Recommended Standards and Guidance for Performance, Application, Design, and Operation & Maintenance

Mound Systems

May 2020

Washington State Department of
Health

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For information or additional copies of this report contact:
Wastewater Management Program
Physical address: 101 Israel Road SE, Tumwater, WA 98501
Mailing Address: PO Box 47824, Olympia, Washington 98504-7824

Phone: (360) 236-3330
FAX: (360) 236-2257
Webpage: www.doh.wa.gov/wastewater
Email: wastewatermanagement@doh.wa.gov

Umair A. Shah, MD, MPH
Secretary of Health

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Glossary of Terms: A glossary of common terms for all RS&Gs can be found on the DOH Web site at www.doh.wa.gov/Portals/1/Documents/Pubs/337-028.pdf.

Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272A WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances -** When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology -** The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

Glossary of Terms: A glossary of common terms for all RS&Gs can be found on the DOH Web site at http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-028.pdf.

The recommended standards contained in this document have been primarily written to support the design of on-site sewage systems with design flows less than 3500 gpd, but may also be applied to large on-site sewage systems (LOSS).

With the adoption of the revised LOSS rule, chapter 246-272B WAC, in 2011, some provisions of the RS&Gs may not be appropriate or allowed for LOSS. Many applicable requirements from the RS&Gs have already been included in the LOSS rule. Design engineers and others interested in LOSS are directed to consult the rule and LOSS program staff before or instead of the RS&Gs.

Typical RS&G Organization:

Standards Section	Explanation
Performance	How this technology is expected to perform (treatment level and function).
Application	How this technology is to be applied. This section includes conditions that must be met prior to proceeding with design. Topics in this section describe the “approved” status of the technology, component listing requirements, permitting, installation, testing and inspection requirements, etc.
Design	How this technology is to be designed and constructed (includes minimum standards that must be met to obtain a permit).
Operation and Maintenance	How this technology is to be operated and maintained (includes responsibilities of various parties, recommended maintenance tasks and frequency, assurance measures, etc).
Appendices	Design examples, figures and tables, specific applications, and design and installation issues.

Introduction

A mound system is characterized by:

- A pretreatment device (usually a conventionally sized septic tank – WAC 246-272A),
- Pressure distribution components (pump chamber, pump and controls, and low-pressure distribution laterals), including drip distribution, and
- The "mound", which includes the filter media, an infiltration bed, a distribution system, a soil cap and topsoil cover. (See Figure 1).

Septic tank effluent, pumped from the pump chamber to the distribution system in the infiltration bed flows through the filter media where it undergoes physical, biological, and chemical treatment and then passes directly into the underlying natural soil for dispersal.

Mounds are an excellent treatment and dispersal choice on appropriate sites, but they are not very forgiving. Special attention must be given to siting, design, pre-construction planning, site preparation, filter media selection, construction and maintenance of these systems. *Quality control throughout the process cannot be overemphasized.*

Specifically, the following items/issues are the "Critical Items" to address when applying mound technology:

- Suitable siting / application of the mound system technology, to both the site and the project.
- Accurate soil type and soil depth determination.
- Rigid adherence to the design concept that mounds must be "long and narrow" and located only along the topographical contours of the site.
- Mound systems have specific siting, design, construction, and maintenance conditions which when not fully met, lead to operational problems.
- Careful selection and placement of filter media.

Typical Applications of Mound Systems

Mound system design has been developed for those site conditions in which adequate vertical separation is not available between the bottom of a SSAS and a restrictive layer, or a water table. Mound system design addresses the following site and soil conditions.

- **Permeable or slowly permeable soils with a high water table.**

  Whether the water table is seasonal or permanent, these soils have inadequate vertical separation to provide satisfactory treatment with SSAS systems. Elevated water table may be due to landscape position, slow soil permeability, or a shallow restrictive layer that inhibits downward water movement.

  The mound system addresses these conditions by providing treatment before the effluent enters the native soil. By using timed dosed uniform distribution and adequate vertical separation in the selected filter media, vertical unsaturated flow is maintained, thus ensuring the maximum treatment permitted by this technology. Figure 3 shows typical effluent movement through this system.

- **Excessively permeable soils over unprotected aquifers or shallow permeable soils overlying excessively permeable soils or creviced or porous bedrock.**

  These sites present the risk of inadequate wastewater treatment before it reaches unprotected aquifers in excessively permeable conditions. This represents a significant public health risk.

  The mound system helps assure a known level of wastewater treatment before it is discharged to the sub-soil. Figure 3 shows the typical effluent movement through this system, with most of the flow being downward.

- **Slowly permeable soils without a high water table.**

  These soils are subject to severe damage from smearing and compaction, especially during the construction of systems using SSAS, which drastically reduces the permeability of the soil by destroying water-moving pores and channels. As a result these sites present a high potential for site and soil interface damage in addition to the need for large drainfields to provide adequate infiltration area. The advantages of a mound system for these sites are:

  - The mound effluent enters the more permeable natural topsoil over a larger area where it can move laterally until absorbed by the less permeable subsoil (Figure 3).

  - The biomat that develops at the bottom of the infiltration area will not clog the filter media as readily as it would the less permeable natural soil.

  - The infiltration area within the filter media is much smaller than it would be if placed in the more slowly permeable subsoil although the total mound area is probably larger than would be for a conventional drainfield system if one could be used.

Mound systems are used primarily in shallow soils overlying a restrictive layer or elevated groundwater table. The shallower the soil the more attention must be paid to transporting the treated effluent away from the point of application. Some of the principles that control the movement of treated effluent under and away from the mound (or any other dispersal system) include:

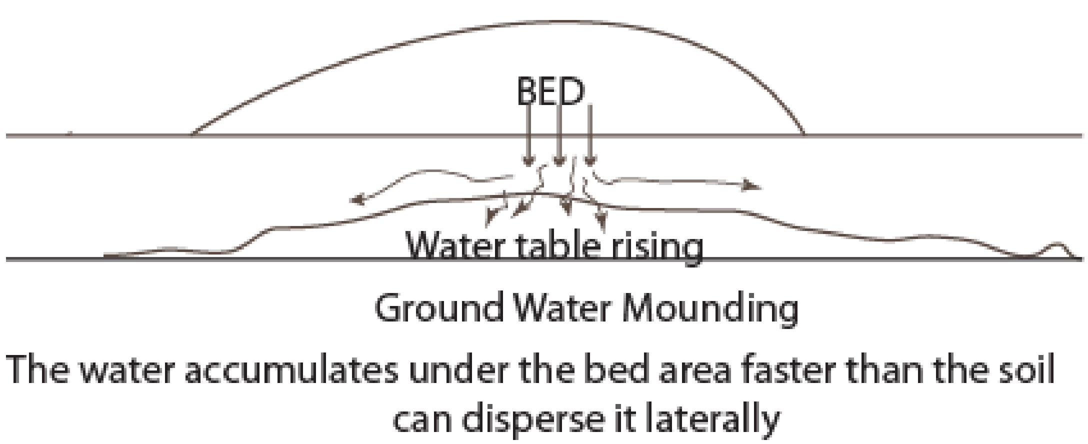
- Under any trench or bed treated effluent will accumulate as the system is used. This accumulation, called a "groundwater mound" will form on top of the restrictive layer or water table. The height of this groundwater mound is governed by the slope or gradient it generates. The slope must increase until it is great enough to drive the water away as fast as it is added. The concern here is that the groundwater mound may accumulate to such a degree as to severely reduce - or eliminate - the unsaturated vertical separation critical for providing treatment.

- The tighter the soil, the steeper the slope the groundwater mound of treated effluent must have in order to drive a given amount of treated effluent through a given area.

