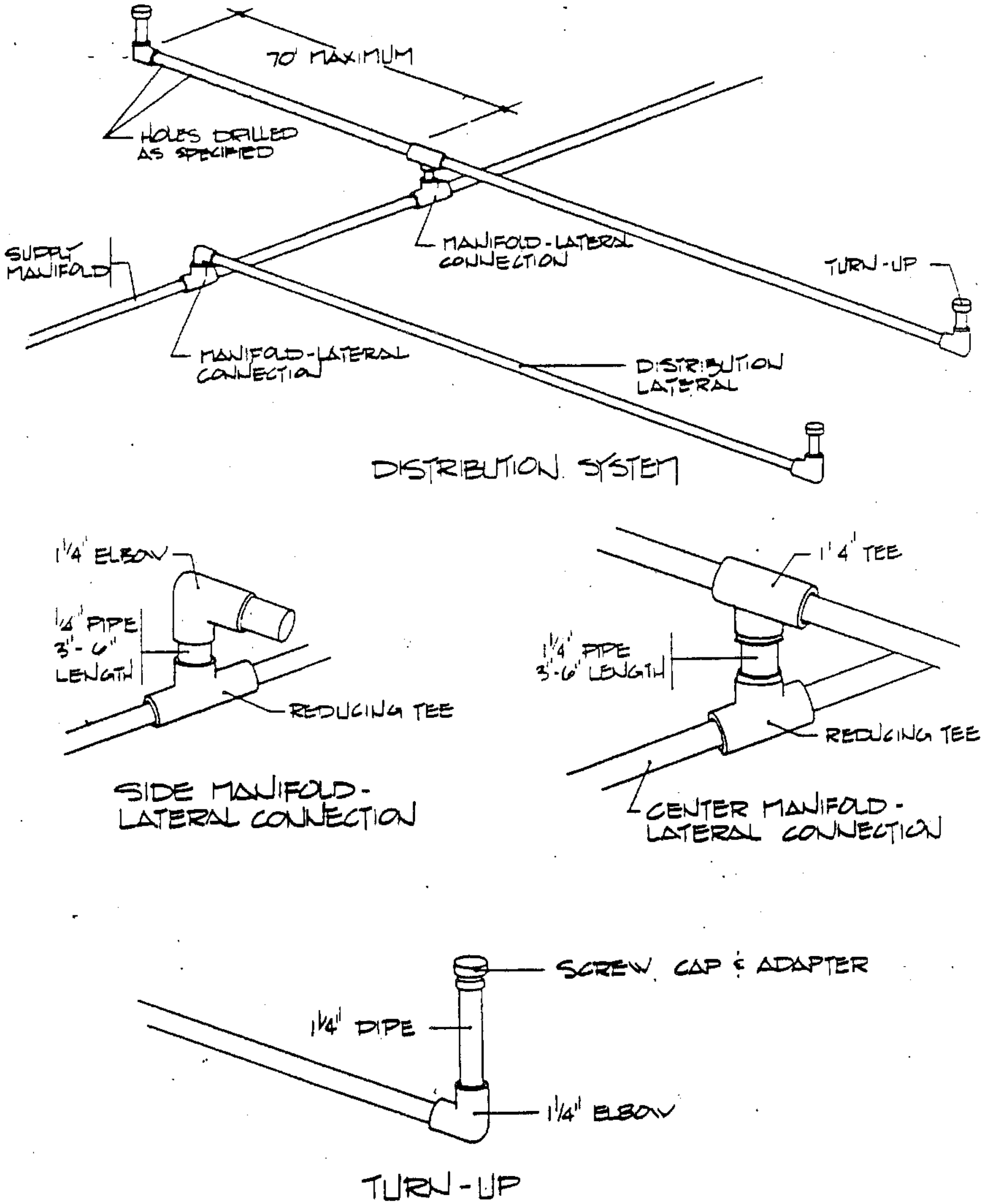

Figure 9. Details of distribution system

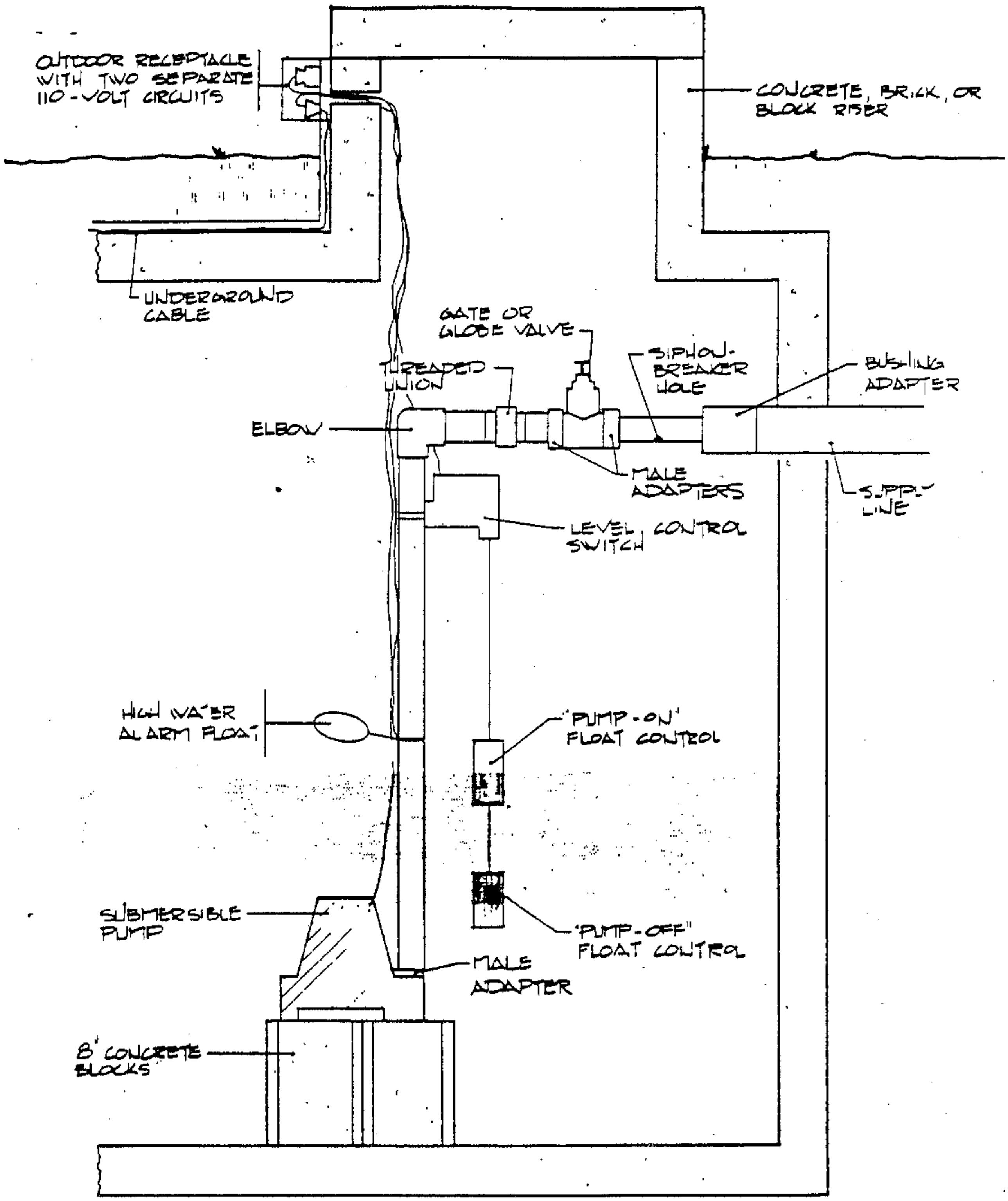

Figure 10. Details of pumping chamber

built-in switches should be avoided, unless the switch can be adjusted for the quantity of water to be pumped. The selection of pump size is discussed in Chapter 5. Pumps in the range of ¼ to 4/10 horsepower generally provide sufficient capacity for residential mound systems, but the pumping requirements for each system must be checked against the performance curve of the pump to be used. It is better to use a slightly larger pump than necessary, because the final pressure can be adjusted with the in-line gate or globe valve.

When the mound is located downhill from the pump, dosing and distribution can be done using intentional siphoning rather than pumping. A gravity-dosing siphon replaces the electric pump. The siphon must be selected to match the dosing volume. Siphon selection and maintenance are not discussed in this manual.

The controls for the pumping system include a switching control for turning the pump on and off and a high-water alarm to signal pump malfunctions (Figure 10). The control system must be adjustable to meet the recommended loading rates for different sizes and shapes of pumping chambers. The controls must also be sealed against entry of corrosive and explosive gases from the effluent and should have National Electrical Manufacturing Association (NEMA) approval.

The two types of switches which have proven the most useful are magnetic level-control switches and sealed, mercury switches. The magnetic level control consists of two floats suspended from a sealed, magnetic switch. This switch has been reliable and the pumping volume is easily adjusted. Mercury switches are activated by a sealed float which contains a tube of mercury in contact with power leads. Best performance has been obtained using two switches—one to close the pump circuit and the other to open it. Automatic timers with backup mercury floats have been successful in a few systems where uniform timing of the doses was important. Diaphragm and some mechanical float switches have not been acceptable for mound use. The range of adjustment is often inadequate and the switches do not provide good service in a sewage environment.

