Design and Construction Manual for Sand Mound Systems

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(5th Edition)

State of Maryland
Department of the Environment
Water Management Administration
Wastewater Permits Program
On-Site Systems Division

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SECTION ONE
INTRODUCTION

1.1 PURPOSE

This manual provides information on site selection, design and construction of sand mound sewage disposal systems in Maryland. The manual has been prepared for use in Department-sponsored training programs and applies to small residential systems with five bedrooms or less. Larger sand mound systems and systems receiving non-domestic sewage may require more detailed soil- hydrogeologic investigations, different sizing and design criteria and additional pretreatment.

Specific site evaluation, design, installation and maintenance criteria which may not be discussed in this manual are required if any Sand Mound system is to be considered a Class IV BAT. Refer to the most current version of the MDE document called " BAT CLASS IV: SAND MOUNDS" for the specific requirements.

The procedures used in this manual involve standardization of some design criteria in order to simplify design and construction. Designers and contractors are encouraged to review other references for additional information. A list of references is provided.

In the following sections procedures are presented for:

- Selecting a site
- Determining the mound dimensions and orientation on the site
- Designing the pressure distribution network and pumping system
- Constructing the system

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1.2 DESCRIPTION

A sand mound system is an on-site sewage disposal system that is elevated above the natural soil surface in a suitable sand fill material (**Figures 1.1 and 1.2**). Gravel-filled absorption beds are constructed in the sand fill, and effluent from a double-compartment septic tank or BAT unit is pumped into the absorption area through a pressure distribution network. The use of an effluent filter in the outlet end of the septic tank is required when a BAT unit is not required. Pretreatment of sewage occurs in the septic tank or BAT unit, and additional treatment occurs as the effluent moves downward through the sand fill and into the underlying natural soil.

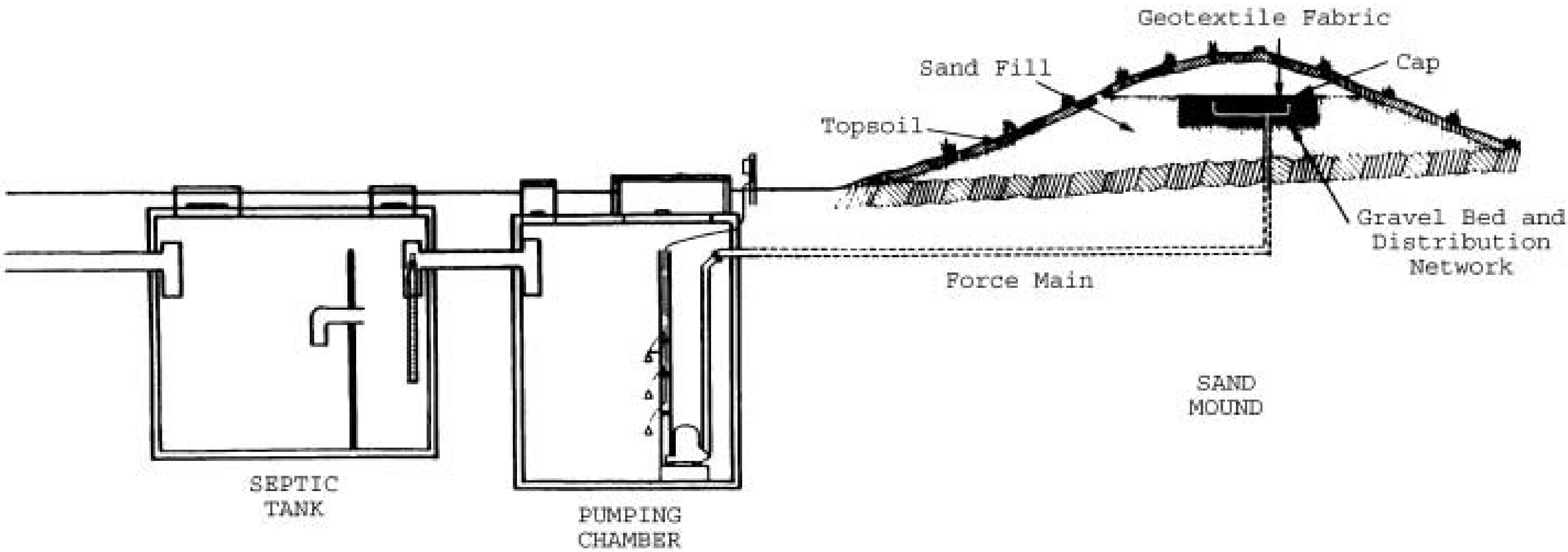


FIGURE 1.1 – TYPICAL CROSS SECTION OF A SAND MOUND SYSTEM SERVED WITH SEPTIC TANK EFFLUENT

(not to scale)

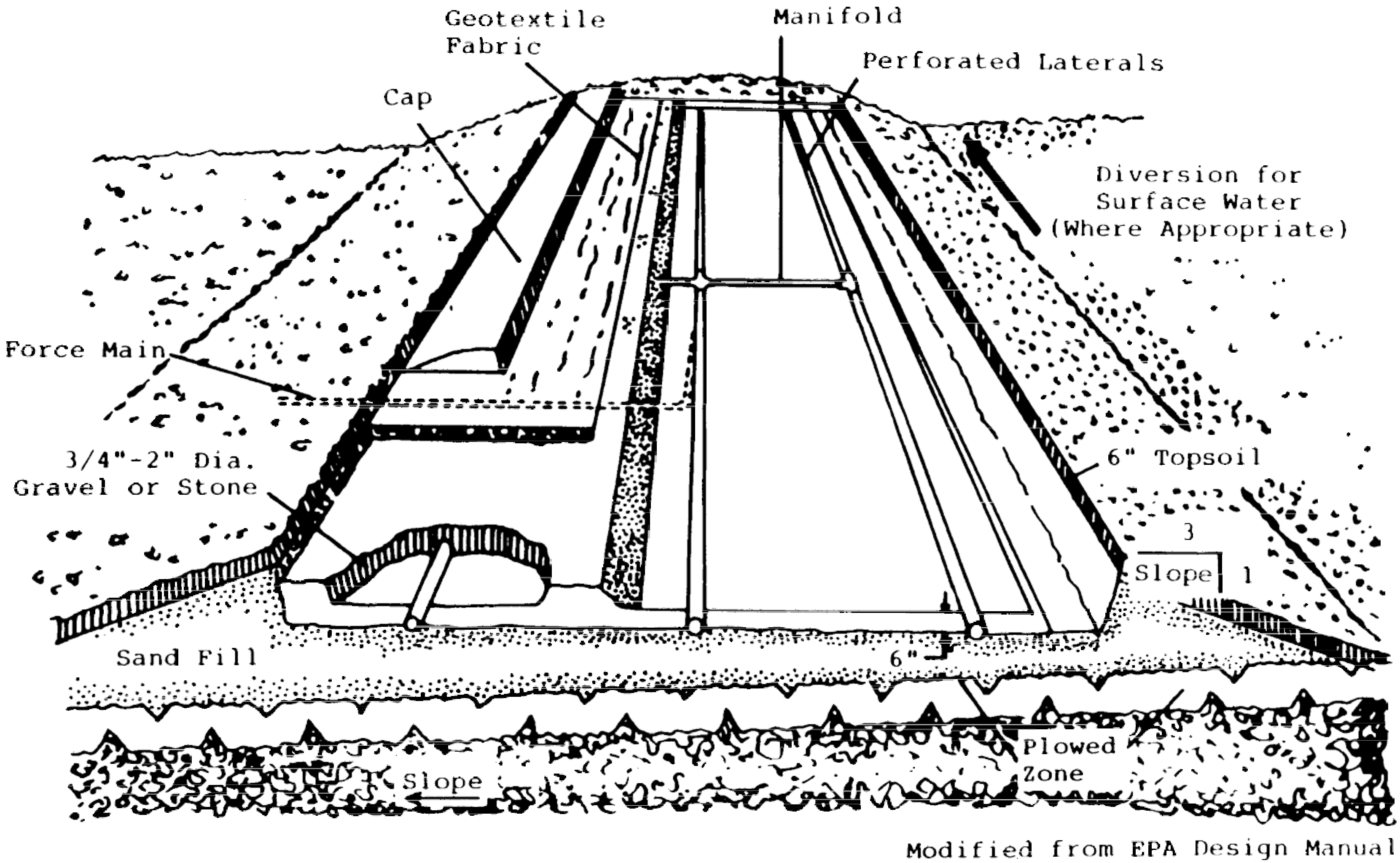


FIGURE 1.2 – DETAILED SCHEMATIC OF A SAND MOUND SYSTEM WITH 3 LATERAL ROWS AND 6 TOTAL LATERALS

The purpose of the design is to overcome site limitations that prohibit the use of conventional trench on-site sewage disposal systems.

The design can overcome the following site limitations:

- High water tables
- Shallow soils over fractured bedrock
- Slowly permeable soils

Presently in Maryland, sand mound systems that meet conventional on-site sewage disposal criteria are designed to overcome high water tables or shallow soils over fractured bedrock and are approved for routine use. Sand mound systems on slowly permeable soils, with rates of 60-120 minutes per inch, are currently nonconventional (alternative) and may be installed in repair situations or on certain existing lots of record

SECTION TWO
SITE CRITERIA

2.1 GENERAL

This section summarizes site criteria used to determine if a site is suitable for a sand mound. Site criteria are presented in **Table 2.1**, and land area requirements for the initial mound are presented in **Table 2.2**.

A detailed site evaluation, conducted by local health department county staff or by a qualified consultant, must be performed at each site to determine suitability. The evaluator must have a thorough knowledge of the principles and practices associated with proper soils evaluation, as well as an understanding of the design and function of sand mounds. Evaluation techniques from the current edition of the MDE *Site Evaluation Training Manual for On-Site Sewage Treatment and Disposal Systems* should be employed. This includes the “Cylinder Infiltrometer Test Method” described in Appendix J of the site evaluation manual.

TABLE 2.1
SITE CRITERIA FOR SAND MOUND SYSTEMS

Item	Criteria
Landscape Position	Well to moderately well drained areas, level or sloping. Crests of slopes or convex slopes are most desirable. Avoid depressions, bases of slopes and concave slopes unless suitable drainage is provided.
Slope	0 to 12% for soils with percolation rates equal to or faster than 60 min./inch.[a]
Minimum Horizontal Separation Distances from Edge of Basal Area	
Wells	50 feet in confined aquifer 100 feet in unconfined aquifer
Surface Water	100 feet
Slopes >25%	25 feet
Boundary of Property	10 feet
Building Foundations	10 to 30 feet
Soil Requirements	
Profile Description	Soils with a well-developed and relatively undisturbed A horizon (topsoil) are preferable.
Unsaturated Depth	24 inches of unsaturated soil should exist between the original soil surface and seasonally saturated horizons or pervious fractured bedrock.
Depth to Impermeable Barrier	3 to 5 feet.[b]
Percolation Rate	2 to 60 minutes/inch measured at 12 to 24 inches. 60-120 minutes/inch for alternative sand mounds[c]
Linear Loading Rate	Less than or equal to 10 gallons per linear foot[d]
Land Area Requirements	5,800 to 13,300 square feet.[e]

[a] Mounds have been sited on slopes greater that these, but experience is limited. In those cases, an MDE variance is required.
[b] Acceptable depth is site dependent.
[c] Cylinder infiltrometers are used to measure percolation rates. Tests are run in the least permeable soil horizon in the upper 24 inches. In shallow soils over pervious fractured bedrock, cylinder infiltrometer tests can be run at 12 inches.
[d]A detailed soil description and site evaluation is necessary to determine an appropriate linear loading rate for difficult sites. The linear loading rate concept is also discussed by Jerry Tyler and Laura Kuns in a publication called "*Designing with Soil: Development and Use of a Wastewater Hydraulic Linear and Infiltration Loading Rate Table*". This document can be downloaded from the Small Scale Waste Management Project at http://www.soils.wisc.edu/sswmp/online_publications.htm (Publication # 4.42)
[e] Total area required for initial mound and recovery area(s) is dependent on design flow and site- specific data.. A minimum of 10,000 ft2 sewage disposal area is required.