- The slope of the restrictive layer acts like, and is additive to, the slope of the groundwater mound of effluent. The slope of the ground surface is an indicator of the slope of the restrictive layer provided that the restrictive layer is relatively parallel to the ground surface.

Consideration of these principles mandates that on any site, under any conditions, the mound system must be long and narrow and placed only along the contours of the site / slope.

Figure 1—Ground Water Mounding



1. Performance Standards

1.1. Performance Criteria

When properly sited, designed, installed, operated and maintained, a mound system consistent with these recommended standards and guidance is expected to achieve treatment performance equal to Treatment Level B or C. Mounds must have a minimum of 3 feet of total unsaturated flow beneath the bed.

1.1.1. Treatment Level B. When using a mound system to meet Treatment Level B, there must be at least 24 inches of filter media and a minimum of 12 inches of vertical separation.

1.1.2. Treatment Level C. When using a mound to meet Treatment Level C, there must be at least 12 inches of filter media and a minimum of 24 inches of vertical separation.

1.2. Mound Treatment Sequence

When preceded by a treatment product listed on the List of Registered On-site Treatment and Distribution Products as meeting Treatment Level B, a mound system (properly sited, designed, installed, operated and maintained in a manner consistent with these recommended standards and guidance) is expected to achieve treatment performance equal to Treatment Level A.

1.2.1. When effluent is delivered to a mound by timed dosing, then the dispersal to the native soil will also be considered as receiving timed dosing.

Mounds are a poor choice on sites where either or both the vertical separation and the horizontal separation are severely limited (such as less than 12" VS or less than 25 feet HS).

Sites must be critically evaluated for their suitability for a mound system. The soil depth and/or water table conditions might necessitate consideration of a mound for a particular site but the overall site may not be a suitable application of the technology. Mound location, topography of the site, upland conditions, encroachments, surface water flow, soil type and structure, hydraulic conductivity, etc. are but a few of the critical issues to address on every proposed mound site.

Lots or sites that are forested or heavily covered with underbrush make this process very difficult, if not virtually impossible. As accurate soil depth assessment is essential, sites that do not lend themselves to clear evaluation must be adequately brushed and cleared before soils evaluation.

The clearing performed must be representative of the extent of site and soil disturbance anticipated with the future development and construction. This will help assure that the conditions that exist at the time of the mound system installation will be the same as those that existed at the time of the site / soil evaluation. Furthermore, the initial mound site, the replacement area, and the 30 foot protected zone downslope from both mounds must be adequately protected during site development to assure that the site / soil conditions will remain compatible with the approved design and construction plan throughout the project.

1.3. Listing

Mounds are a public domain technology and are on the Department of Health's List of Registered Onsite Treatment and Distribution Products as a Category 1 combined treatment and soil dispersal technology (designed to treat residential sewage).

2. Application Standards

2.1. Permitting

2.1.1. Permitting and installation of mound systems are subject to local and state code and at a minimum must comply with WAC 246-272A.

2.1.2. All required permits, must be obtained from the appropriate local health officer prior to installation and use. For sites where mounds are used to meet Treatment Level B, some means acceptable to the local health jurisdiction must be implemented to assure proper on-going operation and maintenance (O&M) of the system components as long as the facility is served by the on-site sewage system. The following, used separately or in combination, are examples of approaches for assuring long-term O&M:

2.1.2.1. recording the requirement for an on-going service contract on the property deed;

2.1.2.2. issuing an operating permit (in addition to the initial installation permit), with the requirement for maintaining a service contract;

2.1.2.3. requiring a management entity to provide O&M assurance. Examples of management entities include: cities & towns, public utility districts, water & sewer districts, special-use districts, and corporations with demonstrated capacity to assure long-term management.

2.2. Mound Location

Locate the mound in open areas for exposure to sun and wind where evaporation and transpiration will be maximized.

2.2.1. Do not construct mound systems in drainage ways, depressions, or areas subject to flooding.

2.2.2. Upslope runoff must be diverted around the mound.

2.2.3. Good design practice must consider drainage constraints for both upgradient and downgradient area drainage. The local health officer may require additional site evaluations and/or testing to analyze the site before siting the mound system.

A crested site is the most desirable because the mound can be situated such that the effluent can move laterally down both slopes. The level site allows lateral flow in all directions, but may present problems as the groundwater mound that develops under the mound may rise to the ground surface beneath the mound in slowly permeable soils. The most common application is the sloping site where all the liquid moves in one direction away from the mound (Figure 3). However, proper design can overcome this limitation. The mound should be placed on the upper portions of the slope, not at the base of the slope. On a site with a complex slope (two directions), the mound should be located so that the treated wastewater is not concentrated in one area downslope.

Sites with large trees, numerous smaller trees or large boulders are less desirable for installing a mound system because of difficulty in preparing the surface and because of the reduced infiltration area (exposed soil) available beneath the mound. Tree roots, stumps and boulders are like rock fragments, they occupy space, and thus reduce the amount of soil available for receiving and transmitting treated wastewater away from the mound area.

If no other site is available, leave the tree stumps cut off at ground level rather than disturbing the native soil by removing them. A larger-than-normal mound area may be necessary if many, or large, stumps or boulders are involved, so sufficient soil is available to accept the effluent. The amount of increased basal area and/or mound size should be technically justified and sufficient to make up for the soil infiltration area lost to the tree trunks, stumps, and boulders.

In addition to increasing the size of the system extra care and consideration must be given to adequately prepare the soil infiltrative surface under less-than-ideal conditions. Such a site may very well necessitate meticulous hand spading of part or all of the area under the mound.

2.3. Minimum Original Soil Depth and Filter Media Depths

2.3.1. Mound systems must be designed to meet the minimum vertical separation requirements and treatment level specified by WAC 246-272A, Table VI or WAC 246-272A, Table IX. The depth of filter media is dependent upon the treatment level requirement of a given site. See Table 1 for possible applications of mounds consistent with the vertical separation requirements in rule.

2.3.1.1. In order to be expected to produce effluent meeting Treatment Level B, a total of 3 feet of unsaturated soil/media depth must be present. This must include a minimum depth of 24 inches of filter media (regardless of the level of pretreatment) and a minimum of 12 inches of undisturbed, unsaturated, original soil, as measured from the original ground surface, under all parts of the bed.

2.3.1.2. In order to be expected to produce effluent to produce effluent meeting Treatment Level C, a total of 3 feet of unsaturated soil/media depth must be present. This must include a minimum depth of 12 inches of filter media and a minimum of 24 inches of undisturbed, unsaturated, original soil, as measured from the original ground surface, under all parts of the bed.

2.3.2. If the mound is preceded by a treatment technology listed on the List of Registered On-Site Treatment and Distribution Products as meeting either Treatment Level A or B, a mound can be expected to produce effluent meeting Treatment Level A when a minimum depth of 24 inches of filter media and 12 inches of undisturbed, original soil as measured from the original ground surface is present.

2.3.2.1. If a mound is preceded by a treatment technology identified on the List of Registered On-Site Treatment and Distribution Products as meeting Treatment Level A or B and is to be used for dispersal only, a total of 3 feet of unsaturated soil/media depth must be present. This must include a minimum depth of 12 inches of filter media and minimum of 24 inches of undisturbed, unsaturated, original soil, as measured from the original ground surface, under all parts of the bed.

Generally, when the site evaluation indicates the depth of soil to a water table is less than 18 inches, there is a need to confirm that there are at least 12 inches during the wet season. Therefore, when there is any doubt that there is sufficient unsaturated soil depth, the permit should be held for a wet season evaluation to identify accurately the location of high water tables. As potential vertical separation (or soil depth) decreases, seasonal site checks to evaluate water table levels become increasingly critical to the on-site sewage system design, function, and protection of public health.