In addition to the on and off control floats, there must be a separate float control for the high-water alarm. This may be a sealed, mercury float switch mounted several inches above the on float. The high-water alarm should consist of a light bulb and/or audible signal mounted over a sign marked "wastewater system alarm" in a visible place in the home, such as the kitchen or utility room. It should be on a separate electrical circuit from the pump power line and be equipped with a test switch. The alarm is activated if the water level in the pumping tank rises above the pump-on float control. The tank provides at least one day or more of excess storage capacity (depending on water use in the home) during which time the system must be repaired. Refer to Chapter 8 for repair and maintenance tips.

Complete control boxes for high-water alarms are available commercially. Simpler and cheaper systems can be assembled by an electrician. There are two basic requirements for an alarm system:

- It must operate on a separate electrical circuit from the pump.
- It must activate a labeled and easily visible (or audible) signal in the home whenever the water exceeds the normal pump-on level in the tank.

Imported fill, gravel and topsoil

These materials together can make up a large part of the cost of a mound. It is important that they be selected with care. Mound fill material should be loamy sand, sand or sandy loam in texture. The best material contains about 90 percent sand and 10 percent finer material. The fill must not be hauled or worked when wet.

Most mounds in North Carolina are constructed with two feet of fill. In some areas as little as one foot of fill is used in conjunction with wider line spacing to build a system which is a hybrid between a low-pressure pipe system and a mound. These systems should only be designed and constructed by people familiar with their operation.

Gravel size should be from ⅛ to one inch. Pea gravel or crushed rock may be used, but it must be washed. Topsoil should be suitable for establishing good growth of grass on the mound. Very fine and very coarse soils should be avoided.

A layer of filter or paving fabric, builder's paper or straw should be placed between the gravel and topsoil to prevent topsoil from falling into the gravel and clogging the pores. The fabric is the sturdiest and easiest to use and is manufactured by a number of companies. The material must be permeable to air and water.