TABLE 2.2
APPROXIMATE SAND MOUND DIMENSIONS & AREA REQUIREMENTS FOR SITES WITH PERCOLATION RATES 2-60 MINUTES PER INCH[a]

Three Bedroom (450 gpd) 375 Square Feet Bed Absorptive Area					
Percent of Slope	4 × 94	5 × 75	6 × 63	8 × 47	Absorption Bed Dimensions (Ft.)
0%	27 × 120 3240	28 × 101 2828	29 × 89 2581	31 × 73 2263	Final Dimensions (Ft.) (Square Feet)
6%	29 × 121 3509	30 × 102 3060	31 × 90 2790	34 × 75 2550	Final Dimensions (Ft.) (Square Feet)
12%	33 × 121 3993	34 × 103 3502	36 × 91 3276	39 × 76 2964	Final Dimensions (Ft.) (Square Feet)
Four Bedroom (600 gpd) 500 Square Feet Bed Absorptive Area					
Percent of Slope	5 × 100	6 × 83	8 × 63	9 × 60	Absorption Bed Dimensions (Ft.)
0%	28 × 126 3528	29 × 109 3161	31 × 89 2759	32 × 86 2752	Final Dimensions (Ft.) (Square Feet)
6%	30 × 127 3810	31 × 110 3410	34 × 90 3060	35 × 88 3080	Final Dimensions (Ft.) (Square Feet)
12%	34 × 128 4352	36 × 111 3996	39 × 102 3978	41 × 89 3649	Final Dimensions (Ft.) (Square Feet)
Five Bedroom (750 gpd) 625 Square Feet Bed Absorptive Area					
Percent of Slope	6 × 104	8 × 78	9 × 75		Absorption Bed Dimensions (Ft.)
0%	29 × 130 3770	31 × 104 3224	32 × 101 3232		Final Dimensions (Ft.) (Square Feet)
6%	31 × 131 4061	34 × 106 3604	35 × 103 3605		Final Dimensions (Ft.) (Square Feet)
12%	36 × 132 4752	39 × 107 4173	41 × 104 4264		Final Dimensions (Ft.) (Square Feet)

[a] **Based on mounds having 24 in. upslope sand fill depth & bed design infiltration rates of 1.2 gpd/ft^2.**

SECTION THREE
MOUND DIMENSIONS

3.1 GENERAL

This section presents a procedure for sizing sand mound systems. Background data from a proposal or permit application and site evaluation data are used to calculate absorption bed dimensions and select the best orientation of the mound. Bed dimensions are then used along with site data to determine final mound dimensions. The design process and the effects of background and site data on final mound dimensions are explained. Diagrams showing a cross section and plan view of a mound and equations for calculating mound dimensions are given in **Figures 3.1 and 3.2** and **Table 3.1**. The sand mound design example presented in this manual is based on the following site data:

Example

Slope	=	6%
Depth to High Water Table	=	24 inches
Design Flow	=	750 gallons per day (gpd) based on a five-bedroom (BR) home

3.2 DESIGN PROCEDURE

3.2.1 Slope

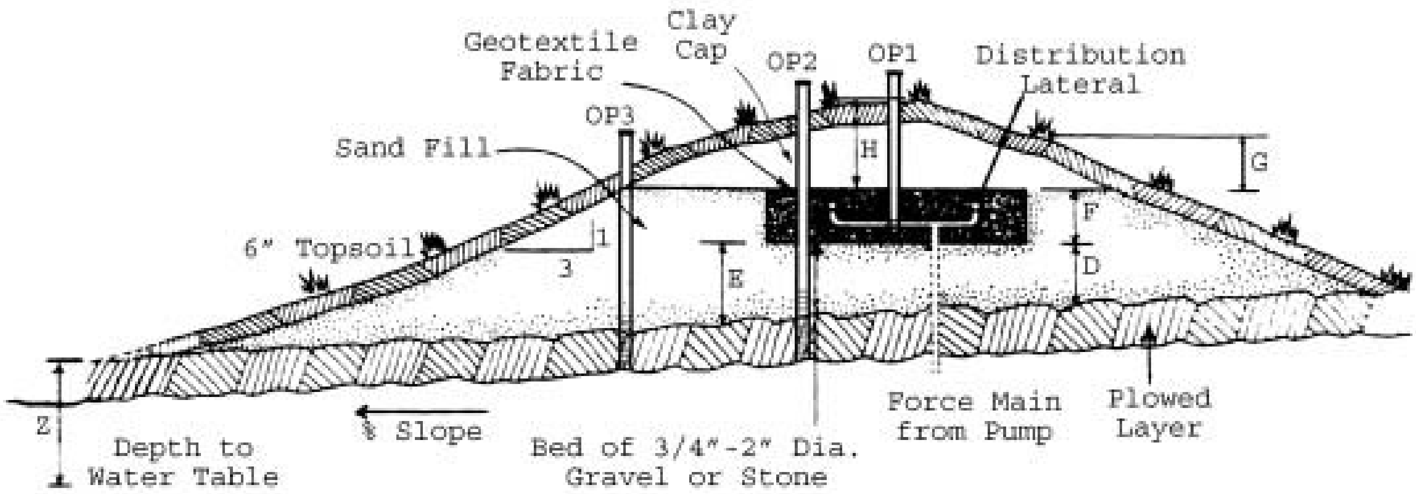
Slope is important in sand mound design because it influences the depth of sand fill below the absorption bed and the final mound dimensions. Slope percent may be measured directly on-site with a clinometer or abney level. Slope may also be determined by using a lock level, dumpy type level, or an accurate large-scale detailed plan with contour lines and the following equations:

$$\% \text{ Slope} = \text{Change in elevation over a 100-foot distance}$$

$$\% \text{ Slope} = \text{Rise/run} \times 100$$

SAND MOUND

Cross Section

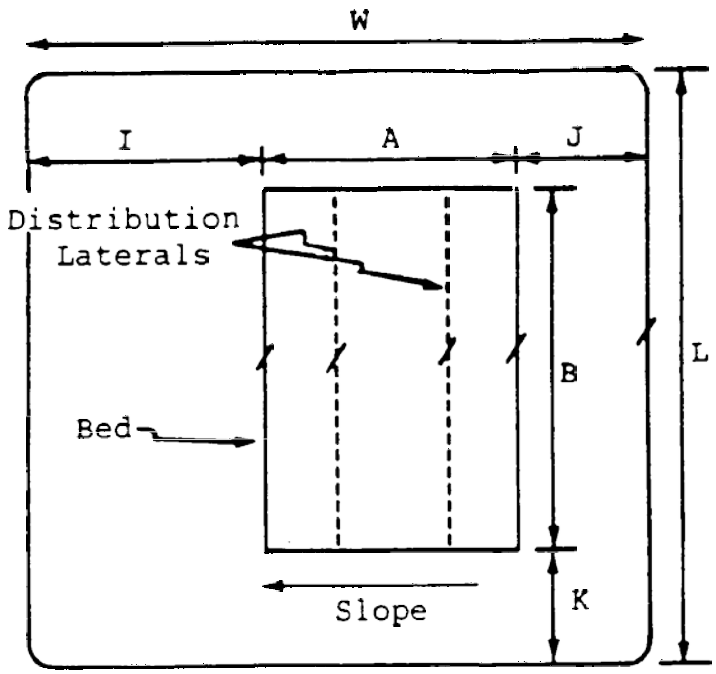


D	=	Upslope Sand Fill Depth (in.)
E	=	Downslope Sand Fill Depth (in.)
F	=	Bed Depth (in.)
G	=	Cap and Topsoil Height at Bed Edges (in.)
H	=	Cap and Topsoil Height at Bed Center (in.)
Z	=	Depth to Water Table (in.)
OP	=	Observation Ports (**required**)

FIGURE 3.1 – DESIGN WORKSHEET CROSS SECTION

SAND MOUND

Plan View



A	=	Bed Width (ft.)
B	=	Bed Length (ft.)
K	=	Sideslope Setback (ft.)
J	=	Upslope Setback (ft.)
I	=	Downslope Setback (ft.)
W	=	Total Width of Mound (ft.)
L	=	Total Length of Mound (ft.)

FIGURE 3.2 – DESIGN WORKSHEET, PLAN VIEW

TABLE 3.1
EQUATIONS FOR CALCULATING SAND MOUND DIMENSIONS

Absorption bed ft.^{2} $(A \times B) = \frac{\text{Design flow}}{1.2 \text{ gpd / ft.}^2}$ = _________________ ft.^{2}

Bed length (B) = ____________________ ft. (42 ft. to 104 ft. dependent on site)

Bed width (A) = $\frac{\text{Bed area} \quad \text{ft}^2}{\text{Bed length} \quad \text{ft.}}$ = _________________________ ft. (12 ft. or less)

Upslope sand fill depth (D) = 48 in. – Z in. = ________________________ in. (12 in. min.)

Downslope sand fill depth (E) = $[12A \times \% \text{ slope}] + D$ in. = ____________________ in.

Cap + topsoil at bed center (H) = 18 in.

Cap + topsoil at bed edge (G) = 12 in.

Total bed depth (F) = 10 in.

Sideslope setback (K) = $\left[\frac{(D + E)}{2} + 28 \text{ in.}\right] \times 3$ = _________________________ in.

Upslope setback (J) = $(22 \text{ in.} + D) \times 3 \times$ upslope corr. factor = ___________________ in.

Downslope setback (I) = $(22 \text{ in.} + E) \times 3 \times$ downslope corr. factor = _________________ in.

Total width of mound (W) = $12A + J + I$ = ____________________ in.

Total length of mound (L) = $12B + K + K$ = _________________ in.

Example

A site has a 3-foot rise in elevation over a 50-foot run. To calculate percent slope, divide the rise by the run, then multiply by 100. 3 feet/50 feet × 100 = 6% slope. For use in mathematical equations 6% would be expressed as 0.06 or 6/100.

3.2.2 Design Flow

The design flow is estimated in gallons per day (gpd). The minimum design flow for a residence is based on 150 gpd/bedroom (BR).

Example

Design Flow for a five-bedroom home:

5 BR × 150 gpd / BR = 750 gpd

3.2.3 Absorption Bed Area

Absorption bed area is determined by dividing the design flow by the design infiltration rate of the approved sand fill. A design infiltration rate not to exceed 1.2 gpd/ft.^{2} is used. Rates as low as 0.8 gpd/ft.^{2} are suggested for sand fill that marginally meets State of Maryland specifications . The absorption bed area can be calculated using the following equation:

$$\text{Bed Area (BA)} = \frac{\text{design flow (gpd)}}{\text{design infiltration rate (gpd/ft.}^2\text{)}}$$

Example

$$\text{Bed Area (BA)} = \frac{\text{750 gpd}}{\text{1.2 gpd/ft.}^2} = 625\ \text{ft.}^2$$