Table 1. -Treatment Component Performance Levels and Method of Distribution Possible Applications for Mounds in WAC 246-272A

Vertical Separation in inches	Soil Type		
	1	**2**	**3-6**
12 < 18	**A** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with one foot of filter media beneath bed for dispersal only or Mound with 2 feet of filter media beneath bed***	**B** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with one foot of filter media beneath bed for dispersal only or Mound with 2 feet of filter media beneath bed)***
≥ 18 < 24	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***
≥ 24 < 36	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**C** - pressure **(Mound with one foot of filter media beneath bed)**	**E** - pressure **(Mound with one foot of filter media beneath bed)**

The maximum ground slope on which a mound can be reasonably installed with customary construction equipment is 20%.

Design and placement of mounds on slopes greater than 20% mandates that special care and consideration be given to slope stability installation techniques, and design elements of "long & narrow". These issues may require the services of qualified / experienced engineers, geologists, soil scientists, or others, depending upon the site conditions.

2.4. Setbacks

Setbacks are measured between the perimeter of the basal area of the filter media and the respective features. Table 2 describes mound setbacks. Other minimum setbacks are as specified in WAC 246-272A.

Table 2. Additional Minimum Setback Requirements

When the item to be setback[1] from is:	Upgradient[2]	Downgradient[3]
Setback distance from property lines, other soil dispersal components, driveways, buildings, ditches or interceptor drains, subsurface storm water infiltration systems, or any other development which would either impede water movement away from the mound or channel groundwater to the mound area	**10 feet**	**30 feet**
Setback distance from well, suction line or surface water.	**100 feet**	**100 feet**

[1] The edge of required basal area
[2]The item is upgradient when liquid will flow away from it upon encountering a water table or restrictive layer.
[3]The item is downgradient when liquid will flow toward it upon encountering a water table or restrictive layer.

2.5. Influent Characteristics

2.5.1. Wastewater from residential sources must receive pre-treatment at least equal to that provided by a conventional two-compartment septic tank, before discharge to a mound.

2.5.2. Wastewater from non-residential sources or high-strength wastewater from residential sources must receive pre-treatment sufficient to lower the waste-strength to the level of that commonly found in domestic residential septic tank effluent before discharge to a mound.

When addressing unique wastewater strengths from the septic tank, such as those characterized by high BOD_5 or TSS or oil and grease, the mound system, like the intermittent sand filter, has inherent limitations. The wastewater applied to the mound should not be higher in strength than Treatment Level E. Lower wastewater strengths, without increased flow rates, is preferable for assuring long-term operation of a mound system. High-strength wastewater and wastewater from non-domestic sources (such as restaurants, espresso stands, hotels, bed and breakfast establishments, industrial and commercial wastewater sources, etc.) should be individually evaluated for treatability and degree of pretreatment required prior to a mound for final treatment and dispersal.

2.6. Minimum Land Area / Density

The use of a mound system does not provide for a reduction in the minimum land area requirements established in WAC 246-272A. Site development incorporating a mound must meet the minimum land area requirements established in state and local codes.

2.7. Reserve Area

A reserve area with suitable site conditions for a mound installation must be set aside. The reserve area must meet the requirements of WAC 246-272A.

2.8. Installation

Mounds must be protected from surface drainage. Installation may require grading, building a berm, or providing other drainage system upslope from the mound to divert water around or away from the mound.

2.8.1. Equipment

2.8.1.1. A tracked vehicle with a maximum pressure on the soil of 7 psi must be used to place the filter media, prepare the bed, shape the mound and add the topsoil cover. A wheeled vehicle must not be used for this work, or travel over the basal area or over the area included within 30 feet downslope of the basal area.

> *Given the make and model of equipment, a manufacturer can provide the psi of the tracks. Proper installation techniques also require prudent maneuvering over the fill material, such as not leaving the equipment parked and running while on the fill and not performing locked track turns on the fill. Both of these and certain other practices can compact the soil under the fill.*

2.8.1.2. A spring-loaded agricultural chisel plow, or other acceptable apparatus or method, must be used to prepare the soil before constructing the mound system (See Appendix E. Site Preparation and Construction). Rototilling is not an acceptable substitute and must not be used.

2.9. Inspection

All site inspections before, during, and after construction of the mound system must be accomplished by the local health officer or other appropriate jurisdictional representative, or by a person (designer or engineer) identified and approved by the appropriate jurisdictional authority.

2.10. Gravel Material

"Drainrock" as defined in WAC 246-272A: Clean, washed gravel or crushed rock ranging in size from three-quarters inch to two and one-half inches, and containing no more than two percent by weight passing a US No. 8 sieve and no more than one percent by weight passing a US No. 200 sieve.

2.11. Gravelless Distribution Technologies

Gravelless distribution technologies may be used in place of gravel in mound systems. Only those gravelless drainfield products on the current List of Registered On-site Treatment and Distribution Products may be permitted by the local health jurisdiction.

2.12. Mound Media

2.12.1. Mound Media Specifications **-** Filter media must meet either the Coarse Sand Media or ASTM C-33 specification for particle size graduation detailed in Appendix C. Filter media used in constructing a mound must be accompanied with a written certification from the supplier that the sand fully conforms to one of the media specifications listed in Appendix A as determined by ASTM D136 (dry sieving) and ASTM C-117 (wet sieving).

See Section 3.4 for the minimum dosing frequency required with the Coarse Sand Media

2.12.2. In order to prevent differential settling when the mound is put into service, the filter media must have a uniform density throughout.

Uniform density may be accomplished one of two ways, depending on the moisture content of the filter media during construction. If the filter media is so dry that it can be poured (like salt or sand in an hourglass), it can simply be poured or pushed with a tracked vehicle into position, then settled lightly (not compacted) to allow about 5% settling - i.e., volume reduction. However, if the filter media is moist enough that it cannot be poured, it should be placed in successive 6-inch lifts with each lift lightly settled. The intent of the light settling in both cases is to eliminate large voids in the media that may collapse later when effluent is added. The light settling may be accomplished by walking on the sand and around monitoring ports. The final bulk density should be approximately 1.3 to 1.4 g/cm^3 (81.2 to 87.4 lb/ft^3). Higher densities will reduce infiltration rates and oxygen exchange potential.

3. Design Standards

3.1. Design Approval

Before construction can begin, the design must be approved by the local health jurisdiction. All site inspections before, during and after the construction must be accomplished by the local health jurisdiction, or by a designer or engineer appointed by that jurisdiction.

These recommended standards provide a systematic approach to mound system design for typical residential sewage. For systems serving other than single-family dwellings the designer is cautioned that simple extrapolation of this information may not be appropriate. As daily wastewater flows increase beyond single-family levels, table values and pre-calculated charts cannot be relied upon solely, and should be carefully confirmed by individual calculations.

3.2. Minimum Daily Design Flow

Residential – For all applications, the design flow is calculated using at least 120 gallons/bedroom/day with a minimum of 240 gallons/day.

Non-Residential – For non-residential applications, a wastewater daily design flow of at least 150% of the estimated daily flow must be used.

3.3. Application Rates

3.3.1. The application rate for the mound infiltration area (bed) varies with the level of pretreatment.

The loading rate to the sand media in mounds is 1.0 gpd/ft^2. It should be noted that in Wisconsin, sand systems are never loaded greater than 1.0 and often are designed at 0.8 gpd/ft^2.

3.3.2. When pretreatment is provided by an approved two-compartment septic tank, the application rate must not exceed 1.0 gpd/sq. ft.