Home water saving devices

Any home with a mound system must be equipped with low-flow showerheads (three gallons per minute) and low-flush commodes (3½ gallons or less per flush) in order to minimize the hydraulic load on the system. Those devices are a simple, low-cost way of reducing water consumption with no inconvenience to the homeowner. They are required by the North Carolina Building Code in all new construction. Low-flow showerheads and retrofit dams for commode tanks should be used in any existing home where a mound is installed.

CHAPTER 7

Installation Procedures

The actual installation of a mound system is tedious but straightforward, and can usually be done by three or four people in two to three days.

Tools and supplies

A back hoe is recommended for moving fill and gravel to the mound, and for excavating for the two tanks. A transit or similar instrument is recommended to keep the mound level as it is built. Other tools needed for installation are:

- shovels, wheelbarrows - for moving gravel.
- electric drill (with power pack or generator, if necessary) - for drilling holes in lateral lines.
- drill bits.
- hack saw, extra blades - for cutting PVC pipe to required lengths.
- PVC glue (and rags).
- mortar - to seal tank openings.
- measuring tape.
- electrical wiring tools.

In addition to tools, a complete list of parts and materials should be compiled from a sketch of the system (See Appendixes 2 and 3).

Site preparation

One of the most important concerns for a mound system is to protect the site from soil disturbance by heavy equipment. Removal or compaction of the topsoil, especially during wet weather, may destroy the site's suitability for a mound. As soon as the absorption area has been designated, it should be flagged, roped off and "quarantined" from construction traffic. No site preparation or mound construction work should occur if the soil is wet. As a rule of thumb, if the soil is too wet to plow, it is too wet to disturb for system construction.

After the location is staked out and the soil is dry enough to plow, the site should be cleared of brush and trees. Larger trees should be cut off rather than uprooted in order to avoid creating depressions and damaging the soil-pore network.

Provisions must be made for intercepting or diverting surface water and shallow groundwater away from the mound, septic tank and pumping chamber. This can be done with grassy swales, open ditches or curtain drains.

Fill, gravel and topsoil

The fill must be put in place so that there is a gradual transition between the fill and underlying soil. Failure to do this could ruin the system by forming a barrier to water movement at the soil-fill interface.

The basal area must be tilled with a small plow or garden tiller or scarified with the teeth of a backhoe before applying the fill. Fill is then moved to the system using a front-end loader, being careful to avoid driving on the tilled area. The first load of fill is pushed into place using a very small crawler tractor with a blade or a garden tiller with a blade. The fill is then tilled into the first few inches of natural soil to create the gradual boundary between the two. Subsequent loads of fill are placed on the system and tilled until the desired height is reached. The mound should be checked with a transit after each load of fill to make sure it is level.

Gravel is placed on the distribution area (not the sideslopes) using either a front-end loader or wheelbarrows. If a front-end loader is used, the easiest method is to cover the entire distribution area with four inches of gravel. When using a wheelbarrow it is easiest just to cover strips 18 inches wide where the distribution laterals will be placed. If the fill is as fine-textured as a sandy loam, a layer of coarse sand may be added between the fill and gravel. This sand will act as a preliminary filter to reduce excessive clogging of the underlying fill.

The lateral lines are assembled on the distribution area as described later, and two inches of gravel are placed over the lines. The gravel is then covered with a layer of filter or paving fabric, builder's paper or straw, and the entire mound covered with six inches of topsoil. Prior to seeding with grass and mulching, the topsoil cap should be shaped so that no area of the mound will collect surface water.

When a mound with a large base is being built, it is often impossible to move all the material into place without some traffic around the sideslopes. If this is the case, the mound can be built in two stages, provided extreme care is used. First, the core of the mound is built up with fill, gravel and topsoil, following the instructions above. Then, the soil around the core is tilled again and the sideslopes are completed. It is important that traffic on the sideslope area be kept to an absolute minimum when the core is being built, and that this procedure be used only when the soil is quite dry and resistant to structural damage.

Tank installation

The two-compartment septic tank is installed in the same way as in a conventional system. Wastewater from the house flows directly into the large compartment of the tank. The pumping chamber is installed next to the septic tank, but its direction must be reversed, so that the tee end becomes the inlet end adjacent to the septic tank. The lower invert of the tee end ensures proper gravity flow from the septic-tank outlet into the pumping chamber. The tanks are connected with an appropriate length of solid, four-inch PVC pipe. Inlet and outlet openings around the pipe must then be sealed with mortar.

The tank access lids must be equipped with water-tight masonry or concrete risers at least six inches above grade. These provide easy access for repair and inspection, and help keep surface water out of the tanks.

If a mound is being installed to replace an existing conventional septic system, only one additional tank (the pump chamber) must be installed. However, the existing septic tank must be pumped out before installing the mound.

Supply manifold

The supply manifold conveys effluent from the pump to the distribution laterals. Any effluent remaining in the lateral lines when the pump shuts off should drain back to the pumping chamber through the supply manifold (unless the system is large enough to require a check valve). The manifold joins each lateral through a short riser-pipe connecting a reducing tee on the manifold to a 1¼-inch elbow or tee on the lateral (Figure 9). This assembly places each lateral pipe a few inches higher than the supply manifold and helps maintain uniform distribution among the laterals. The individual riser units may be assembled earlier and glued in place after the manifold is cut into segments between the laterals.

After the supply manifold has been placed in its trench and lateral lines connected, it should be backfilled with tightly tamped soil. The supply manifold trench must not be backfilled with gravel, or the trench may become a conduit for downslope flow of effluent from the laterals. The outlet hole in the pumping tank should not be sealed with mortar until after the pump is in place.