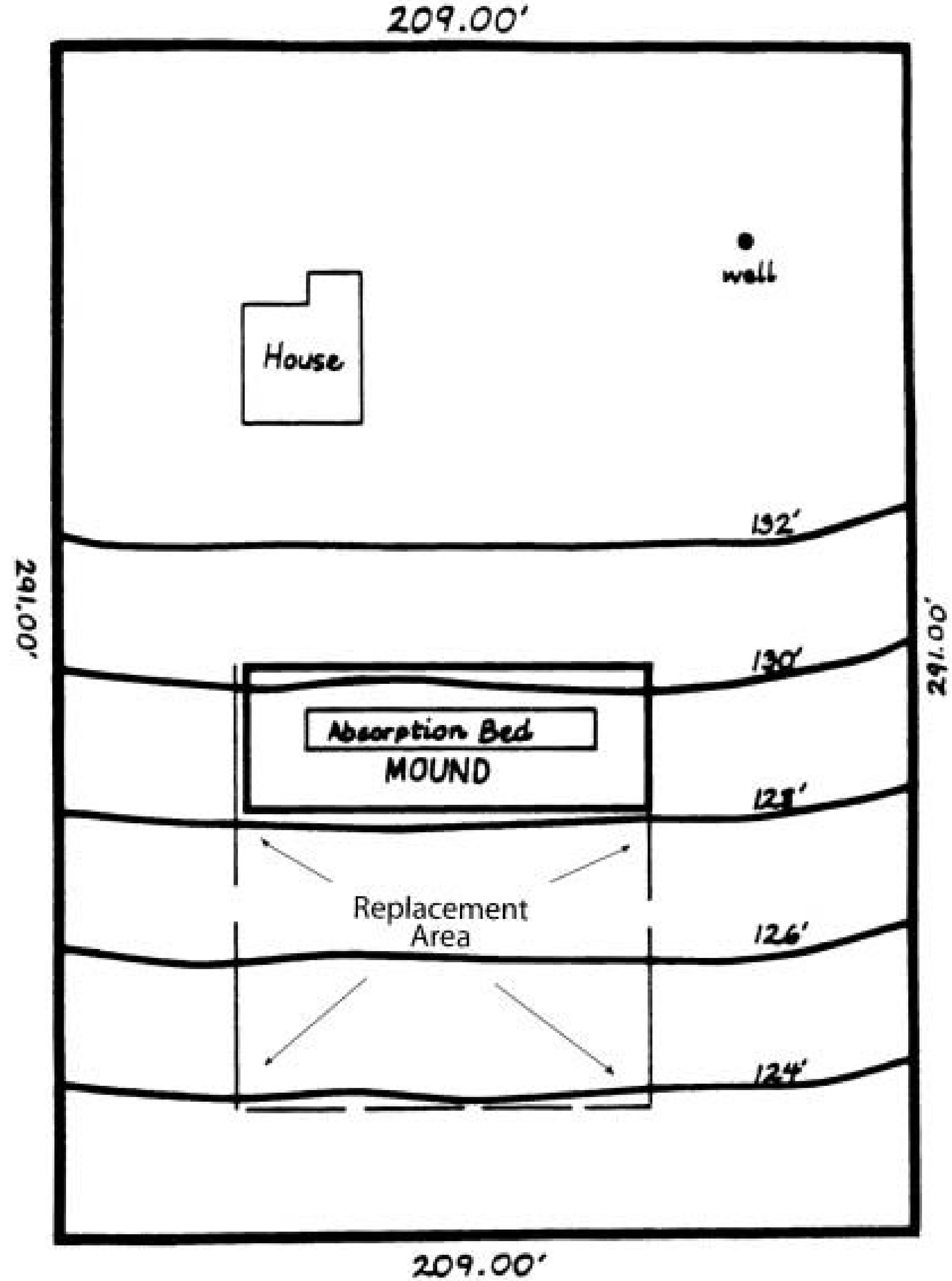
3.2.4 Absorption Bed Length

Bed length will vary from site to site and is often determined based on site constraints such as topography, horizontal separation distances, and lot size. Bed length must be selected by the designer.

Since a rectangular bed (i.e., longer than it is wide) is preferred to a square bed, current regulations do not allow the linear loading rate (determined by dividing the design flow by the length of the gravel bed) on a conventional sand mound to exceed 10 gallons per day per foot (or 6 gallons per day per foot for an alternative mound) This minimizes potential for ponding in the bed, groundwater mounding and the possibility of seepage at the toe of the mound or downslope of the toe. A rectangular bed must be constructed with the long axis parallel to the slope contour. The toe, or bottom edge, of the mound must be installed precisely on contour – all points along that edge must be at the same elevation. The gravel bed must be as close to contour as possible, deviating no more than six inches in elevation along the edge of the bed. In some cases, because of flaring contour lines, a finished mound may be wider at one end than the other.

Beds will generally range between 42 feet and 104 feet in length. In designing a sand mound, remember there is a direct correlation between bed length and bed width (i.e., the longer the bed length the shorter the bed width in order to provide the required absorption bed area). The selected bed length must not be so short as to cause the bed width to exceed 9 feet. Also, in selecting the bed length for a particular site, it is important to remember that the final mound length will be 20 to 32 feet longer than the absorption bed. This additional length is a function of site slope and depth to water table. (See Section 3.2.10 on side slope setbacks for additional explanation.) For example, a site that is essentially flat and 36 inches or deeper to a high water table requires the minimum of 20 feet (10 feet at each end) to be added to the bed length. A site with 12 percent slope and a 24-inch high water table depth would present the most limiting site conditions affecting final mound length and would require the maximum of 32 feet to be added to the bed length.

> **EXAMPLE** Choose a bed length for a site with a 6 percent slope and 24-inch depth to water table where the lot size will only allow a final mound length no greater than 104 feet (See **Figure 3.3**). Subtracting 32 feet for both side slopes from the allowable length provides a safe starting point for calculations.
>
> 104 – 32 feet = 72 feet (bed length)



SCALE
1 inch = 40 ft.

FIGURE 3.3 – SITE PLAN SHOWING THE OPTIMUM LOCATION OF A SAND MOUND ON A SLOPING SITE

3.2.5 Absorption Bed Width

In most cases, a bed width of 9 feet or less must be used to meet the linear loading rate requirement of 10 gallons/linear ft. Bed width is determined by the formula:

$$\text{Bed Width (A)} = \frac{\text{absorption bed (ft.}^2\text{)}}{\text{bed length (ft.)}}$$

Example

$$\text{Bed Width} = \frac{625 \text{ ft.}^2}{70 \text{ ft.}} = 8.9 \text{ ft. or } 9 \text{ ft.}$$

A 75-foot bed length must be used on this site since this length does not cause the linear loading rate to be >10 gallons per linear ft..

3.2.6 Absorption Bed Depth

The absorption bed normally consists of six inches of ¾ to 2 inch-diameter washed and clean aggregate below the distribution pipes, the distribution pipes and two inches of aggregate over the distribution pipes. A slight variation of the depth of aggregate above and around distribution pipes allows a standard bed depth of 10 inches to be used.

3.2.7 Upslope Sand Fill Depth

The upslope sand fill depth below the absorption bed is selected so that the depth of sand fill plus soil above the high water table or pervious bedrock is greater than or equal to 4 feet. A minimum sand fill depth of 12 inches must be maintained regardless of water table or bedrock depth. The upslope sand fill depth may be calculated using the equation:

Upslope Sand Fill Depth (D) = 48 inches – depth to high water table (Z)

Example

If seasonally high water table is 24 inches below the soil surface, an upslope sand fill depth of 24 inches must be used below the absorption bed to provide a 4 foot treatment zone.

D = 48 inches – 24 inches = 24 inches

3.2.8 Downslope Sand Fill Depth

The absorption bed must be constructed level. On sloping sites, the downslope sand fill depth will be greater than the upslope sand fill depth to compensate for the change in elevation along the slope. To calculate the downslope sand fill depth, the difference in elevation of the bed edges is determined and added to the upslope sand fill depth according to the equation:

Downslope Sand Fill Depth (E) = (bed width × % slope) + upslope sand fill depth

Note: The slope percent is expressed as a fraction.

Example

$$E = \left(\frac{12\text{ inches}}{\text{foot}}\right) \times (9\text{ feet}) \times \frac{6}{100} + 24\text{ inches} = 30\tfrac{1}{2}\text{ inches}$$

3.2.9 Cap and Topsoil

The fine textured silt loam (not clay) cap placed above the bed provides frost protection and promotes runoff. The cap should be at least 12 inches deep over the bed center and at least 6 inches deep over the bed edges. The topsoil cover is 6 inches deep over the entire mound and provides for vegetative growth.

Example

Cap + Topsoil Depth at Absorption Bed Center (H) = 12 inches + 6 inches = 18 inches (minimum)

Cap + Topsoil Depth at Absorption Bed Edge (G) = 6 inches + 6 inches = 12 inches (minimum)

3.2.10 Side Slope Setback

The side slope setback is the distance the mound extends past the bed ends so that the mound sides have slopes no steeper than 3:1. This distance is calculated using the following procedures:

1. Determine the sand fill depth below the absorption bed center by averaging the upslope and downslope sand fill depths.

2. Add the center sand fill depth to 28 inches to determine the total mound height at the bed center. The 28 inches represents the depth of the cap, top soil and bed at the center of the absorption bed.
3. Multiply the total mound height at the bed center by 3.

This procedure can be expressed by the following equation:

$$\text{Side Slope Setback (K)} = \left(\frac{\text{Upslope Sand Depth} + \text{Downslope Sand Depth}}{2} + 28 \text{ in.} \right) \times 3$$

Example

$$K = \left(\frac{24 \text{ in.} + 30.5 \text{ in.}}{2} + 28 \text{ in.} \right) \times 3 = 166 \text{ in.} \quad \text{(approximately 14 feet)}$$

3.2.11 Upslope Setback

The upslope setback is the distance the mound must extend beyond the upslope edge of the bed so that 3:1 slope is provided. The upslope setback distance is determined by calculating the setback distance as if the mound were on a level site, and then multiplying by an upslope correction factor given in **Table 3.2** to compensate for slope. This is accomplished in the following steps:

1. Determine the height of the mound at the upslope bed edge by adding the upslope sand fill depth (D) to 22 inches. This 22 inches represents the depth of the cap and topsoil (G) and bed (F) at either bed edge.
2. Multiply the height of the mound at the upslope bed edge by 3 to determine the setback distance needed for a level site.
3. Multiply by the appropriate upslope correction factor (see **Table 3.2**) for the site slope.

TABLE 3.2
DOWNSLOPE AND UPSLOPE CORRECTION FACTORS FOR SAND MOUNDS ON SLOPING SITES

Slope %	Downslope Correction Factor	Upslope Correction Factor
0	1.0	1.0
2	1.06	0.94
4	1.14	0.89
6	1.22	0.86
8	1.32	0.80
10	1.44	0.77
12	1.57	0.73

Source: J.C. Converse. Design and Construction Manual for Wisconsin Mounds, 1978.

This procedure is summarized in the equation:

$$\begin{matrix}\text{Upslope} \\ \text{Setback} \\ \text{(J)}\end{matrix} = \left(\begin{matrix}\text{Upslope} \\ \text{Sand} \\ \text{Depth}\end{matrix}\ \text{Fill} + 22 \text{ inches}\right) \times 3 \times \text{Upslope Correction Factor}$$

Example

J = (24 inches + 22 inches) × 3 × 0.86 = 119 inches (approximately 10 feet)

3.2.12 Downslope Setback

The downslope setback is the distance the mound must extend beyond the downslope edge of the bed so that 3:1 slope can be achieved. This distance is determined by calculating the setback distance as if the mound were on a level site, and then multiplying by a downslope correction factor (see **Table 3.2**) to compensate for slope.

This is accomplished in the following steps:

1. Determine the height of the mound at the downslope bed edge by adding the downslope sand fill depth (E) to the bed depth (F), and the combined cap and topsoil depth at the bed edge (G).
2. Multiply the height of the mound at the downslope bed edge by three to determine the setback distance needed for a level site.
3. Multiply by the appropriate downslope correction factor for the site slope.

This procedure is summarized in the equation:

$$\begin{matrix}\text{Downslope} \\ \text{Setback (I)}\end{matrix} = \left(\begin{matrix}\text{Downslope} \\ \text{Sand} \\ \text{Depth}\end{matrix}\ \text{Fill} + 22 \text{ inches}\right) \times 3 \times \text{Downslope Correction Factor}$$

Example

I = (30.5 inches + 22 inches) × 3 × 1.22 = 192 inches (16 feet)

Note: The downslope toe elevation of the sand mound must be on contour, even if it requires the dimensions of the mound to deviate from rectangular. This should help to eliminate the possibility of toe seepage.

3.2.13 Total Mound Width

Total mound width is determined by adding the upslope setback and the downslope setback to the bed width.

Example

Mound width (W) = 9 ft. + 16 ft. + 10 ft. = 35 ft.

3.2.14 Total Mound Length

Total mound length is determined by adding the side slope setbacks to the bed length. Convert mound length to nearest foot.

Example

Mound Length (L) = 75 ft. + 14 ft. + 14 ft. = 103 ft.

3.2.15 Basal Area Requirement

Mound design for soils with percolation rates greater than 45 minutes per inch require an extra step to determine adequate basal area exists to absorb the effluent before it reaches the perimeter of the mound. Basal area is defined as the sand fill-natural soil interface in the mound available to absorb effluent. On level sites the entire perimeter of the mound defines the basal area since lateral flow can occur in all directions. On sloping sites only the area immediately below and downslope from the absorption bed is considered. The basal area on sloping sites can be calculated by adding the bed width to the downslope setback and multiplying by the bed length.

The equations for determining the basal area provided in a mound are as follows:

$$\text{Basal Area (Level Site)} = L \times W$$

$$\text{Basal Area (Sloping Site)} = (A + I) \times B$$

The procedure for determining the amount of basal area required can be determined by referring to **Table 3.3**, or by using the following equation:

$$\text{Basal Area Required} = \frac{\text{Design Flow (gpd)}}{\text{Design Infiltration Rate of Soil (gpd/ft.}^2\text{)}}$$

If the basal area provided by the mound is less than required, basal area is increased by adding to the length and width of a mound on a level site or by adjusting the downslope setback of a mound on a sloping site.