3.3.3. When the mound is preceded by a treatment technology identified on the List of Registered On-site Treatment and Distribution Products as meeting Treatment Level B, the application rate may exceed 1.0 gpd/ft^2 but must not exceed 2.0 gpd/ft^2 when the following conditions are met:

3.3.4. The maximum width of the infiltration area (bed) is no greater than 50% of that identified in Table 3.

3.3.5. There is no reduction in the length of the bed (same as it would be if designed at 1.0 gpd/sq. ft.).

3.3.6. There is no reduction in the required size of the basal area (sized according to Table 4.)

3.3.7. The system is not being used to meet Treatment Level A.

3.3.7.1. No reductions are allowed when gravelless distribution technologies are used.

The application rate for the basal area varies with Soil Type. See Table 4.

3.4. Minimum Dosing Frequency

A timer-controlled system (timed-dosing) is required. The minimum dosing frequency or dose volume is dependent on the media specification used with the mound. To assure that appropriate dose volumes are delivered to the mound, the timer must be set to dose the mound at the following minimum dosing frequency:

Media Specification	**Number of Doses/Day (Minimum)**
Coarse Sand Media	18 times per day
ASTM C-33	4 times per day

Sites must be critically evaluated for their suitability for a mound system. The soil depth and/or water table conditions might necessitate consideration of a mound for a particular site but the overall site may not be a suitable application of the technology. Mound location, topography of the site, upland conditions, encroachments, surface water flow, soil type and structure, hydraulic conductivity, etc. are but a few of the critical issues to address on every proposed mound site.

Lots or sites that are forested or heavily covered with underbrush make this process very difficult, if not virtually impossible. An accurate soil depth assessment is essential, sites that do not lend themselves to clear evaluation must be adequately brushed and cleared before soils evaluation.

The clearing performed must be representative of the extent of site and soil disturbance anticipated with the future development and construction. This will help assure that the conditions that exist at the time of the mound system installation will be the same as those that existed at the time of the site / soil evaluation. Furthermore, the initial mound site, the replacement area, and the 30 foot protected zone downslope from both mounds must be adequately protected during site development to assure that the site / soil conditions will remain compatible with the approved design and construction plan throughout the project.

The configuration of the mound system responds to the slope, shape, size and feature characteristics of the site and is determined by the rectangular dimensions of the infiltration bed in response to the depth of unsaturated soil (see Table 3 below).

Table 3. Maximum Bed Width[1]

Type of Restrictive Layer	Available Soil Depth (inches)		
	12 - < 18	18 - < 24	≥ 24
Water table or other restrictive layer, excluding non-creviced bedrock.[1]	5 feet	7.5 feet	10 feet
Bedrock, non-creviced.[1]	Not Allowed	7.5 feet	10 feet

[1] The noted bed widths are the maximum cumulative widths permitted for one or more beds on the same downhill plane on a single parcel.

3.5. Infiltration Area Bed; gravel, approved gravelless product or subsurface drip

The size of the infiltration area (the bottom infiltrative surface area of the bed) is determined by applying the following formula:

$$\underline{\underline{\textit{Infiltration Area } (ft^2)}} = \frac{\text{Daily Design Flow (gal/day)}}{1.0 \text{ gallons/ft}^2\text{/day}}$$

3.5.1. Bed Width – Maximum bed width is matched with the maximum depth of available soil in Table 3.

Bed Width (A) = Dependent on soil depth. See Table 3.

3.5.2. Bed Length **-** The length of the infiltration area (the bottom infiltrative surface area of the bed) is determined by applying the following formula:

$$\underline{\underline{\textit{Bed Length (B)}}} = \frac{\text{Required Bottom Infiltrative Surface Area}}{\text{Bed Width (A)}}$$

3.5.3. Bed Depth **-** A minimum of 6 inches of drainrock is placed beneath the distribution pipe, 2 inches above the pipe.*

Bed Depth (F) = 9 inches (minimum for 1-inch diameter lateral)

*Gravelless distribution technologies may be used to distribute the effluent into the filter media, including chambers, gravelless substitute and drip, making the proper adjustments for different geometries of these technologies. The distribution technology used must meet the intent and requirements of timed dosed pressure distribution.

3.5.4. Bed Grade - The bottom of the bed must be level (± ½ inch).

3.6. Mound Height

The mound height consists of:

3.6.1. the filter media depth below the bottom of the bed (D & E),

3.6.2. the infiltrative bed depth (F), and

3.6.3. the cap and topsoil depth (G & H).

3.7. Filter Media Depth

The depth of filter media is dependent upon the treatment level requirement of a given site. If a mound system is proposed to be used on a site whose conditions require a technology meeting Treatment Level B or C, a minimum unsaturated vertical flow path of 3 feet is required. This depth may consist of the natural soil and mound filter media, but there must always be a minimum of 12 inches of filter media. (See Table 1 for possible applications)

3.7.1. In order to be expected to produce effluent meeting Treatment Level B, a minimum depth of 24 inches of filter media under all parts of the bed (or infiltrative surface into the filter media) is required regardless of the level of pretreatment. This means that a mound with a minimum of 24 inches of media preceded by a treatment technology identified on the List of Registered On-site Treatment and Distribution Products as meeting Treatment Level B can be expected to produce effluent meeting Treatment Level A.

3.7.2. In order to be expected to produce effluent meeting Treatment Level C, a minimum depth of 12 inches of filter media under all parts of the bed (or infiltrative surface into the filter media) is required. (See 2.3.2)

3.7.3. If the mound is preceded by a treatment technology identified on the List of Registered On-site Treatment and Distribution Products as meeting Treatment Level A or B, only 12 inches of filter media below the bed is required when the mound is used only for dispersal. (See 2.3.2)

3.7.4. The depth of filter media below the infiltration bed varies with ground slope according to the following formulas:

Filter media depth below upslope edge of bed (D) = 1 or 2 feet as determined by site characteristics and design assumptions.

Filter media depth below downslope edge of bed (E) = D + [% natural slope as a decimal x width of bed (A)]

3.8. Filter Media Length and Width

The length and width of the filter media are dependent upon the length and width of the infiltration bed, filter media depth and side slopes of the filter media.

3.8.1. Side slopes must be no steeper than 3:1 (i.e. 3 feet of run to every 1 foot of rise) (Figure 6). Appropriate topsoil may be used to make the slopes gentler (such as 4:1 to facilitate landscaping and lawn mowing) than the required 3:1 slopes, once the 3:1 slope exists with the filter media.

3.8.2. The filter media length consists of the end slopes (K) and the bed length (B).

3.8.3. The filter media width consists of the upslope width (J), the bed width (A), and the downslope width (I). On sloping sites the downslope width (I) will be greater than on a level site if a 3:1 side slope is maintained. Table 5 gives the slope correction factors (multipliers) for slopes from zero up to 20% assuming a 3:1 side slope.

3.9. Cap and Topsoil Depth

The soil placed over the entire mound must be selected and placed to promote aeration of the mound, rainwater movement off and away from the mound, and establishment and maintenance of a vegetative cover. The cap may consist of a material as course textured as the filter media, and the topsoil may be as fine as a medium-to-fine sandy loam.

3.9.1. The final settled depth of the cap and topsoil should be no less than 12 inches above the center and 6 inches above the outer edge of the bed. Additional depth of topsoil may be needed during final construction activities to assure that the minimum depths are achieved following natural settling of the soil.

3.9.2. The depth and type of topsoil used must not adversely inhibit the free transfer of oxygen to the bed and filter media of the mound.

3.9.3. Cap and Top Soil (G & H):

Unsettled cap and topsoil depth at bed center (H) = 18 inches.

Unsettled cap and topsoil depth at bed edges (G) = 12 inches.

3.9.4. The mound must not be left without a vegetative cover or allowed to go to weed. Mowed turf grass and turf sod are the best vegetative covers for mounds.