Lateral lines

The lateral lines are assembled on the distribution area. The 1¼-inch PVC pipes should be laid out and cut to proper lengths for the lateral lines. Holes are drilled (in a straight line) according to the design specifications after the laterals have been cut to their proper length. The first hole in each lateral should be drilled two to three feet from the manifold; the last hole should be drilled two to three feet from the end of the lateral. Holes are only drilled through one side of the pipe. If the drill bit should go through both sides, or if a hole is drilled in the wrong place, it can be sealed by wrapping with duct tape. Lateral pipes are placed with the holes down on the gravel. A short turn-up with a capped end is at the end of each lateral (Figure 9). The capped end must be brought up above or flush with the final grade. The turn-up may be placed inside a short length of four-inch or six-inch PVC or terra cotta pipe to protect it from lawn mower damage, while still providing easy access. When installing each lateral, care must be taken to ensure that the holes are oriented downward and the turn-up pointed upward before the quick-drying PVC glue hardens. After the lateral lines are in place and leveled, they are covered with gravel, fabric and topsoil as described earlier.

Pump and controls

Details of pump installation are shown in Figure 10. The pump must be placed on two concrete blocks set next to each other on the bottom of the tank. This prevents the pumping of any solid particles which can clog the mound system. A piece of nylon rope or other corrosion-resistant material should be attached to the pump and to the outlet pipe for lifting the pump in and out of the chamber. (The PVC outlet pipe is too fragile to support the pump.)

Controls are fastened to the outlet pipe with clamps or brackets supplied by the manufacturer. The lower level control or pump-off must be positioned above the pump, so that the pump remains submerged at all times. The upper level control (pump-on) is positioned to pump a specified volume of effluent (Chapter 5). The high-water control float is then mounted about three inches above the upper pump-on control. (**Note:** Care must be taken to ensure that the floats do not become entangled by other components in the tank such as the electric power cord or the lifting rope.)

The outlet pipe should be connected to the supply manifold with a threaded PVC union to allow quick removal. The gate or globe valve must also be installed in the supply line (within the pump chamber) to allow final adjustment of the pressure. If effluent will be pumped downhill, a ¼-inch siphon-breaker hole must be drilled in the bottom of the supply line before it leaves the pump tank. This breaks any vacuum in the system and prevents the inadvertent siphoning of effluent out of the tank. This hole is very important.

Power and control cords should be guided out of the pump chamber through a recessed channel or opening that will protect the cords from damage by the concrete lid.

Electrical connections

As noted earlier, the pump and high-water alarm must be placed on separate electrical circuits. (If the pump circuit fails, the alarm must still be able to operate.) Follow the manufacturer's recommendations for proper fuses or circuit-breakers.

All electrical connections must be made outside the pumping chamber. Power cords from the pump and controls should be plugged into a NEMA-approved outdoor receptacle mounted outside of the pumping chamber. The receptacle must not be located inside the pumping chamber due to the corrosive and explosive gases that may form from the sewage.

Electrical connections may be made inside the pumping tank only if wired inside a sealed, watertight box. Some level-control switches have such a box built into the housing but are more expensive than the plug-in devices.

Wiring between the pumping chamber and the house should meet state and local code requirements. A lightning arrestor is recommended to protect the pump and controls from electrical surges.

Proper operation check

After all components have been installed and connected, the system should be checked for proper operation. With electrical power turned off, fill the pumping chamber with a garden hose (or allow effluent to accumulate) until the liquid rises to the level of the high-water alarm float.

Turn on the electrical power. The alarm light should go on in the house, and the pump should start operating. The alarm light should go off when the liquid level falls below the high-water float. The pump should turn off when the liquid reaches the lowest float control. Be sure the pump is still completely submerged.

Pressure head adjustment

The pressure head must be adjusted to match that specified in the design. The pressure head is measured as the height liquid will rise above the turn-up elbow when the pump is running. To adjust the head glue a four-foot length of pipe (preferably clear) to a threaded adapter that will screw onto the turn-up adapters. Replace the turn-up cap with the pipe and adapter. Then turn the power on to allow liquid to rise in the pipe and adjust the gate or globe valve in the pumping tank until the effluent reaches the desired height in the pipe. Remember to include the distance below the mound surface to the lateral line when measuring the height.

Final landscaping

After the mound system is installed, the following should be checked to ensure that the system will not be overloaded with excess rainwater and runoff:

- The mound is shaped to shed rainwater and is free of low areas.
- Curtain drains, grassy swales or ditches for diverting ground and surface water are properly installed.
- Gutter and downspout drains are directed away from the system.

Any problems should be corrected before approving the system.

Finally, the entire area must be planted with grass in order to prevent erosion. The mound should be limed if necessary and fertilized before planting. After applying an appropriate grass seed, the area should be heavily mulched with straw or other suitable material.

CHAPTER 8
Inspection and Maintenance

Installation inspection

The successful performance of a mound relies on proper design and installation. The details for a given system, from site preparation to final landscaping, should be carefully specified on the Improvements Permit. This helps clarify the responsibilities of the property owner, contractor and permitting agency and helps avoid last-minute surprises when issuing a Certificate of Completion. Items on the Improvements Permit (and associated design specifications for the mound system) should be inspected by the permitting agency in four stages as outlined in Appendix 4.

Regulatory agencies are strongly recommended to withold the Certificate of Completion until all the above requirements are satisfied. A checklist similar to Appendix 4 should be completed and filed each time a system is installed to ensure completion of the requirements.

Operation inspections

A properly designed and installed mound requires very little maintenance. Several routine items should be checked periodically and an extra pump should be available. Mound systems should be observed by the regulatory agency at one, three, six and nine months after initial installation, and every six months thereafter. An inspection report should be completed and filed each time the system is checked. A sample format is shown in Appendix 5.

Routine maintenance

All septic tanks, whether for conventional or alternative systems, require occasional pumping. Sludge and scum accumulation should be checked annually. Virtually all solids will be retained in the first compartment of the two-compartment tank. Little or no accumulation should occur in either the second compartment of the septic tank or in the pumping chamber. The rate of sludge accumulation will vary with individual living habits. Most septic tanks require pumping about once every four years.