An equation for determining the adjusted downslope setback on sloping sites is:

$$\text{Adjusted Downslope Setback} = (\text{Basal Area Required} \div B) - A$$

Example 1

Check the basal area for the mound previously described and located on a site that has a percolation rate between 45–60 min./inch. Verify that adequate basal area exists by using the following procedure:

1. Determine the basal area required by dividing the design flow by appropriate design infiltration rate from **Table 3.3**.

   $$\frac{750 \text{ gpd}}{0.5 \text{ gpd/ft.}^2} = 1500 \text{ ft.}^2 \text{ required}$$

2. Determine the basal area provided in the mound according to the formula $(A + I) \times B$:

   $$(9 \text{ ft.} + 16 \text{ ft.}) \times 75 \text{ ft.} = 1875 \text{ ft.}^2 \text{ provided}$$

3. Comparison of the two calculations shows that sufficient basal area exists in this mound.

Note: Adequate basal area is not provided in all cases where the percolation rate is between 45 and 60 min./inch. Where beds are wider or sand fill is shallower, additional basal area will be required.

Example 2

Check the basal area for the mound previously described and located on a site with a percolation rate between 60–120 min./inch. Determine if adequate basal area exists and provide more if necessary.

1. Determine the basal area required:

$$\frac{750 \text{ gpd}}{0.25 \text{ gpd/ft.}^2} = 3000 \text{ ft.}^2$$

2. Determine the basal area provided in the mound according to the formula $(A + I) \times B$:

$$(9 \text{ ft.} + 16 \text{ ft.}) \times 75 \text{ ft.} = 1875 \text{ ft.}^2$$

3. Compare the basal area required to that provided. Since the basic design does not provide sufficient basal area, calculate the adjusted downslope setback that is needed according to the equation (Basal Area Needed $\div$ B) – A.

$$(3000 \text{ ft.}^2 \div 75 \text{ ft.}) - 9 \text{ ft.} = 31 \text{ ft.}$$

Note: The downslope setback increases from 16 feet to 31 feet. This changes the overall mound width from 35 feet to 50 feet.

TABLE 3.3
BASAL AREA REQUIREMENTS FOR SAND MOUNDS

USDA Soil Texture	Percolation Rate min./inch[a]	Design Soil Infiltration Rate gpd/Ft.^{2}	Basal Area Required		
			3BR Ft.^{2}	4BR Ft.^{2}	5BR Ft.^{2}
Sand, sandy loam	2–30	1.2	375	500	625
Loam, silt loam	31–45	0.75	600	800	1000
Silt loam, silty clay loam	46–60	0.5	900	1200	1500
Clay loam, clay	61–120	0.25	1800	2400	3000

[a] Percolation rate measured in the least permeable zone in the upper 24 inches of the soil with cylinder infiltrometers.

3.2.16 Protection of Receiving Environment

A minimum 25 feet wide area downslope of the mound must be designated on a site plan as an area to be protected from compaction and free of structures such as buildings and driveways. The purpose is to protect the underground flow path the sewage will take upon exiting the mound. When limiting zones are shallow beneath the mound, this distance should be increased accordingly. It is recommended that this are be designated on the record plat.

3.2.17 Stacked Mound Spacing

In some instances, the site evaluation determines that a low linear loading rate is required due to depth to restrictive soil horizons. To achieve such a low linear loading rate, the mound must be designed long enough on contour to allow the soils on the site to accommodate the sewage flow. This can be problematic if there is not enough available contour for a single mound. If site conditions allow, it may be justified to split the total required mound length into two mounds (one located at a higher elevation) that are spaced far enough apart along the slope. The spacing should be a minimum of 25 feet apart as measured horizontally from the toe (base) of the upper mound to the upper edge of the gravel bed of the lower mound. Lesser spacing may be considered on a case by case basis and is system, site, and soil dependent.

SECTION FOUR
PRESSURE DISTRIBUTION NETWORK AND PUMPING SYSTEM

4.1 GENERAL

This section presents a procedure for designing a sand mound pressure distribution network and pumping system. The function of the pressure distribution network in a sand mound is to uniformly distribute effluent over the absorption area in prescribed doses. The pressure throughout the distribution network must be nearly equal so that the volume of effluent discharged from each perforation is nearly equal during each dose. A 5/16 inch diameter perforation and 42 inch (3.5 ft.) perforation spacing are recommended and are used as the first iteration in the design example presented in this manual. Achieving the optimal design of a pressure distribution network usually requires more than one iteration. Using absorption beds instead of trenches is usually recommended and simplifies the design procedure; but it is important to remember that all sand mound designs should be site specific with emphasis on designing the mound best suited for each location. Varying perforation size and spacing, lateral spacing, and using trenches instead of beds are methods that can be employed to optimize performance.

Example

The example problem is a sand mound system with a 750 gpd design flow. The minimum absorption area is 625 sq. ft. For sand mounds that serve households under 5 bedrooms, an absorption bed is recommended. The absorption bed dimensions are 9 feet × 75 feet.

4.2 DESIGN PROCEDURE FOR DISTRIBUTION NETWORK

4.2.1 Length of Lateral From Manifold

Prior to a final determination of lateral length, determine whether a center or end feed network will be employed. Once this is done, the number of holes per lateral and hole spacing are calculated and the final lateral length can be determined.

End Feed Network:

If the length along the contour of the absorption bed is less than 51 feet, an end manifold distribution system as shown in **Figure 4.1** can be used. In an end feed network, the length of the lateral, from manifold to distal end, is equal to the bed length minus ½ the perforation spacing, minus the distance from the bed end to the manifold (usually 1 ft.).

End Feed Lateral Length = Bed Length – (½ Perforation Spacing + 1 ft.)

Center Feed Network:

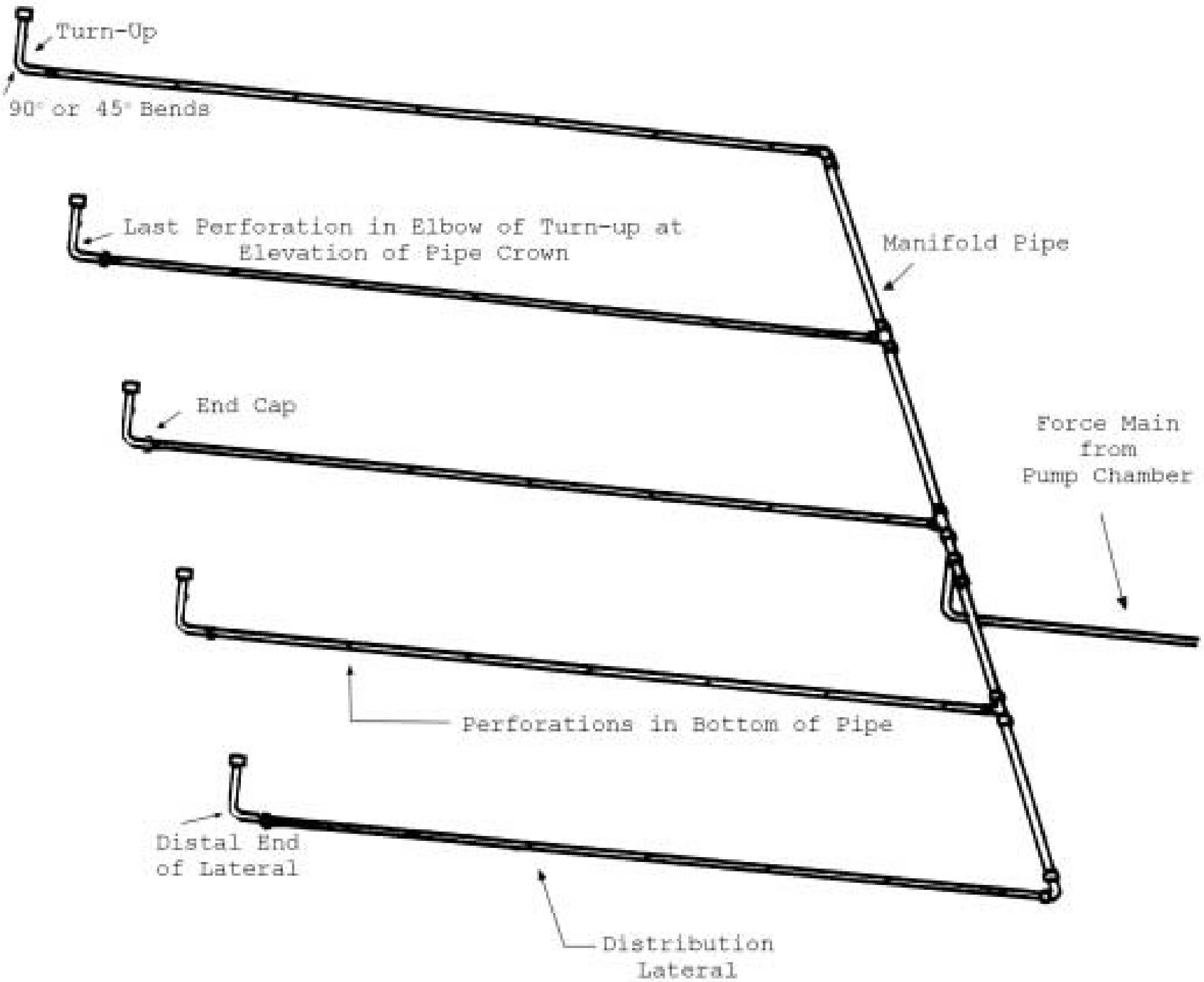
It is recommended that systems with absorption beds longer than 41 ft. have a central manifold distribution network as shown in **Figure 4.2**. A central manifold network allows for the use of small lateral diameters and consequent small dose volumes when beds longer than 51 ft. are specified. The length of the lateral in a center feed network is equal to ½ the bed length minus ½ the perforation spacing.

Center Feed Lateral Length = ½ Bed Length – ½ Perforation Spacing

Example

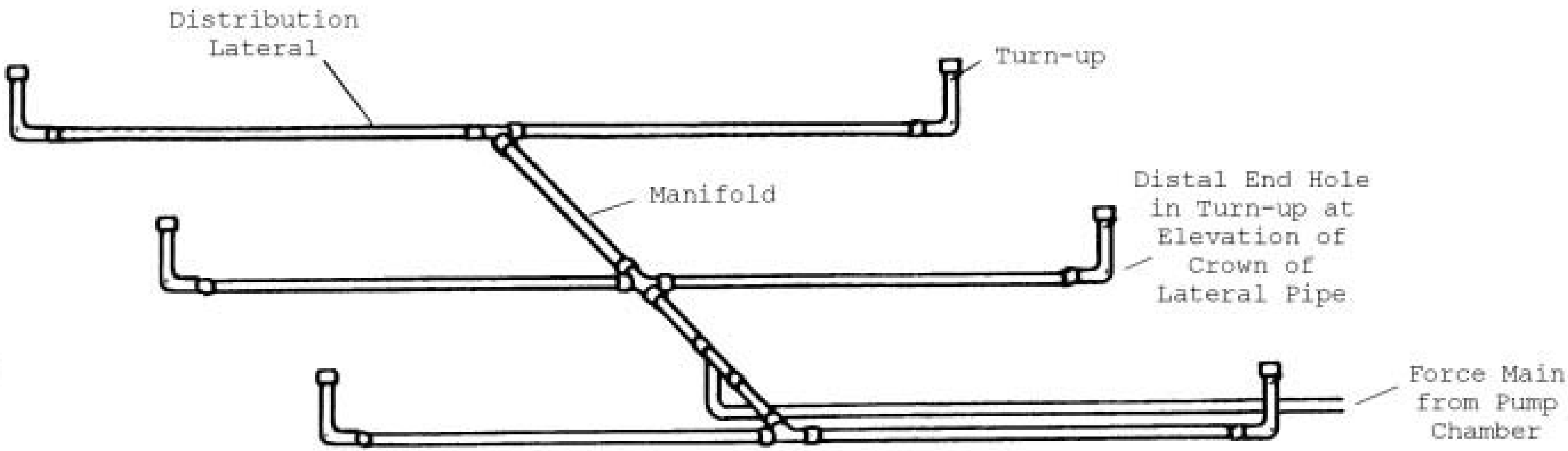
Length of Absorption bed = 75 feet

Seventy (75) feet is greater than 51 feet, therefore a central manifold distribution network is used. A 3.5 ft. perforation spacing can be used.