The cap provides frost protection, a barrier to infiltration, retains moisture for vegetation and promotes runoff of precipitation. The topsoil aids in establishing and maintaining a good vegetative cover. The cap and topsoil will settle during construction and usage. It is important that the finished settled cap and topsoil promote runoff and contain no depressions. Some soils may settle a great deal so be sure to place adequate depth of soil to allow for settling in achieving the final settled depth of cap and topsoil.

The use of a medium to fine sandy loam will enhance moisture retention for plant growth and increased rainwater runoff. Exercise caution, however, so as not to use soils with such fine texture as to severely reduce oxygen transfer through the cap. Coarse textured soils, such as sands, are not recommended, as they drain rapidly and allow more intrusion of precipitation into the infiltration bed.

Care and maintenance of the soil cover is important. Different sites will present different landscaping options for the mound, in terms of yard surface contouring and plantings. If landscaping is not going to occur soon after installation, seeding with turf grass or placement of turf sod is highly recommended to hold the soil and prevent erosion. In any case the mound must not be left without a vegetative cover or to go to weed. Mounds without satisfactory vegetative cover are often damaged by children digging, small animal damage, livestock trampling, or erosion.

3.10. Basal Area

The amount of basal area required is dependent upon the permeability of the original soil. Table 4, which is from WAC 246-272A, gives the infiltration/loading rates for determining the needed basal area.

Table 4 - Infiltration/Loading Rates for Sizing Basal Area for Mound Systems
(WAC 246-272A)

SOIL TYPE	SOIL TEXTURAL CLASSIFICATION DESCRIPTION	LOADING RATE gal./sq. ft./day
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils excluding Soil types 5 & 6, all soil types with greater than or equal to 90% rock fragments.	1.0
2	Coarse sands.	1.0
3	Medium sands, loamy coarse sands, loamy medium sands.	0.8
4	Fine sands, loamy fine sands, sandy loams, loams.	0.6
5	Very fine sands, loamy very fine sands; or silt loams, sandy clay loams, clay loams and silty clay loams with a moderate structure or strong structure (excluding a platy structure).	0.4
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.	0.2
7	Sandy clay, clay, silty clay and strongly cemented firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, any soil with appreciable amounts of expanding clays.	Unsuitable

3.10.1. For level sites, the total basal area, i.e. the area of soil beneath the filter media [length of filter media (L) x width of filter media (W)] is available for effluent absorption into the native soil. See Figure 6.

3.10.2. For sloping sites, the only available basal area is the area beneath the bed (A x B) and the area immediately downslope from the bed [bed length (B) x downslope width (I)]. It includes the area enclosed by [B x (A + I)]. See Figure 9. The upslope and end slopes will transmit very little of the effluent on sloping sites, and are therefore disregarded.

3.10.3. The available basal area must equal or exceed the required.

$$\underline{\text{Basal Area Required}} = \frac{\text{Daily Design Flow}}{\text{Infiltration Rate of Original Soil}}$$

Basal Area Available = B x (A + I) on sloping site or = L x W on level site.

The basal area is the interface between the natural soil and the filter media. Its function is to accept the effluent from the filter media, assist the filter media in treating the effluent, and transfer the effluent to the subsoil beneath the filter media for lateral movement to the subsoil outside of the mound.

If sufficient area is not available for the given design and site conditions, corrective action is required to increase the dimensions of the filter media area. The preferred method to increase basal area is to lengthen the bed rather than simply extending the toe of the filter media. Again, be advised that if a mound cannot be designed and laid-out "long and narrow" other enhanced treatment technologies should be selected rather than err in designing or locating a mound system.

3.11. Mound Placement

The following design conventions for system layout and mound placement must be followed.

3.11.1. On sloping sites, the mound must be aligned with its longest dimension parallel to the site contours so as not to concentrate the effluent into a small area as it moves laterally downslope.

3.11.2. The mound must not be aligned, by design or construction, perpendicular to the contours.

3.11.3. On all sites the infiltration bed must be as long and narrow as possible to limit the linear loading rate of effluent to assure that all the effluent infiltrates into the natural soil before it reaches the toe of the filter media.

3.11.4. If the site does not permit the design of a "long and narrow" mound along the contours of the site, other on-site sewage treatment and dispersal technology must be selected. Mound systems are only suitable for sites where all of the design and siting criteria can be satisfactorily met.

3.11.5. Two or more beds on the same downhill plane are not permitted if the total bed width exceeds the specified maximum bed width in Table 3, unless the distance between beds is so great that a curtain drain meeting all the required setbacks can be properly installed between the farthest extensions of the two basal areas.

Some variables to consider regarding curtain drains at a specific site are vertical separation, soil type, percent slope, maximum bed width and type of restrictive layer.

3.12. Pressure Distribution

A method providing uniform distribution with timed dosing throughout the bed in the filter media is required. The pump chamber and the distribution system must be designed in accordance with the Recommended Standards and Guidance for Pressure Distribution or Recommended Standards and Guidance for Subsurface Drip Systems. If drip is used, the dripline must be at least 2 feet from the outer edge of the mound. The drip bed must include at least 6 inches of filter media over the drip lines. Design, layout, and installation of the pump chamber-to-mound transmission line must consider, and satisfactorily address, the potential for channeling groundwater or surface water to either the mound or the pump chamber causing infiltration-related problems.

3.13. Monitoring Ports

Each mound should have a minimum of two monitoring ports, one placed in the infiltration bed down to the gravel-sand interface (except where subsurface drip distribution system is used), and one downslope from the bed down to the sand-native soil interface. Another useful monitoring port would be installed through the sand-native soil interface into the native soil several inches. The installation of monitoring ports is for the purpose of monitoring system status and aiding in problem analysis. The methods of installing and securing observation ports are provided in Figure 11. Well-designed and installed monitoring ports:

- Extend to at least the ground surface of the final landscape grade surface.
- Are firmly anchored to prohibited unauthorized removal.
- Are accessible for routine observation.
- Are secured or otherwise protected for accidental or unauthorized access.
- Provide visual access to the filter bed-bottom in the gravel portion of a gravel-filled sand filter and, in gravelless chambers to the interior of the chamber.

3.14. Construction Plan

A construction plan must be developed and submitted as a part of the project design. A construction plan includes, among other necessary details:

3.14.1. The routes for ingress and egress for construction vehicles, assuring that adequate protection is afforded the mound, and surrounding areas, especially downslope areas. The mound system, including the area around the base and downslope, must be protected to prevent damage caused by vehicular, livestock, or excessive pedestrian traffic.

3.14.2. The means to assure that the reserve area is not subject to damage or soil compaction from vehicular or other site development activity.

3.14.3. Instructions for erecting a temporary construction fence or protective barrier around the proposed mound, designated reserve, and the adjacent area (particularly downslope from the primary and reserve mound sites) to assure that the area is not damaged by other construction activity before installation of the mound system. These areas must be unmistakably identified on the site so as to preclude potential site damage. Such fencing or identification is the responsibility of the sewage system designer.

3.14.4. Instructions, layout and specifications for proper grading, diking, ditching and subsurface drainage to prevent the intrusion of off-site surface and subsurface waters into the mound area, and

3.14.5. Requirements for proper installation equipment and construction procedures. (See Appendix E. Site Preparation and Construction.)

The procedures used in the construction of a mound system are just as critical as the design of the system. Good design with poor construction will result in system failure. It should be emphasized that the soil must only be worked when the moisture content is low to avoid compaction and puddling. Consequently, installations must be made only when the soil is as dry as required. The approved construction plan must be followed.

4. Operation & Maintenance Standards

4.1. Management

4.1.1. The local health officer may require a maintenance agreement with supporting legal documents before approving a proposed mound system. Maintenance agreements are recommended when, in the opinion of the local health authority, the optimum operation of the mound system is assured by such an agreement.