Some mound systems may gradually accumulate solids at the ends of the lateral lines. These should be removed at least once a year by unscrewing the caps on each of the turn-ups and back-flushing the laterals with a garden hose.

Pressure head in the laterals should also be checked and adjusted one month after installation and annually thereafter (Chapter 7). Proper pump and float-control operation should be checked during all routine inspections. If the alarm panel has a "push-to-test" button, it should be checked regularly. Pump maintenance should follow the manufacturer's recommendations.

Repair procedures

The alarm light should go on whenever effluent in the pump chamber rises above the pump-on level control. This can occur for several reasons:

- Power failure: If there has been a power failure, effluent will continue to accumulate in the tank until power is restored. At this time the alarm may come on for a brief period (less than 30 minutes), but will go off as soon as the pump draws down the effluent.
- Pump or switch failure: If the pump or level controls malfunction, they can be quickly replaced by unscrewing the PVC union and lifting the entire assembly out of the pumping chamber (use the nylon lift rope). Be sure to turn off the power supply, and disconnect all cords before removing or replacing the pump or control assembly.
- Clogged valve or discharge holes: If the distribution system becomes clogged, the tank will not be emptied. Back-flush the laterals and supply manifold if necessary.

Before replacing any components, make sure that the level controls have not simply become tangled. The problem can usually be isolated by checking the pump operation independently from the controls. Repair or replace the appropriate components.

CHAPTER 9

Mound Design and Installation on Sloping Ground

A sloping site presents a special set of problems for mound design. The mound must be carefully planned to avoid local overloading and seepage of effluent. This chapter highlights changes in the design procedure which are necessary when designing mound systems on slopes.

Layout

The procedure parallels that in Chapter 3, with careful emphasis placed on the following points.

- The surface of the distribution area must be level. More fill will be required on the downslope side of the distribution area than on the upslope side.
- The effects of slope can be lessened by making the distribution area as long and narrow as possible along the contour.
- Since effluent percolating through the mound will move downhill, the basal area can include only the areas directly beneath and downslope from the distribution area.
- Interceptor or curtain drains are usually necessary to divert water moving from uphill.
- Installation on slopes greater than ten per cent is not recommended.
- Mounds on slopes are often larger and more difficult to install than similar mounds designed for level ground.

The size of the mound distribution area is calculated as described in Chapter 3. When determining the shape, the area should be as long and narrow along the contour as space will allow, especially on slopes exceeding five percent. Six to eight feet is a practical minimum width for the distribution area, and individual lateral lines should not extend more than 70 feet in length past the supply manifold.

Step 1. Determine the dimensions of the distribution network.

Example:

For a 600 ft^2 distribution area with a width of 10 ft:

Length = area/width
= 600 ft^2/10 ft
= 60 ft

Dimensions are 10 ft x 60 ft

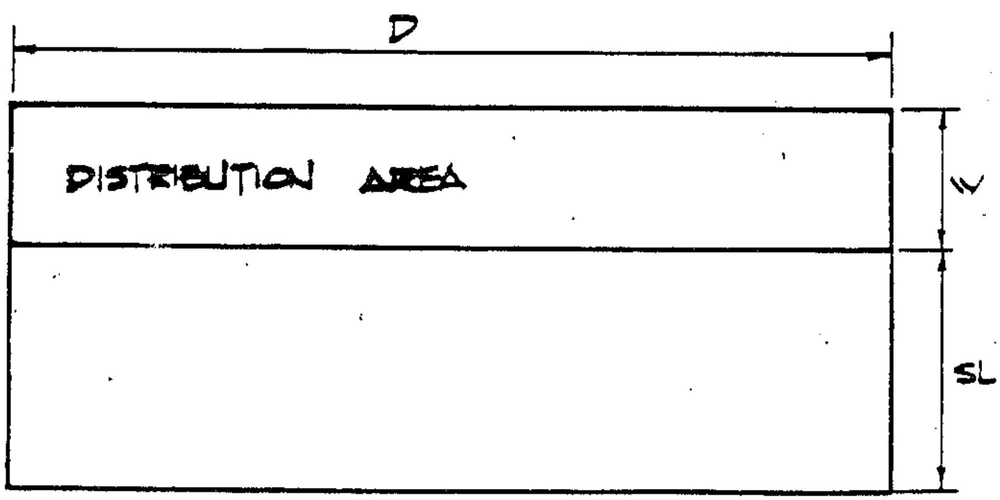

Figure 11. Basal area to meet soil-absorption requirements on sloping lots

The mound base for sloping systems must be designed to meet both soil-absorption and geometry requirements, just as for level systems. But the basal dimensions for sloping lots are calculated differently from level lots as described below.

The basal dimensions are calculated by adding the sideslope dimensions to the distribution-area dimensions. The sideslope dimensions are computed and compared for both soil-absorption and geometry requirements. To meet both sets of requirements, the larger dimensions are chosen.

The basal area needed to meet soil-absorption requirements on sloping lots includes only the area directly beneath and downslope of the distribution area (Figure 11). The size of the mound basal area (BA) is calculated as described in Chapter 3.

Step 2. Calculate mound basal area.

Example:

For a 450 gpd wasteflow and 0.25 gpd/ft^2 loading rate:

BA = 450 gpd/0.25 gpd per ft^2
= 1800 ft^2

Then, the lower sideslope is calculated using the equation,
SL = (BA/D)−W, where
D = length of distribution area
W = width of distribution area
SL = length of lower sideslope (Figure 11)

Step 3. Calculate lower sideslope.