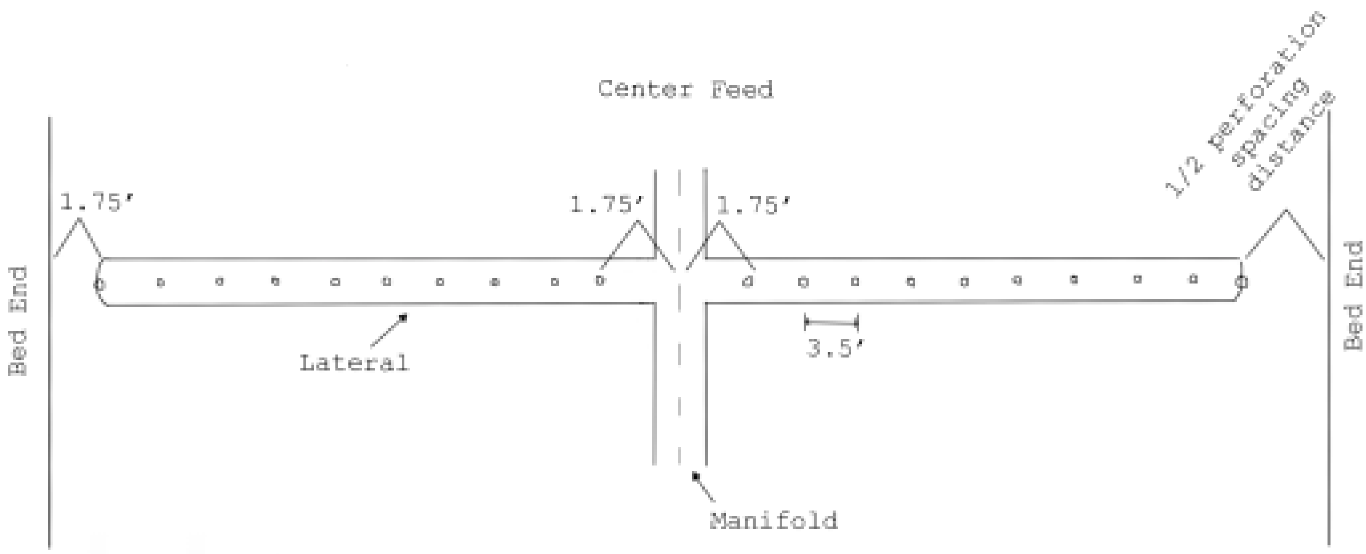
Modified from EPA Design Manual

FIGURE 4.1 – END MANIFOLD DISTRIBUTION NETWORK



Modified from EPA Design Manual

FIGURE 4.2 – CENTRAL MANIFOLD DISTRIBUTION NETWORK WITH 3 LATERAL ROWS AND 6 TOTAL LATERALS



*Bed length is 70' from example problem.
*Laterals are 33.25' from center manifold.

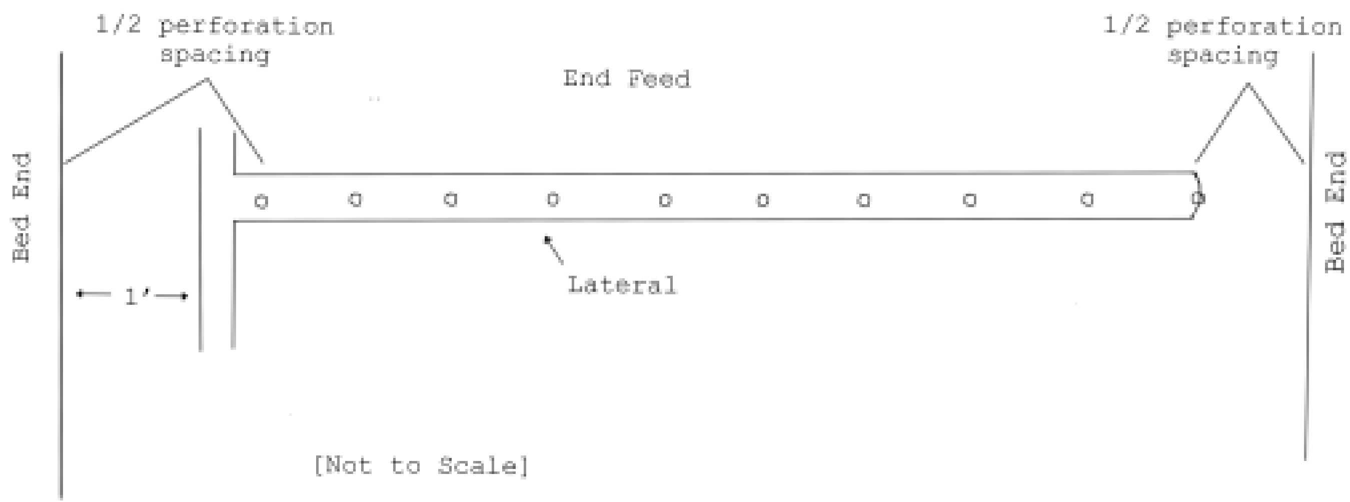


FIGURE 4.3 – PERFORATION SPACING AND LATERAL LENGTH DIAGRAMS

Lateral Length = (0.5 × 75 ft.) – (0.5 × 3.5 ft.) = 35.75 ft. – 1.75 ft. = 34 ft.

Note: The distribution lateral ends at the last perforation drilled in the turn-up.

4.2.2 Number of Perforations Per Lateral

The number of perforations per lateral from the manifold to the distal end can be calculated using the following equations:

1. *End Feed* = bed length divided by spacing between perforations.
2. *Center Feed* = 0.5 × bed length divided by spacing between perforations.

Note: To avoid fractional numbers of perforations, it will usually be necessary to modify the perforation spacing from the recommended 3.5 ft. If a fractional number of perforations is calculated using the above formula with a 3.5 ft. spacing, the nearest whole number of perforations can be chosen. The final perforation spacing can then be determined according to the equation in the following section.

Example

Center Feed Manifold

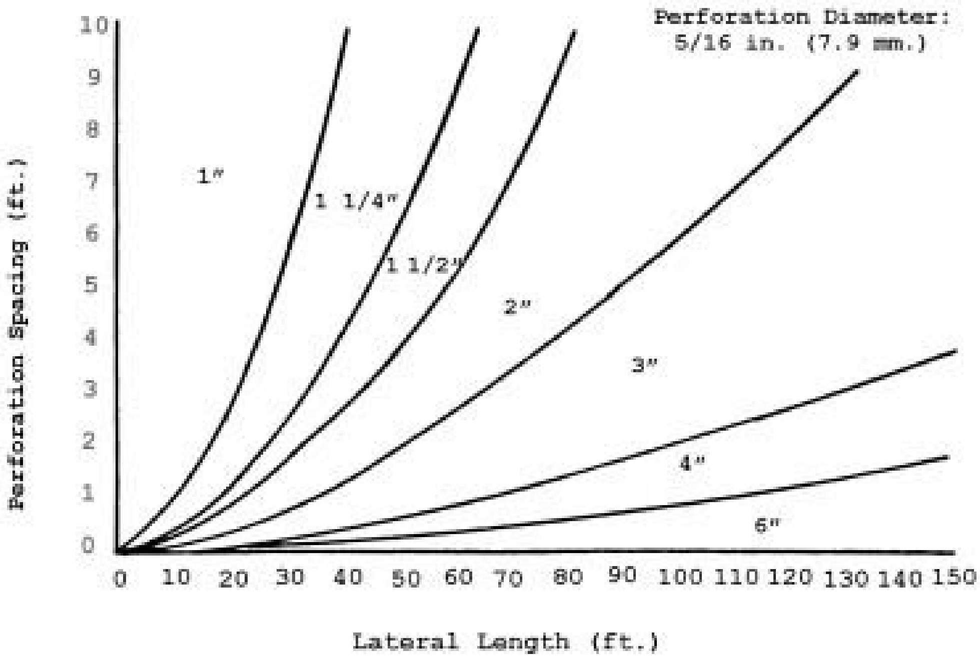
Bed Length	=	75 ft.
Perf. Spacing	=	3.5 ft.
0.5 × 75 ft. / 3.5 ft.	=	11 perforations

4.2.3 Spacing Between Perforations

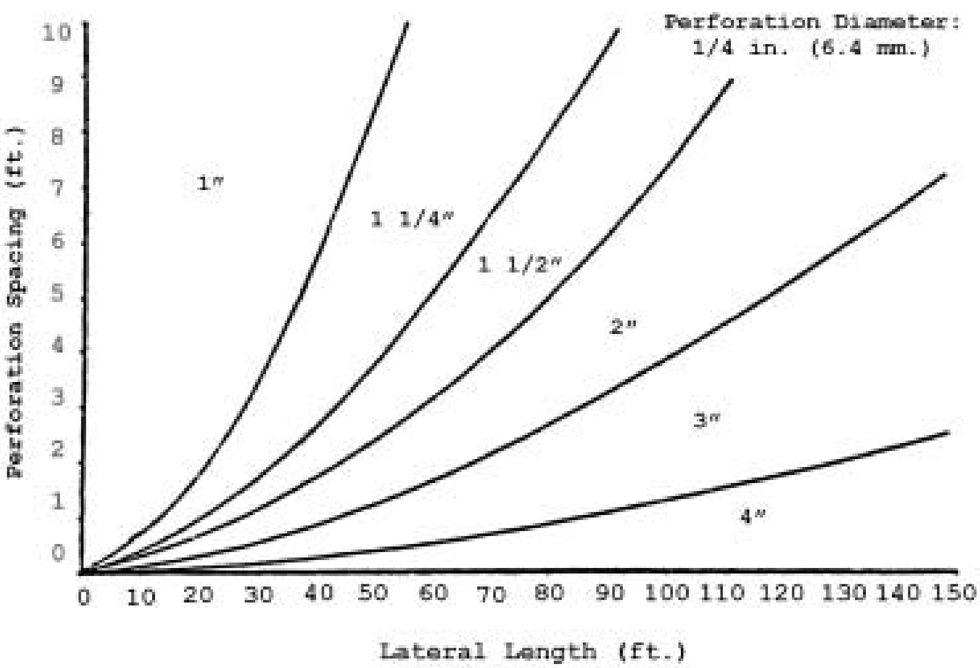
Perforation spacing is determined according to the following equations.

1. *End Feed* = bed length divided by number of perforations per lateral.
2. *Center Feed* = 0.5 × bed length divided by number of perforations per lateral.

The distance between the end of the bed and the last perforation is ½ the perforation spacing. To calculate the distance between the manifold and the first perforation, use the following formulas and refer to **Figure 4.4**:



Minimum Lateral Diameter for Plastic Pipe (C_h = 150) Versus Perforation Spacing and Lateral Length for 5/16 in. Diameter Perforations (Otis, 1981)



Minimum Lateral Diameter for Plastic Pipe (C_h = 150) Versus Perforation Spacing and Lateral Length for 1/4 in. Diameter Perforations (Otis, 1981)

FIGURE 4.4 – PERFORATION SPACING AS A FUNCTION OF PERFORATION DIAMETER, LATERAL DIAMETER AND LATERAL LENGTH

1. $Center\ Feed = 0.5 \times$ perforation spacing

2. $End\ Feed = (0.5 \times$ perforation spacing$) - 1$ ft.*

* 1 ft. is the distance from the manifold to the end of the bed. This distance allows the manifold to be surrounded by gravel and to be covered by geotextile fabric, providing for its protection during placement of cap and topsoil.

Note: Employing perforation spacings of approximately 3.5 ft. on laterals spaced two to four feet apart should provide adequate distribution of effluent to all portions of the absorption bed. However, recent research indicates that having a perforation serving no more than 4–6 sq. ft. of absorption bed optimizes treatment of the effluent by the sand.