4.1.2. Owner Responsibilities—The owner of the residence or facility served by a mound is responsible for assuring proper operation and providing timely maintenance for all components of the on-site wastewater treatment and soil dispersal system. This includes inspecting the entire system at a frequency appropriate for the site conditions and the type of on-site sewage system as specified by the local health jurisdiction (LHJ). Contact the local health department/district for what qualifications are required of a person to perform any specialized monitoring and maintenance activities.

4.2. Operation and Maintenance (O&M) Manual

4.2.1. An O&M manual for the mound system must be provided by the system designer. The manual must contain the following:

4.2.1.1. The system owner's responsibilities include established system operation, inspection, recording keeping, reporting, and permit requirements.

4.2.1.2. Key contact information including names and telephone numbers of the local health authority, system designer, component manufacturer, supplier/installer, and/or the management entity to be contacted in the event of an emergency or system failure.

4.2.1.3. Design description including a narrative that describes how the system works, its intended performance, and operating limits of the design. The narrative should include a brief description of each major process or component and discuss its function in the system and its expected performance. For proprietary products, include manufacturer's standard product literature, including performance specifications and maintenance recommendations needed for operation, monitoring, and maintenance.

4.2.1.4. Diagrams of the all major system components, including system design drawings, system record drawing, and schematics for all electrical and mechanical components installed.

4.2.1.5. Information on the periodic monitoring and maintenance requirements of the system. List and describe monitoring and maintenance activities for septic tank, dosing tanks, sand filter, drainfield, control panel, pumps, motors, switches, alarms, etc. including recommended component settings for routine operation and monitoring.

4.2.1.6. A list and description of key operating activities and measures that should be employed or avoided to protect the sewage system's treatment processes and components. Examples include use of low flow fixtures, spreading out laundry and other high water use activities over several days, selective and limited use of bleach and other household chemicals, elimination of garbage grinders, not disposing unwanted and outdated medications down the drain, and maintaining suitable soil cover, landscaping and vegetation for the sand lined trench system and the reserve area.

4.2.1.7. A trouble shooting guide: Including information on "trouble-shooting" common operational problems that might occur. This information should be as detailed and complete as needed to assist the system owner to make accurate decisions about when and how to attempt corrections of operational problems, and when to call for professional assistance.

4.3. Monitoring and Maintenance

4.3.1. Minimum monitoring and maintenance activities for mound systems include:

4.3.1.1. Inspect septic tank yearly for structural integrity, proper baffling, ground water intrusion, and proper sizing. Inspect and clean effluent baffle screen and also pump tank as needed;

4.3.1.2. Pump dosing tanks, clean the effluent screen, inspect and clean the pump switches and floats yearly. Pump the accumulated sludge from the bottom of the chambers whenever the septic tank is pumped, or more often if necessary;

4.3.1.3. Check monitoring ports for ponding. Conditions in the monitoring ports must be observed and recorded by the service provider during all operation and maintenance activities for the mound and other system components. The person monitoring the system needs to be aware of the impact of dose frequency has on the observed ponding level;

4.3.1.4. Inspect and test yearly for malfunction of electrical equipment such as timers, counters, control boxes, pump switches, floats, alarm system or other electrical components, and repair as needed. System checks should include improper setting or failure of electrical, mechanical, or manual switches;

4.3.1.5. Check for mechanical malfunctions (other than those affecting sewage pumps) including problems with valves or other mechanical or plumbing components;

4.3.1.6. Check for material fatigue, failure, corrosion, or use of improper materials, as related to construction or structural design;

4.3.1.7. Check for system neglect or improper use, such as hydraulic or organic loading beyond the operating capacity, introduction of toxic or hazardous substances into the system, extraneous flows into system, drainage from surface runoff or non-sewage drains directed towards where the system is located, soil compaction, damage by soil removal and grade alteration, and unsuitable cover material or vegetation;

4.3.1.8. Check building usage for changes in wastewater strength, hydraulic flow, or other conditions that could affect the performance of the mound and/or the entire system. Sampling, testing, and troubleshooting may be required by the local health officer on a case-by-case basis, depending on the nature of the problem, availability of laboratories, or other factors. This may include sampling of specific chemical/biological indicators, such as BOD, TSS, fecal coliforms, etc.;

4.3.1.9. Check for system installation problems such as improper location or failure to follow design;

4.3.1.10. Check for overflow or backup problems where sewage is involved;

4.3.1.11. Maintain a written chronological record of ponding level observations, and monitoring and maintenance activities. If the system has a reduced size drainfield, this should be included in the report to the local health jurisdiction responsible for permitting the system;

4.3.1.12. Service all system components as needed, including product manufacturer's requirements/recommendations for service.

4.4. Observed Conditions/Troubleshooting/Actions

4.4.1. When a system evaluation, or any other observation, reveals either of the following listed conditions, the owner of the system must take appropriate action to correct the situation according to the direction and approval of the local health officer:

4.4.1.1. System failure, as defined in WAC 246-272A, or,

4.4.1.2. A history of long-term, continuous and increasing ponding of effluent within the system of such magnitude, if left unresolved, will probably result in untimely system or component failure.

Typical failure conditions that may occur with a mound are:
(1) Severe clogging at the bed/filter media interface.
(2) Severe clogging at the basal filter media/ natural soil interface.
(3) Plugging of the distribution network.
(4) Sewage breakout at the toe of the mound.

4.4.2. The Trouble Shooting Guide provides additional information to help determine what the appropriate actions are. This information should be as detailed and complete as needed to assist the system owner to make accurate decisions about when and how to attempt corrections of operational problems, and when to call for professional assistance.

4.4.2.1. Check for system neglect or improper use, such as hydraulic or organic loading beyond the operating capacity, introduced toxic or hazardous substances into the system, extraneous flows into system, drainage from surface runoff or non-sewage drains directed towards where the system is located, soil compaction, damage by soil removal and grade alteration, and unsuitable cover material or vegetation.

4.4.2.2. Check building usage for changes in wastewater strength, hydraulic flow, or other conditions that could affect the performance of the mound system. Sampling and testing may be required by the local health officer on a case-by-case basis, or troubleshooting depending on the nature of the problem, availability of laboratories, or other factors. This may include sampling of specific chemical/biological indicators, such as BOD, TSS, fecal coliforms, etc.

4.4.3. Appropriate actions include:

4.4.3.1. Evaluation of building usage for a change in wastewater quality or quantity, or other conditions that could be causing the observed ponding within the system or failure;

4.4.3.2. Modifications or changes within the structure relative to wastewater strength or hydraulic flows;

4.4.3.3. Repair or modification of the on-site sewage system;

4.4.3.4. Expansion of the on-site sewage system.

The cause of the failure must be determined first. If the clogging is due to hydraulic overloading or unusual wastewater characteristics, efforts should be made to reduce the wastewater volume or strength. It may also be necessary to; enlarge the mound, remove cap and reconstruct the infiltration bed, clear the distribution network. In extreme cases, the filter media must be removed and replaced with new filter media or the mound system rebuilt on another site.

Local permits must be obtained before construction begins, according to local health jurisdiction requirements. Any observed problem, repair or modification activity must be reported as part of the monitoring activity for the site. For an on-site sewage system with a reduced size drainfield, the repair or modification required may include the installation of additional drainfield to enlarge the system to 100% of the initial design size. Repair or modification is not limited to this option.