Example:

For the example mound with a 10 ft x 60 ft distribution area and 1800 ft^2 basal area:
BA = 1800 ft^2
D = 60 ft
W = 10 ft
SL = (1800 ft^2/60 ft) −10 ft
= 20 ft

To calculate the sideslope dimensions to meet geometry requirements, the fill height must be known. More fill will be needed on the lower side of the mound than the upper side to obtain a level distribution area (Figure 12). The height of fill on the lower side (HL) is calculated using the equation,
HL = HU + (G x W), where
HU = height of fill on upper side
G = grade (slope) of site
W = width of distribution area

Step 4. Calculate fill height for lower side of distribution area.

Example:

For a 10 ft x 60 ft distribution area on a 6% grade with two ft of fill on the upper end:
HU = 2 ft
G = .06
W = 10 ft
HL = 2 ft + (.06 x 10 ft)
= 2.6 ft

For stable sideslopes there must be three feet of horizontal distance for every foot of fill height. The sideslope length will vary on each side of the mound, depending on the fill height (Figure 13). In Figure 13:

SU = upper sideslope length
SL = lower sideslope length
SS = side sideslope length
HS = average side fill height = (HU + HL)/2

Step 5. Calculate the sideslope lengths to meet geometry requirements.

Example:

For HU = 2.0 ft and HL = 2.6 ft
SU = 3 x HU
= 3 x 2 ft = 6 ft
SL = 3 x HL
= 3 x 2.6 ft = 8 ft