4.2.4 Diameter of Perforations in Laterals

Experience in Maryland and other states indicates that a 5/16 inch diameter perforation is best for avoiding clogging. However, a ¼ inch perforation may be used if an effluent filter and a three-foot discharge head are employed, or if the mound receives pretreated effluent from a sand filter or other advanced pretreatment unit such as a BAT unit

4.2.5 Diameter of Laterals

Using a 5/16 inch perforation diameter and 42-inch spacing between perforations, lateral diameter is a direct function of lateral length. The following lateral diameters apply:

TABLE 4.1
SELECTION OF LATERAL DIAMETERS FOR 5/16-INCH DIAMETER PERFORATION AND 42-INCH SPACING

Lateral Length (L) (ft.)	Lateral Diameter (in.)
L Less than 23	1
L between 23 and 36	1¼
L between 36 and 47	1½
L between 47 and 50	2

Note: The charts in **Figure 4.4** show how the interrelated factors of perforation diameter, perforation spacing and lateral length affect the lateral's diameter. This figure must be used with ¼ inch perforations and/or when spacings other than 3.5 ft. between perforations are used. **Table 4.1** can only be used to determine lateral diameter when employing 5/16 inch perforations spaced 3.5 ft. apart.

Example

The individual lateral length is 34 feet. Since 34 is less than 36 but greater than 23, both the chart and **Figure 4.4** indicate that a minimum 1¼ inch diameter lateral be used with 5/16 inch perforations spaced 3.5 feet apart.

4.2.6 Spacing and Number of Laterals

Laterals must be spaced so that effluent is applied uniformly to the absorption area. Laterals should be spaced two to four feet apart to accomplish this. The space between laterals equals the width of the absorption bed divided by the number of lateral rows. The distance between the lateral and the upslope and downslope edges of the absorption bed is ½ the distance between the laterals. If the bed width is made divisible by three, the space between laterals can be standardized at three feet.

Example

Width of bed is nine feet. Use three for number of lateral rows:

$$\frac{9\text{ feet}}{3} = 3\text{ feet} = \text{distance between laterals}$$

Note: The number of laterals should be chosen so that the width of the absorption bed divided by the number of laterals gives a spacing between two and four feet.

4.2.7 Last Perforation in Each Lateral

To provide an outlet for air trapped in the distribution system during the pumping cycle, and to promote rapid draining of the laterals upon pump shut off, the last perforation in each lateral should be located at the elevation of the crown of the pipe in a turn-up as shown in **Figure 4.5**.

4.2.8 Diameter of Manifold and Force Main

The manifold can be from two to three inches in diameter. Typically, the diameter of the manifold will be the same diameter as the force main connecting the manifold to the pump. At the flow rate required for most residential mound systems, velocity and friction may become excessive when using a two-inch diameter force main. A three-inch force main is then recommended.

4.2.9 Placement of the Pump Chamber and Force Main

The pump chamber must be installed so that the mound (and future replacement mounds) will drain back after each pump cycle. If possible, the pump chamber and force main should be installed in such a way as to not disturb the downslope of the sand mound or of future replacement mounds. Generally, coming along the upslope edge of the mound with the force main is the acceptable way to handle this.

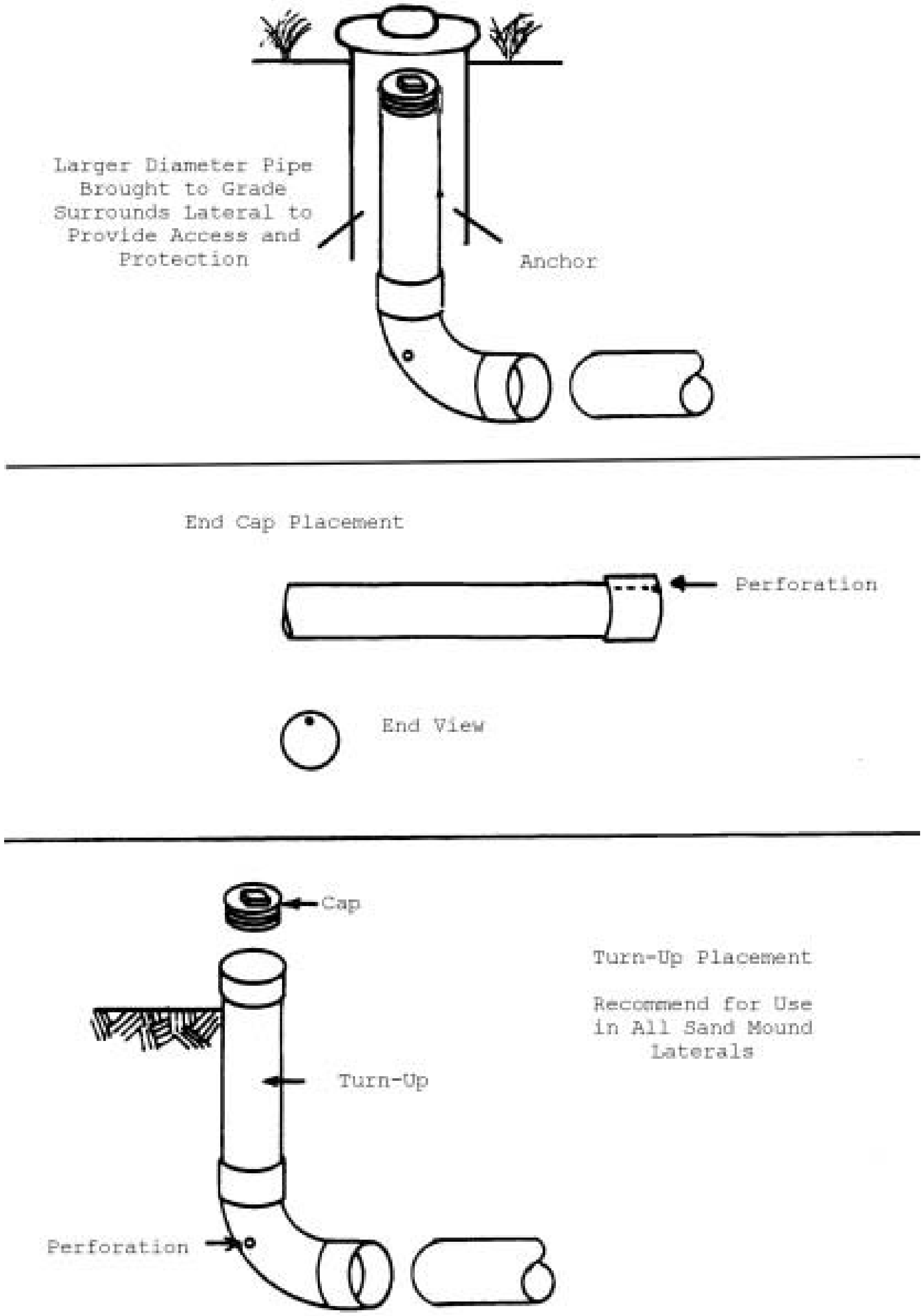


FIGURE 4.5 – ALTERNATIVES FOR PLACEMENT OF THE END PERFORATION IN A DISTRIBUTION LATERAL

4.3 DESIGN PROCEDURE FOR THE PUMPING SYSTEM

For the example problem, assume the difference in elevation between the pump inlet and the highest part of the distribution network is eight feet, and the length of the force main is 60 feet.

4.3.1 Dose

The minimum dose must be no less (the volume of the force main and manifold)+ (5 $\times$ volume of the laterals). Pipe volume can be calculated using **Table 4.2**.

Example

Length of force main and manifold = 66 feet of three-inch diameter pipe

Length of laterals = 215 feet of 1¼ inch pipe.

66 feet $\times$ 38.4 gallons/100 feet = 25.34 gallons

215 feet $\times$ 7.8 gallons/100 feet = 16.77 gallons

(5 $\times$ 16.77 gallons) + 25.34 gallons = 109.19 gallons

TABLE 4.2 PIPELINE SIZE AND VOLUME

A. Actual Inside Diameter (Inches)

Nominal Pipe size (inches)	Outside Diameter (inches)	PVC Flexible Pressure Pipe				PVC Rigid Pipe	
		SDR32.5	SDR26	SDR21	SDR17	Sch. 40	Sch. 80
1	1.315		1.195	1.189	1.161	1.049	0.957
1¼	1.660	1.54	1.532	1.502	1.464	1.380	1.278
1½	1.90	1.78	1.754	1.72	1.676	1.610	1.50
2	2.375	2.229	2.193	2.149	2.095	2.067	1.939
2½	2.875	2.699	2.655	2.601	2.537	2.469	2.323
3	3.50	3.284	3.23	3.166	3.088	3.068	2.90
3½	4.0	3.754	3.692	3.62	3.53	3.548	3.364
4	4.50	4.224	4.154	4.072	3.97	4.026	3.826
5	5.563	5.221	5.135	5.033	4.909	5.047	4.813
6	6.625	6.217	6.115	5.993	5.845	6.065	5.761
8	8.625	8.095	7.961	7.805	7.609	7.981	7.625

B. Volume Per 100 Feet (Gallons)

Nominal Pipe size (inches)	PVC Flexible Pressure Pipe				PVC Rigid Pipe	
	SDR32.5	SDR26	SDR21	SDR17	Sch. 40	Sch. 80
1		5.8	5.8	5.5	4.5	3.7
1¼	9.7	9.6	9.2	8.7	7.8	6.7
1½	12.9	12.6	12.1	11.5	10.6	9.2
2	20.3	19.6	18.8	17.9	17.4	15.3
2½	29.7	28.8	27.6	26.3	24.9	22.0
3	44.0	42.6	40.9	38.9	38.4	34.3
3½	57.5	55.6	53.5	50.8	51.4	46.2
4	72.8	70.4	67.7	64.3	66.1	59.7
5	111	108	103	98.3	104	94.5
6	158	153	147	139	150	135
8	267	259	249	236	260	237

Notes: "SDR" means standard dimension ratio and is the ratio of outside pipe diameter to wall thickness. Source: Modified from ASTM Standards D-1785, D-2241, D-2729, and F-405.

4.3.2 Pumping Chamber

A typical pump chamber detail is given in **Figure 4.6**.

a. *Watertight* – T– On sites with shallow water tables, a pump chamber may have to be installed into the water table. If a pump chamber leaks, groundwater will infiltrate the pump chamber when effluent has been pumped out to the mound. To avoid this possibility, the pump chamber must be installed as close to the ground surface as possible with all seams located above the high water table. All tanks should be tested for water tightness, preferably after the installation of manhole risers which must terminate a minimum of six inches above finished grade. It is critical to properly attach manhole risers to pump chambers and other tanks, properly sealing the interface between the two.

b. *Sizing the pump chamber* – The pump chamber must have the capacity to accommodate a pump positioned on a six-inch riser, one dose volume, and one day's design flow storage capacity above the high water alarm.

Example

One Day Storage Capacity	=	750 gallons
Dose	=	125 gallons
Total	=	875 gallons

The pumping chamber normally would need to have an 875-gallon capacity between the pump chamber inlet and the pump off float. Additional capacity in the pump chamber above the inlet can be included as long as the level is not higher than the elevation of the septic tank inlet invert. **Note:** The pump must be located on a six-inch riser. Settings of floats in equal volume pump chambers will vary as pump chambers' dimensions change.