Figures

Figure 1. Ground Water Mounding

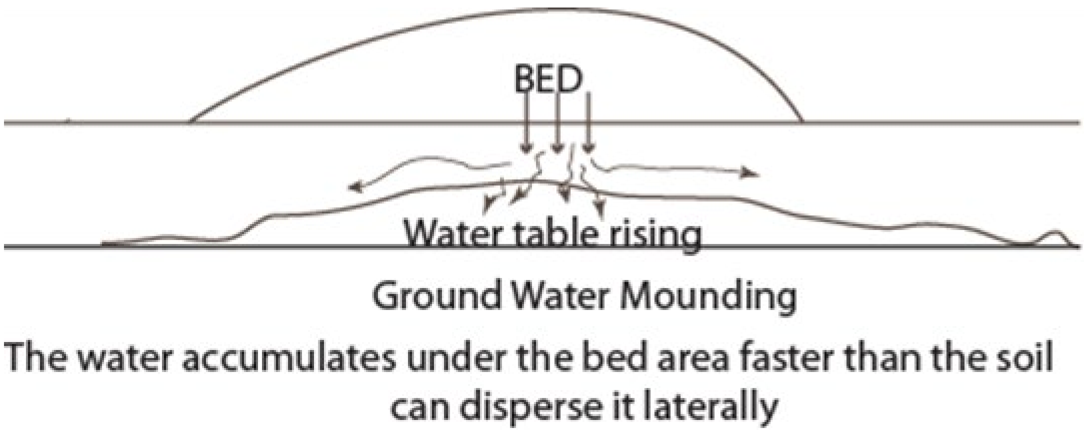


Figure 2. Typical Mound OSS

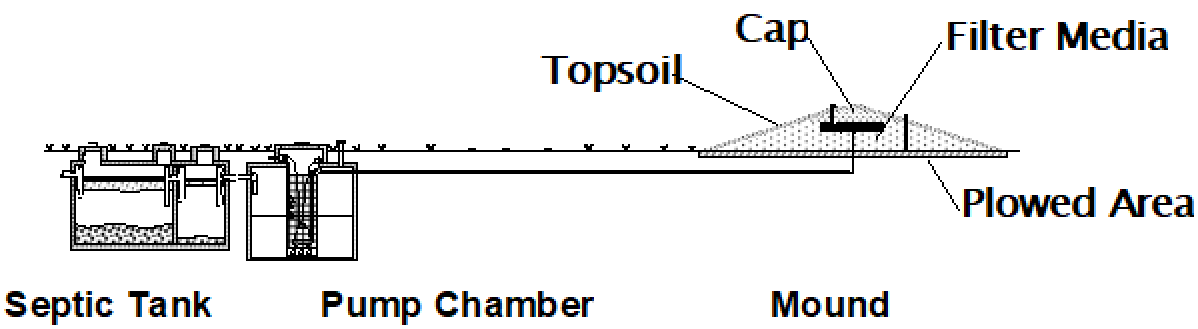
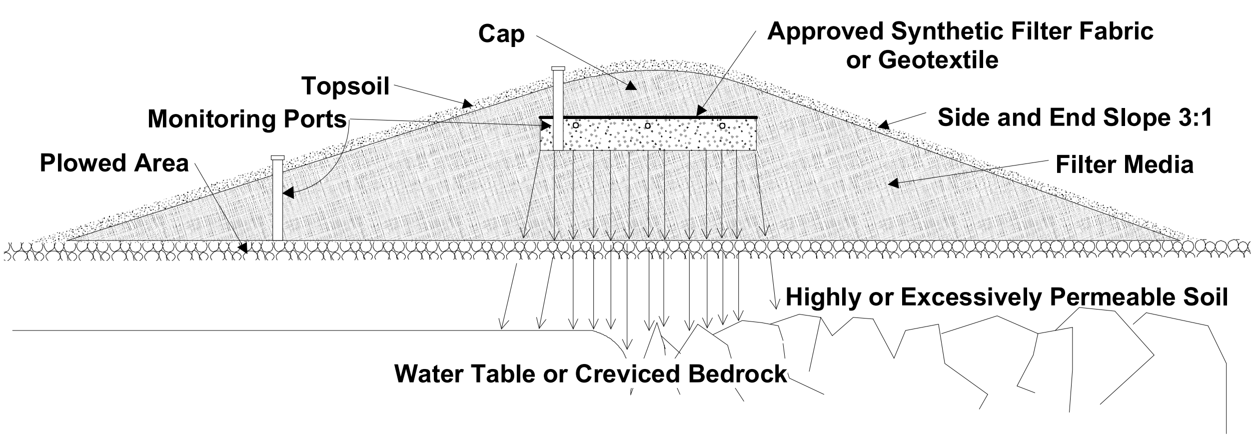


Figure 3. Cross-Section Showing Effluent Movement in Permeable or Excessively Permeable Soils (Type 1 Soils)



Please note that vertical separation is from the mound basal area to the restrictive layer.

Figure 4. Cross-Section of a Typical Mound System Showing Effluent Movement in a Slowly Permeable Soil on a Sloping Site