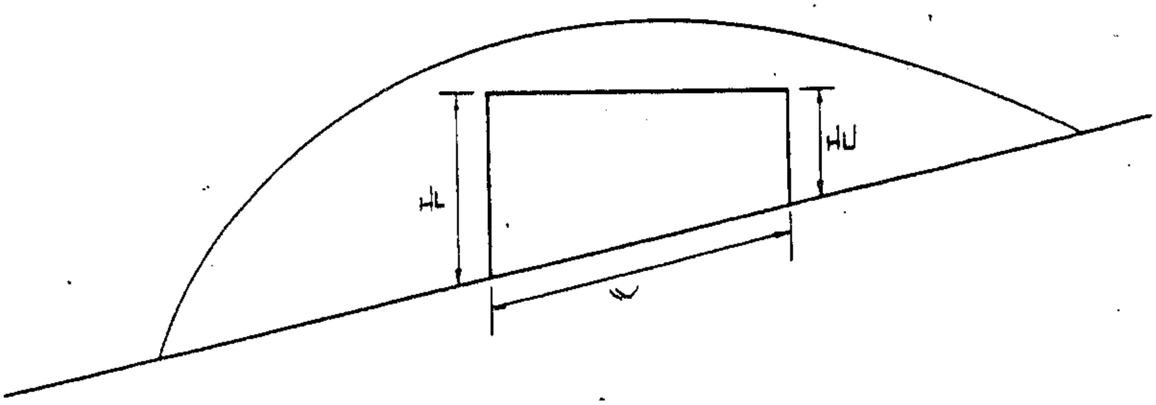

Figure 12. Fill height on sloping lots

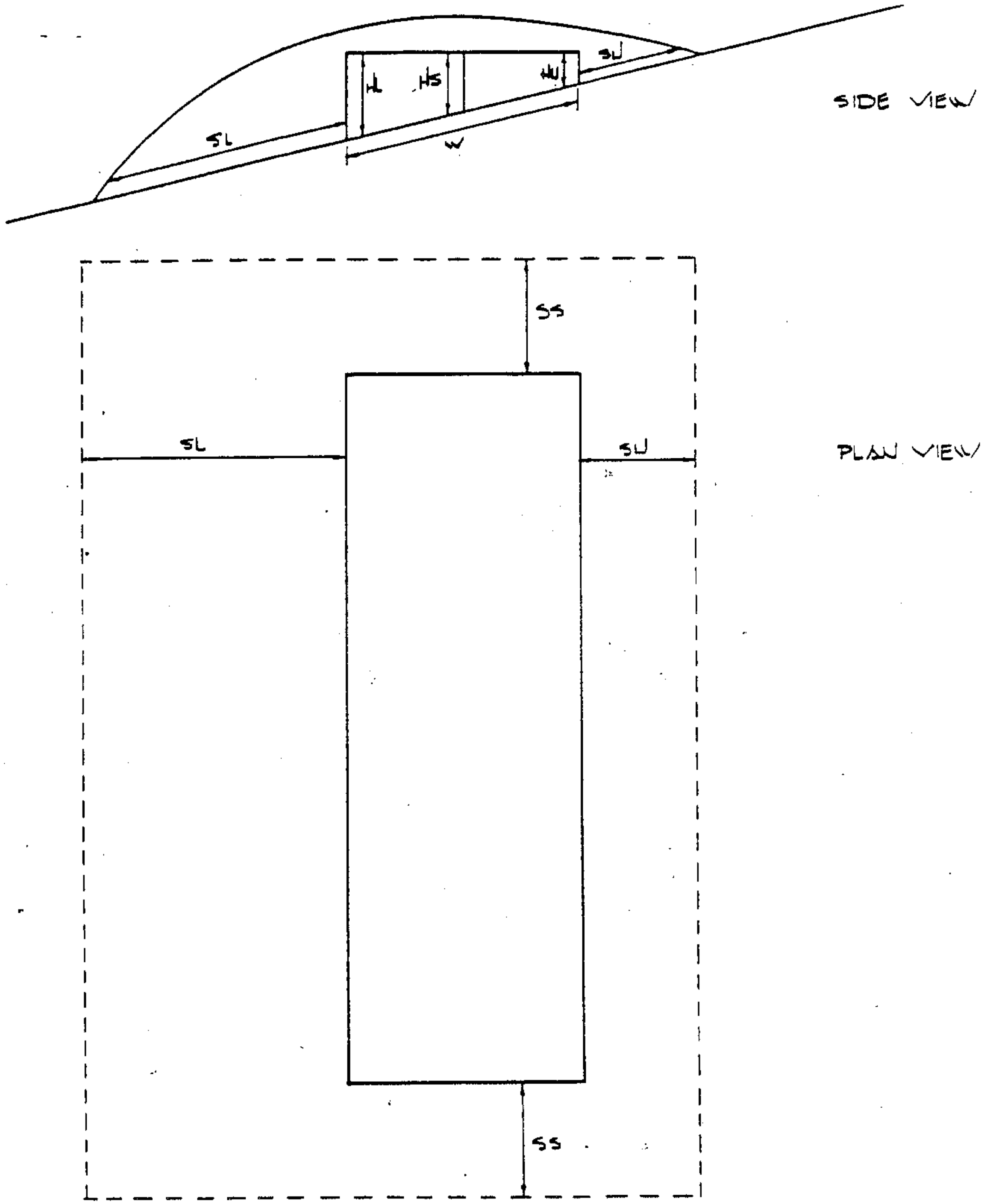

Figure 13. Basal area to meet geometric requirements on sloping lots

SS = 3 x HS
= 3 [(2 + 2.6 ft)/2]
= 3 x 2.3 ft = 7 ft

Step 6. Compare sideslope lengths calculated for both requirements (Steps 3 and 5). Choose the larger lengths for computing the basal dimensions of the mound.

Example:

Sideslope	Geometry Requirements	Soil-Absorption Requirements
SU	6 ft	0
SS	7 ft	0
SL	8 ft	20 ft

Step 7. Calculate the basal dimensions of the mound by adding the distribution-area and sideslope dimensions.

Example:

For the 10 ft x 60 ft mound: (see Figure 14)
Basal width = W + SU + SL
= 10 ft + 6 ft + 20 ft
= 36 ft
Basal length = D + SS + SS
= 60 ft + 7 ft + 7 ft
= 74 ft
Basal area = 74 ft x 36 ft
= 2700 ft^2

Other considerations

Fill, gravel and topsoil requirements are calculated in the same manner as Chapter 4, except for the following change. The volume of fill was computed using the formula for a trapezoid (pg. 8). On sloping lots the mound is not symmetrical, and this formula slightly underestimates the volume of fill needed. To correct for this underestimate, use the fill height at the lower edge of the distribution network as the mound height. In the example above this height is 2.6 feet.

The distribution system is designed using the same method as Chapter 5. Special care must be taken when selecting the pump. If the mound is located uphill of the pumping tank, the elevation head will be greater than on a level lot. If the hill is large enough, it may become impractical to adjust the system for use with a 4/10 horsepower pump, then a larger, more expensive pump would be needed. If the mound is lower than the pumping tank, either a siphon-breaker hole must be used in the supply line or the pump replaced with a dosing siphon (pg. 18).

Mounds can be built on bench cuts on slopes, provided the basic soil and drainage criteria are satisfied.

The following two installation precautions are vital to the successful operation of a mound on a sloping site.

- The area downslope of the distribution area must be protected from traffic because much of the effluent will be absorbed there.
- The distribution area must be carefully leveled so that uniform effluent distribution occurs.

The difficulty in building mounds increases as the slope increases. This should be kept in mind when considering mound installation on sloping sites.

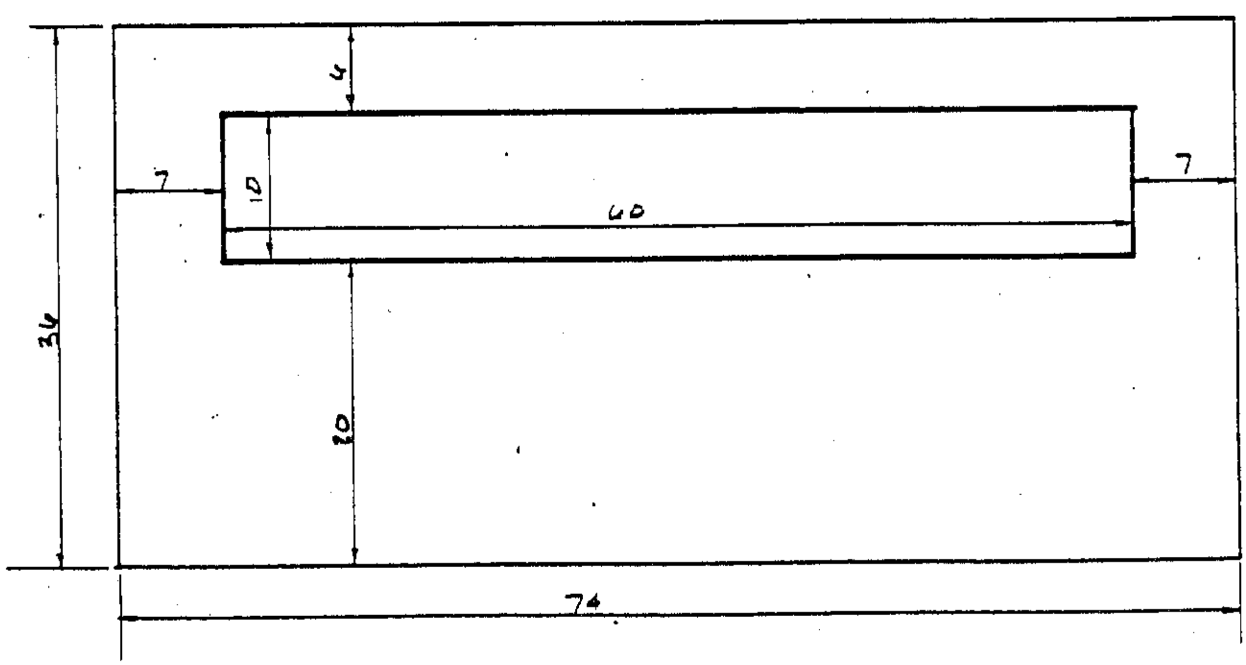

Figure 14. Basal dimensions for example system

Appendix 1. Design specifications for example mound (Chapters 3-5)

File a copy of this sheet along with an accurate sketch for each mound designed.