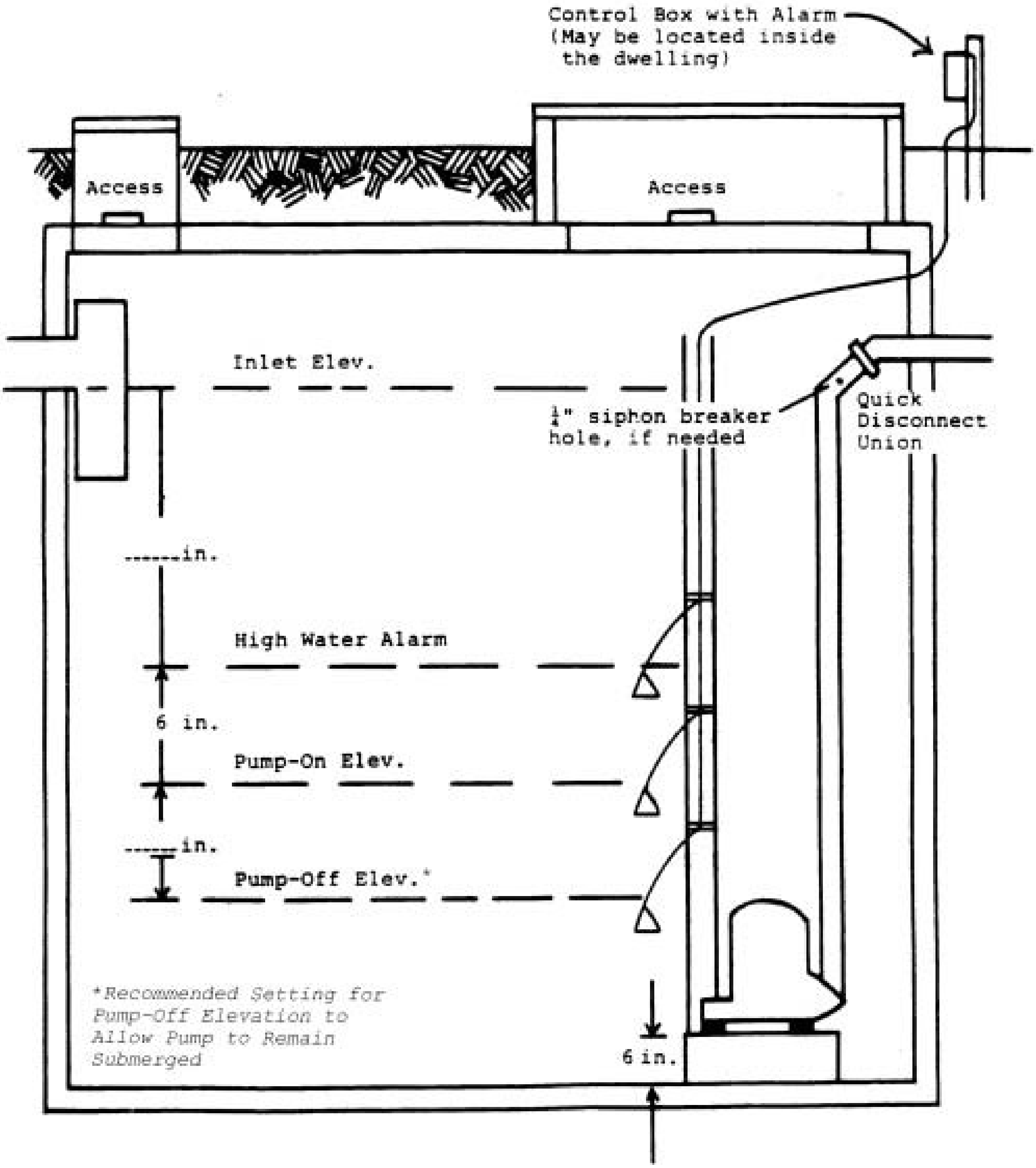


FIGURE 4.6 – TYPICAL PUMP CHAMBER DETAIL

4.3.3 Sizing the Pump

The pump must be capable of delivering the necessary flow (gpm) at the calculated design head (feet).

a. *Flow* – The number of perforations in the system times the discharge rate per perforation is equal to the flow. The discharge rate for a 5/16-inch perforation with two feet of head is 1.63 gpm. The discharge rate for a ¼ inch perforation with three feet of head is 1.28 gpm.

Example

In our problem we have six laterals with ten 5/16 inch perforations per lateral.

10×6 laterals = 60 perforations

Flow = 60×1.63 gpm = 97.8 gpm

b. *Design Head* – Static head (feet) plus friction head (feet) plus 2 ft. of head at distal end of laterals equals the design head.

1. *Static Head* (feet) – The relative elevation of the highest component of the distribution system minus the relative elevation of the pump off float switch.

Example

Relative elevation of pump off float is 124 feet. Relative elevation of manifold is 132 feet. Static head = 132 feet – 124 feet = 8 feet.

2. *Friction Head* (feet) – The head loss due to friction in the pipe between the pumping chamber and the laterals. All fittings, such as 90 degree bends, disconnect unions, and valves, contribute to friction head loss. Fittings' contributions to friction loss can be calculated in equivalent length of pipe by using **Table 4.3**. For example, a two-inch quick disconnect union or coupling adds two feet of equivalent length of pipe to the actual length of two-

inch pipe in the system. Once the total equivalent length of pipe is determined, friction head can be determined. Friction loss (feet) per 100 feet of pipe for a given flow can be found in **Table 4.4**.

TABLE 4.3
ALLOWANCE IN EQUIVALENT LENGTH OF PIPE FOR FRICTION LOSS IN VALVES AND THREADED FITTINGS (ASA A40.8-1955)

Diameter of Fitting	90 Deg. Standard Ell	45 Deg. Standard Ell	90 Deg. Side Tee	Coupling or Str. Run of Tee	Gate Valve	Globe Valve	Angle Valve
Inches	Feet	Feet	Feet	Feet	Feet	Feet	Feet
3/8	1	0.6	1.5	0.3	0.2	8	4
1/2	2	1.2	3	0.6	0.4	15	8
3/4	2.5	1.5	4	0.8	0.5	20	12
1	3	1.8	5	0.9	0.6	25	15
1 1/4	4	2.4	6	1.2	0.8	35	18
1 1/2	5	3	7	1.5	1.0	45	22
2	7	4	10	2	1.3	55	28
2 1/2	8	5	12	2.5	1.6	65	34
3	10	6	15	3	2	80	40
3 1/2	12	7	18	3.6	2.4	100	50
4	14	8	21	4	2.7	125	55
5	17	10	25	5	3.3	140	70
6	20	12	30	6	4	165	80

TABLE 4.4
FRICTION LOSS IN SCHEDULE 40 PLASTIC PIPE, C = 150 (ft / 100 ft)

	Pipe Diameter (In.)								
Flow gpm	**1**	**1-¼**	**1-½**	**2**	**3**	**4**	**6**	**8**	**10**
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	0.07		
150						1.17	0.16		
200							0.28	0.07	
250							0.41	0.11	
300							0.58	0.16	
350							0.78	0.20	0.07
400							0.99	0.26	0.09
450							1.22	0.32	0.11
500								0.38	0.14
600								0.54	0.18
700								0.72	0.24
800									0.32
900									0.38
1000									0.46

Source: EPA Design Manual

Example

We have 66 feet of three-inch diameter pipe from the pump to the laterals. Let us say the fittings add on 25 equivalent feet of pipe. The friction loss then must be calculated for 91 feet (66 + 25) of three-inch diameter pipe at 98 gpm. From **Table 4.4** we know that, at 100 gpm in a three-inch pipe, friction loss would be 2.09 feet per 100-foot length.

$$\text{100 foot length} = \text{2.09 foot friction loss}$$
$$0.91 \times \text{100 foot length} = 0.91 \times \text{2.09 foot friction loss}$$
$$\text{91 foot length} = \text{1.90 foot friction loss}$$

3. *Head at Distal End of Laterals* = 2 feet

Design Head = 8 feet (static) + 1.90 feet (friction) + 2 feet (distal end head) = 11.90 feet.

A pump is needed that can deliver 97.8 gpm at 11.90 feet of head. Using the pump curve given in **Figure 4.7** – Effluent Pump Curves, the pump needed would be the WPH 10, 1 horsepower.

An equation for calculating horsepower is:

$$\frac{\text{Flow} \times \text{Total Dynamic Head} \times \text{Specific Gravity}}{3960 \times \text{efficiency}}$$ (specific gravity of H_2O at 68°F is 1)

For example, use 0.4 for efficiency, as this is common for effluent pumps.

$$\frac{97.8 \times 11.90 \times 1}{3960 \times 0.4} = \text{0.735 horsepower}$$

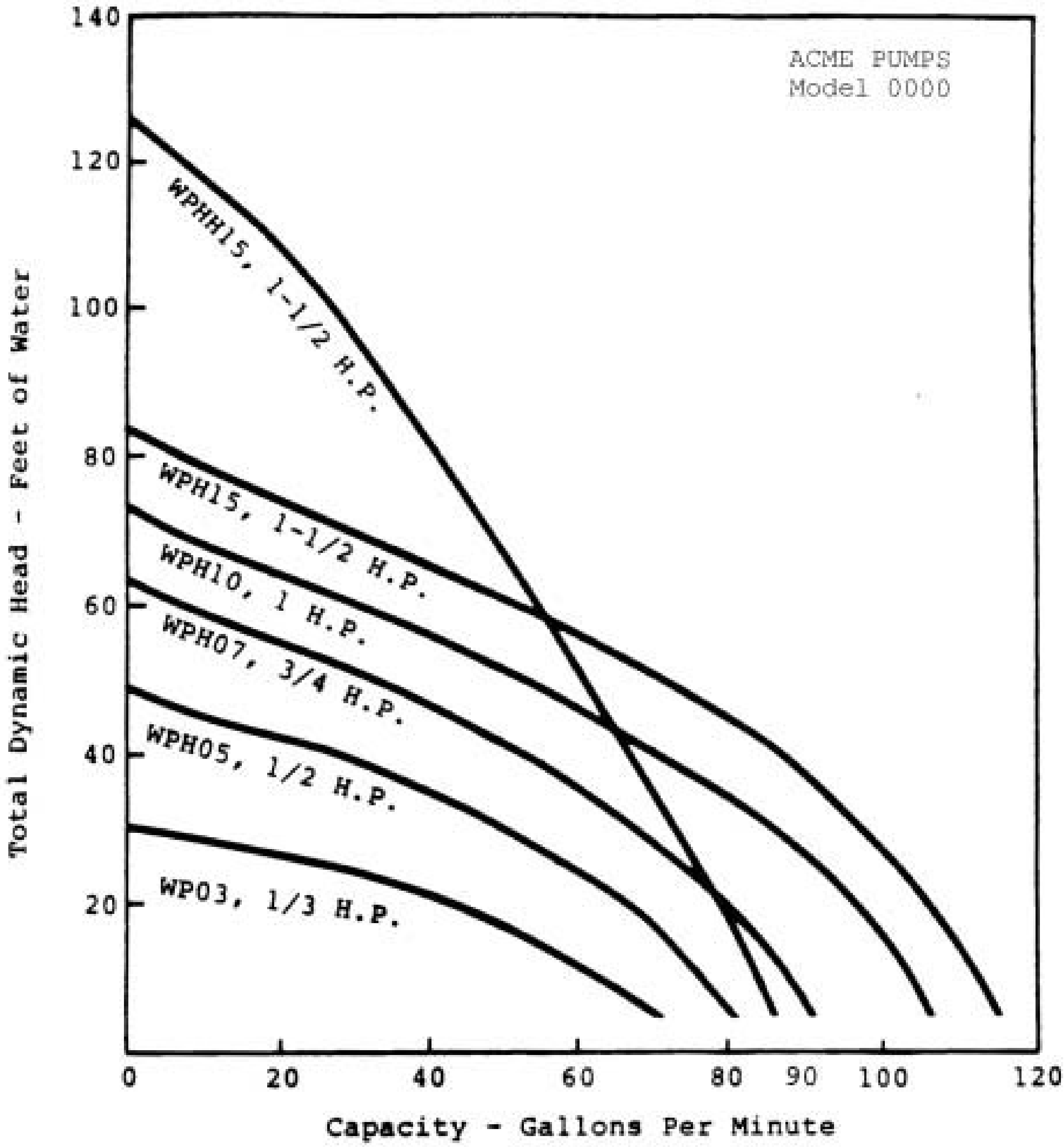


FIGURE 4.7 – EXAMPLE EFFLUENT PUMP CURVES

4.3.4 Adjustment of Float Switches in the Pumping Chamber

The volume between the pump-on float and the pump-off float must equal the dose. The volume between the high water alarm float and the pump chamber inlet must provide at least an average day's design flow. The equation to calculate the distance between the pump-on float and pump-off float is:

$$d = \frac{(D) \times 231}{A}$$

Where:

d	=	distance in inches between pump-on and pump-off floats
231	=	cubic inches per gallon
D	=	dose in gallons
A	=	cross-sectional area of the pumping chamber interior (in.^{2})

To calculate the distance between the high water alarm switch and the pump chamber inlet use:

$$r = \frac{(R) \times 231}{A}$$

Where:

r	=	distance in inches between pump chamber inlet and high water alarm
R	=	one day's flow (reserve capacity) in gallons
231	=	cubic inches per gallon
A	=	cross-sectional area of the pumping chamber interior (in.^{2})

4.3.5 Float Attachment

Floats should be attached to a dedicated float tree that can be removed from the pump pit independent of the pump. Floats should not be hung from the discharge piping. Floats attached to trees with inappropriate straps that are prone to fatigue and failure in the pump pit environment can result in floats becoming detached and premature pump failure. Drilling through a dummy pipe and knotting the float wire on each side of the pipe provides a fail-safe attachment.

4.3.6 Wiring

A panel should always be used. This provides for greater safety since it is not necessary for the entire electrical current energizing the pump to be fed through the floats. It also provides for easier troubleshooting of the mound, allows emergency operation capability in the event of float failure, and allows for the use of timed dosing to enhance a mound’s treatment and hydraulic performance. The high-level alarm float should be wired on a circuit separate from the pumping system.

SECTION FIVE CONSTRUCTION PROCEDURES

5.1 GENERAL

Proper construction is extremely important if the sand mound is to function as designed. Installation of a sand mound system is prohibited when soils are frozen. Construction of the mound should also not occur if the soils are wet. Compaction and smearing of the soil in the location of the mound and downslope should be avoided. Soil is too wet for construction of the mound if a sample, taken anywhere within the uppermost eight inches, when rolled between the hands forms a wire. If the sample crumbles, the soil is dry enough for construction to proceed.

5.2 EQUIPMENT

The following special equipment is recommended:

1. A small track machine (low ground pressure) with blade for placing and spreading the sand fill.
2. A cordless drill with a sharp drill bit for drilling holes in the pipe on-site.
3. A chisel plow or chisel plow attachment mounted to a small tracked machine with low ground pressure tracks for plowing the soil within the perimeter of the mound is preferred over a moldboard plow. Other scarification equipment (preferably on tracks) may be used but must be approved in advance by the inspector.
4. A rod and level for determining bed elevations, slope on pipes, outlet elevation of the septic tank or BAT units, slope of site, etc.

5.3 MATERIALS

The following specifications are required:

1. Sand fill material must be approved by the local Approving Authority prior to hauling to the site. Sand fill shall have an effective size between 0.25 mm and 0.5 mm with a uniformity coefficient of 3.5 or less or an effective size between 0.15 and 0.3 mm and have a uniformity coefficient between 4 and 6 and contain less than 20 percent of material larger than 2.0 mm and less than 5 percent of material less than 0.053 mm. A copy of the receipt and the material certification from the sand supplier showing

the company name, address, phone number, date and product name will be required.

2. Washed river gravel aggregate shall be clean and free off fines and between ¾ and 2 inches in diameter. Crushed limestone must not be used.
3. Geotextile fabric shall be spun filter fabric, not woven.
4. Cap material shall be soil relatively free of coarse fragments and preferably a loam, silt loam or finer texture. Clay texture should not be used for the cap.
5. Topsoil shall be of good quality, and free of debris such as rocks and trash. A silt loam or other medium textured soil is recommended.

5.4 TANK INSTALLATION AND SITE PREPARATION

5.4.1 Locate, fence or rope-off the entire sewage disposal area to prevent damage to the area during other construction activity on the site. Vehicular traffic over the disposal area and directly downslope of the disposal area is prohibited to avoid soil compaction.

5.4.2 Install septic tank or BAT unit treatment tanks with pumping chamber and pumps as shown on the approved design plan and drawings. Access risers should terminate 6 inches above finished grade. **Call for inspection**.

5.4.3 Stake out the initial and recovery mound perimeters in their proper orientation as shown in the drawings. Reference stakes offset from the mound corner stakes are recommended. Locate the upslope edge of the absorption bed within the mound and determine the ground elevation at the highest location. Reference this elevation to a benchmark for future use. This is necessary to determine the bottom elevation of the absorption bed.

5.4.4 Excess vegetation should be cut and removed with minimal machine disturbance. Trees should be cut at ground level and stumps left in place.

5.4.5 Determine the location where the force main from the pumping chamber will connect to the distribution network manifold within the mound.

5.4.6 Install the force main from the pumping chamber to the proper location within the mound. Pipe should be laid with uniform slope back to the chamber so that it drains after dosing. Cut and stub off pipe one foot below existing grade within the proposed perimeter of the initial mound. Backfill trench and compact to prevent seepage along the trench.

5.4.7 Plow or scarify the soil within the perimeter of the mound to a depth of about eight inches, if the soil is not too wet. Chisel plows are preferred. Plowing should be done along the contour. If using a moldboard plow use a two bottom or larger plow and throw the soil upslope leaving a dead furrow at the bottom. Rototilling may not be used. In wooded areas with stumps, roughening the surface to a depth of four to six inches with bucket teeth with extensions may be satisfactory. However, all work should be done from the upslope or sides of the mound if at all possible. After plowing, all foot and vehicular traffic shall be kept off the plowed area. **Call for inspection**.

5.5 FILL PLACEMENT

5.5.1 Relocate and extend the force main several feet above the ground surface.

5.5.2 Place the approved sand fill material on the upslope edge(s) of the plowed area. Keep delivery trucks off the plowed area. No traffic on the downslope side. Fill should be placed and spread immediately after plowing. Move the fill material into place using a small track-type tractor with a blade. Work from the end and upslope side. Always keep a minimum of six inches of sand beneath the tracks of the machine to minimize compaction of the natural soil. The fill material should be worked in this manner until the height of the fill reaches the elevation of the top of the absorption bed.

5.5.3 With the blade of a machine, form the absorption bed. Hand level the bottom of the bed and check it for proper elevation. The bed must be level for proper functioning of the mound. **Call for inspection**.

5.5.4 Shape the sides of the sand fill to design slope (i.e., 3:1 or flatter).

5.6 BED AND DISTRIBUTION NETWORK

5.6.1 Carefully place the washed coarse river gravel aggregate in the bed. Do not create ruts in the bottom of the bed. Level the aggregate to a minimum depth of six inches.

5.6.2 The distribution network is assembled in place setting the manifold to ensure draining the laterals between doses. The laterals should be laid level with the holes directed downward. **Call for inspection**. Test the pumping chamber and distribution network with clean water.

5.6.3 Place additional aggregate to a depth of at least two inches over the crown of the pipe.

5.6.4 Place the spun filter fabric over the aggregate bed. The fabric may extend beyond the bed over the sand fill by a few inches. Do not use woven fabric.

5.7 COVER MATERIAL

5.7.1 Place a finer textured soil material such as sandy clay loam, clay loam, silt loam or loam on top of the fabric over the bed. The minimum depth of this cap shall be six inches at the outer edges of the bed and 12 inches along the center.

5.7.2 Place a minimum of six inches of good quality topsoil over the entire mound surface including sideslopes. Final grading should divert surface water away from the site. **Call for final inspection**.

5.8 VEGETATION

5.8.1 Fertilize, lime, seed and mulch the entire surface of the mound. Grass mixtures adapted to the area should be used. Consult the county extension agent or Soil Conservation Service for recommendations.

5.8.2 Irrigate the seeded mound sufficient to establish growth in a timely manner.

REFERENCES

1. Building Officials and Code Administrators International, Inc. *The Basic/National Private Sewage Disposal Code*, First Edition, County Club Hills, Illinois. 1984

2. Commonwealth of Pennsylvania. *Technical Manual for Sewage Enforcement Officers,* Department of Environmental Resources, Division of Local Environmental Services, Bureau of Water Quality Management. Harrisburg, Pennsylvania. September 1985.

3. Converse, J.C. *Design and Construction Manual for Wisconsin Mounds.* Agricultural Engineering Department, University of Wisconsin–Madision. September 1978.

4. Converse, J.C. and E. J. Tyler. *The Wisconsin Mound System Siting, Design and Construction*. Small Scale Waste Management Project. University of Wisconsin–Madision, College of Agricultural and Life Sciences, College of Engineering. University of Wisconsin – Extension, Division of Economic and Environmental Development. January 1986.

5. Converse, J.C. and E.J. Tyler. *Wisconsin Mound Soil Absorption System: Siting, Design and Construction Manual.* Small Scale Waste Management Project. University of Wisconsin–Madison, College of Agricultural and Life Sciences, College of Engineering. January 2000.

6. Otis, R.J. *Design of Pressure Distribution Networks for Septic Tanks Soil Absorption Systems.* Small Scale Waste Management Project. University of Wisconsin–Madison. 1981.

7. Otis, R.J. *On-site Wastewater Disposal Distribution Networks for Subsurface Soil Absorption Systems.* Rural Systems Engineering. Madison, Wisconsin.

8. U.S. Environmental Protection Agency. *Design Manual, Onsite Waste Water Treatment and Disposal Systems.* Office of Water Program Operations. Office of Research and Development, Municipal Environmental Laboratory. October 1980.

SAND MOUND
SEWAGE DISPOSAL SYSTEM
INSPECTION CHECKLIST

I. Site Preparation

Date and Inspector's Name: ____________________

A. MDE Certified Installer Name ____________________

B. MDE Certified Installer Present____________________

C. Mound perimeter and absorption bed properly staked out on contour (field verified) ____________

D. No compaction by heavy equipment:

1. Within mound perimeter ____________
2. Downslope from mound by 25 ft ____________
3. Within sewage disposal area ____________

E. Vegetation cut and properly removed ____________

F. Trees, if present, cut off at ground level and stumps left in place ____________

G. Soil moisture level low enough to permit construction and soils are not frozen ____________

H. Soil plowed or scarified within mound perimeter, on contour & to a suitable depth ____________

I. Location of BAT unit(s) or septic tank(s) and pump chamber properly staked out ____________

II. Construction

1. Septic Tank(s) or BAT units ____________
2. Number of tanks ____________
3. Tank type and construction meets ____________
   specifications (i.e., top-seam, baffled, etc.) ____________
4. Capacity requirements met ____________
5. Proper installation, bedded and level
6. Inlet and outlet pipes at proper elevations ____________
   and water tight at tank pipe connections ____________
7. Baffles and/or tees properly installed ____________
8. Manhole access & risers 6 inches above finished grade ____________

9. Tank water tightness checked ______________

   a. Weep holes in tank walls/bottom sealed if present ______________
   b. 24-hour leakage test conducted ________________________________
   c. Proper vacuum test conducted ________________________________
   d. Riser to tank lid connection watertight and verified
   ____

B. <u>Pump Chamber</u> Date: __________

1. Design specifications met ______________
2. Six-inch block present under pump ______________
3. Control panel meets specifications and properly sealed ______________
4. Event counter/elapsed time meter/
   flow meter installed, if required on design
5. Proper float elevations (on/off /alarm) ________________
6. Quick disconnect/siphon hole present in pump discharge
   supply line (if required) ______________
7. Proper elevation of influent pipe ______________
8. Inlet and Outlet Pipes through tank walls properly sealed ________________
9. Valves meet specifications on approved plan
10. Tank joints/seams above seasonal high water table ________________
11. Manhole access provided & terminates six inches
    above finished grade ___________
12. Average day's design flow storage capacity above
    high level alarm ______________
13. Force main (supply line) diameter as specified on design ______________

14. High water alarm on separate circuit than pump ___________
15. Riser to tank lid connection watertight ____________

C. <u>Sand Fill and Absorption Area</u> Date: ______________

1. Sand meets proper specifications on design ______________
2. Sand fill brought to proper elevation ___________
3. Sand fill covers basal area ______________
4. Absorption bed proper dimensions
5. Absorption bed level ______________
6. Six-inches of river gravel between sand fill
   and distribution pipe ______________

D. Distribution System Date: ______________

1. Pressure fittings used at joints ______________
2. Fittings adequately bonded ______________
3. Proper diameter of manifold ______________
4. Proper diameter of lateral piping ______________
5. Proper diameter of lateral perforations ___________
6. Proper spacing of lateral perforations ___________
7. Perforations oriented downward ______________
8. End perforation suitable (sleeved/in end cap/ on turn-up radius) ______________
9. Two-inch gravel to cover laterals ______________
10. Check of distribution system under pressure ___________

E. Final Placement of Fill and Topsoil Date: ______________

1. Spun Geotextile fabric in place above gravel bed ______________
2. Tapered cap present:
   A. Twelve-inch depth at center ______________
   B. Six-inch depth at edges ______________
3. Six-inch topsoil cover:
   A. Present and graded ______________
   B. Seeded/Sod ______________
   C. Mulched ______________
4. Sides of mound no steeper than 3:1 slope ______________

F. Monitoring Appurtenances Date: ______________

1. Observation ports:
   A. Proper location and number ______________
   B. Installed to proper depth and stable ______________
2. Lateral turn-ups in place and protected with Pipe sleeves or turf boxes ___________

G. Site Drainage and proper grading (if required) Date: ______________

1. Surface water diversion ______________
2. Curtain drain properly installed ______________
3. Vertical drain ______________

III. **Pumping System Test** Date: ______________

A. Pump-on switch is operational ______________

B. Pump-off switch is operational ______________

C. High level alarm switch is operational ______________

D. Volume of drawdown corresponds with specified dose ______________

E. System achieves specified pressure ______________

IV. **Comments and As Built Drawing:**