Daily waste flow	450 gal
Septic tank size	1200 gal
Pumping tank size	900 gal
Loading rate for fill	0.8 gal/ft²/day
Distribution area	600 ft²
Loading rate for soil	0.5 gal/ft²/day
Basal area	1400 ft²
Volume of fill	81 yd³
Volume of topsoil	27 yd³
Volume of gravel	15 yd³
Total length of laterals	185 ft
Lateral diameter	1¼ in.
Lateral configuration	5 x 3 ft lines
Supply line length	50 ft
Supply line diameter	1½ in.
Manifold placement	side
Hole size	5/32 in.
Hole spacing	3 ft
Number of holes	60
Pressure head	3 ft
Flow per hole	0.50 gpm
Total flow	30 gpm
Elevation head	7 ft
Friction head	3.1 ft
Pressure head	3 ft
Total head	13.1 ft
Pump requirements	30 gpm, 13.1 ft head
Storage volume in laterals	15.8 gal

Appendix 2. Pipe and fittings for example mound (Chapters 3-5)

Type	Size	Quantity	Description
Pipe, 160 psi	4 in.	10 ft	Connects septic tank to pumping tank
Pipe, 160 psi	1½ in.	50 ft	Supply manifold
Pipe, 160 psi	1¼ in.	200 ft	Lateral lines plus extra length for turn-ups and tee risers.
Tee*	1½ x 1½ x 1¼ in.	4	For joining manifold to first 5 laterals
Elbow	1½ x 1¼ in.	1	For joining manifold to last lateral
Elbow	1¼ in.	10	5 for joining laterals to manifold 5 for turn-ups
Male adapter	1¼ in.	5	For turn-ups
Threaded cap	1¼ in.	5	For turn-ups
Male adapter**	1½ in.	3	1 for pump outlet 2 for gate valve
Elbow	1½ in.	1	For pump to supply line connection
Threaded union	1½ in.	1	For quick removal of pump
Gate valve	1½ in.	1	PVC or brass
PVC glue	1 qt	1	
PVC primer	1 qt	1	

*Details of these connections are shown in Figure 9

**Size of this adapter and the following fittings depend on size of pump outlet.

Appendix 3. Other supplies for example mound

Type	Size	Quantity	Description
Fill		81 yd	90% sand, 10% fines
Topsoil		27 yd	To support good crop cover
Gravel		15 yd	Washed
Pump	0.4 hp	1	Submersible effluent pump
Switch		1	Sealed level controls adjustable to 5-inch drawdown
Alarm		1	Sealed mercury float switch and alarm light
Wiring			Approved outdoor receptacle, wire and conduit for 110V service
Septic tank	1200 gal	1	Two compartment
Pumping tank	900 gal.	1	Single compartment septic tank
Risers		2	Concrete risers or well tiles, or blocks and mortar - to raise tank lids six inches above final grade
Lids		2	To fit on risers
Concrete blocks		2	Raised support for pump
Nylon rope		8 ft	To remove pump from tank
Mortar			To seal around supply line and riser
Grass seed			Locally adapted variety
Lime			
Fertilizer			
Mulch			

Appendix 4. Mound construction inspection checklist

Site identification ____________________

Site preparation — Date ____________

1. Is the site in the right location? ______
2. Roped off and protected from traffic? ______
3. Trees and brush cleared? ______
4. Provisions for site drainage? ______
5. Will mound area shed or collect water? ______
6. Comments ____________________

Construction check — Date ____________

1. Fill, gravel, and topsoil:
   - Is the fill suitable? ______
   - Is the topsoil suitable? ______
   - Fill incorporated with underlying soil? ______
   - Depth of gravel suitable? ______
   - Barrier used between gravel and topsoil? ______
2. Tanks:
   - Proper size and type? ______
   - Installed properly? ______
3. Manifold and laterals:
   - Holes drilled properly and placed downward? ______
   - Manifold and laterals connected properly? ______
4. Water conservation devices installed in house? ______
5. Comments ____________________

Operation check — Date ____________

1. Pump and switches operating? ______
2. High water alarm operating? ______
3. Electric receptacle outside pump tank? ______
4. Pressure head in lateral lines? ______
5. Comments ____________________

Final landscaping — Date ____________

1. Site shaped to shed rainwater? ______
2. Any low areas? ______
3. Diversion drains? ______
4. Downspout drains directed away from system? ______
5. Seeded and mulched? ______
6. Comments ____________________

Appendix 5. Maintenance checklist

Site identification ______________________ Date ____________

System type ______________________

Site examination

1. Any rainfall in last 3 days? ______
2. Effluent ponded on surface? ______
3. Indications of recent ponding? ______
4. Ground above system damp and mushy compared to surrounding area? ______
5. Noticeable odor of sewage? ______
6. Other ______________________

____

If any "Yes" answers, sketch location and extent on back of page

Site maintenance

1. Condition of vegetative cover ______________________
2. Site drainage (roof water, ditches, etc.) ______________________
3. Riser and lid ______________________
4. Turn-ups ______________________
5. Erosion ______________________

Pump examination

1. Pump and switch properly plugged in? ______
2. Pump operating? ______
3. Switch operating? ______
4. Good seal where supply line leaves tank? ______
5. Quality of effluent
   Greasy? ______
   Sludge accumulation? ______
6. Measure pressure head and adjust.
   Initial head ______
   Adjusted head ______
7. Comments on problems noted above ______________________

____

____

Comments from homeowner ______________________

____

____

Additional observations ______________________

____