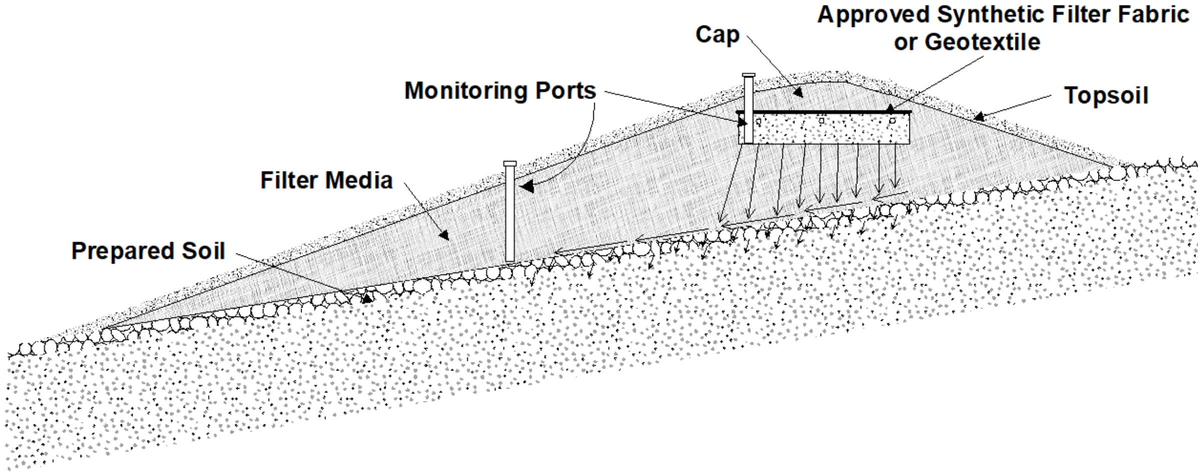


Figure 5. Downslope Setback from Toe of Basal Area

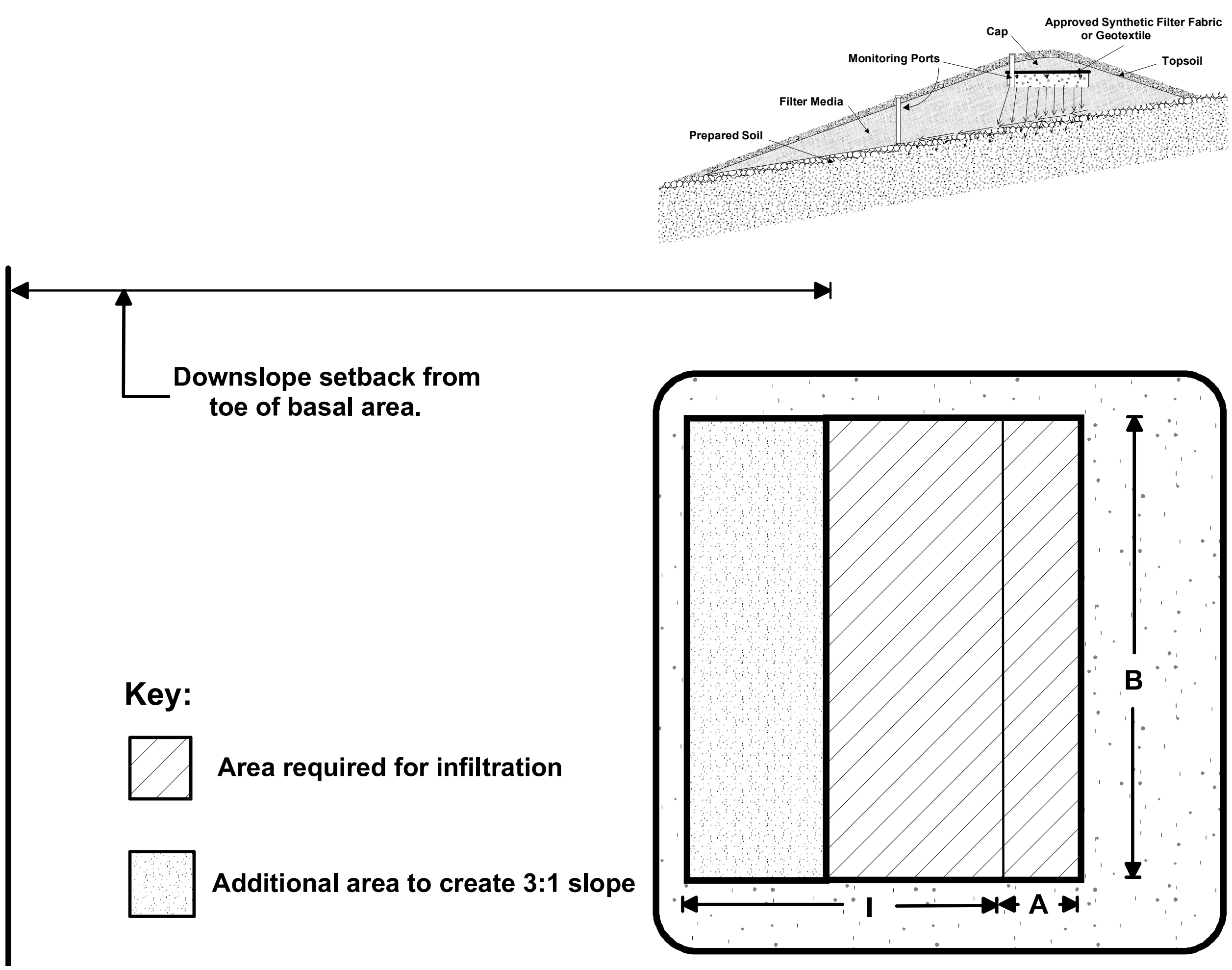
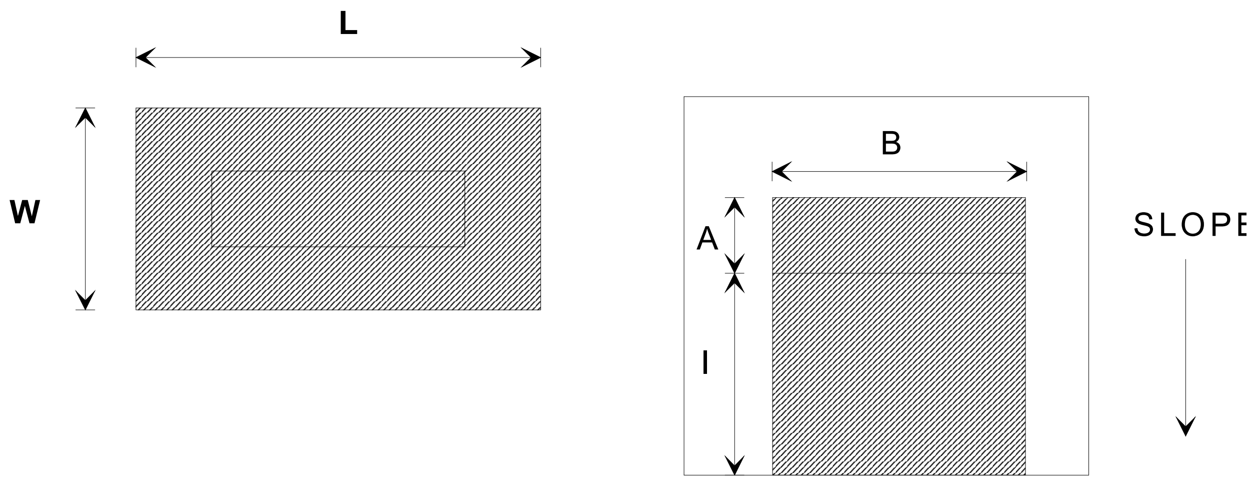


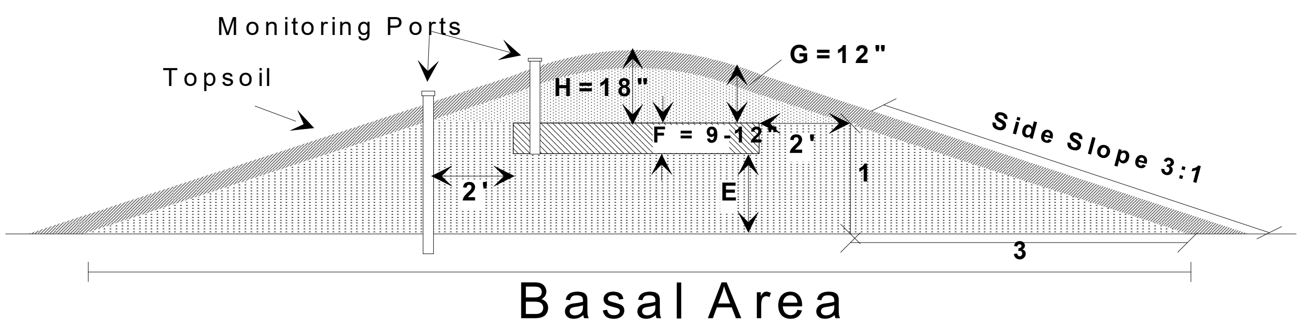
Figure 6. Detailed Plan View of Filter Media and Available Basal Area on Flat and Sloped Sites



Level Site

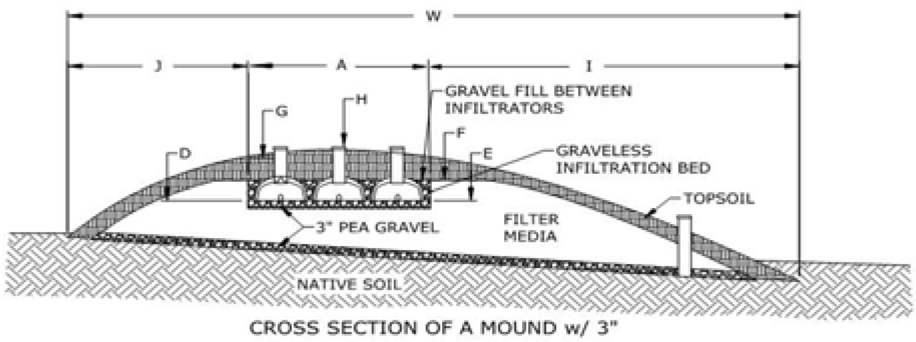
Sloping Site

Figure 7. Detailed Cross-Section of a Level Mound System



Note: the distance between the outer edge of the mound and the bed is 2 feet.
On a level site, there is no "D"

Figure 8. Chambers in Mound with Optional Pea Gravel



CROSS SECTION OF A MOUND w/ 3" OF PEA GRAVEL BETWEEN THE PLOWED SOIL AND FILTER MEDIA

Field experience has shown that 2-4 inch layer of pea gravel at the mound/soil interface may inhibit capillary action. (Adolfson Associates, Inc. 1999)

Figure 9. End Cross-Section of Mound, Showing Minimum Subcomponent

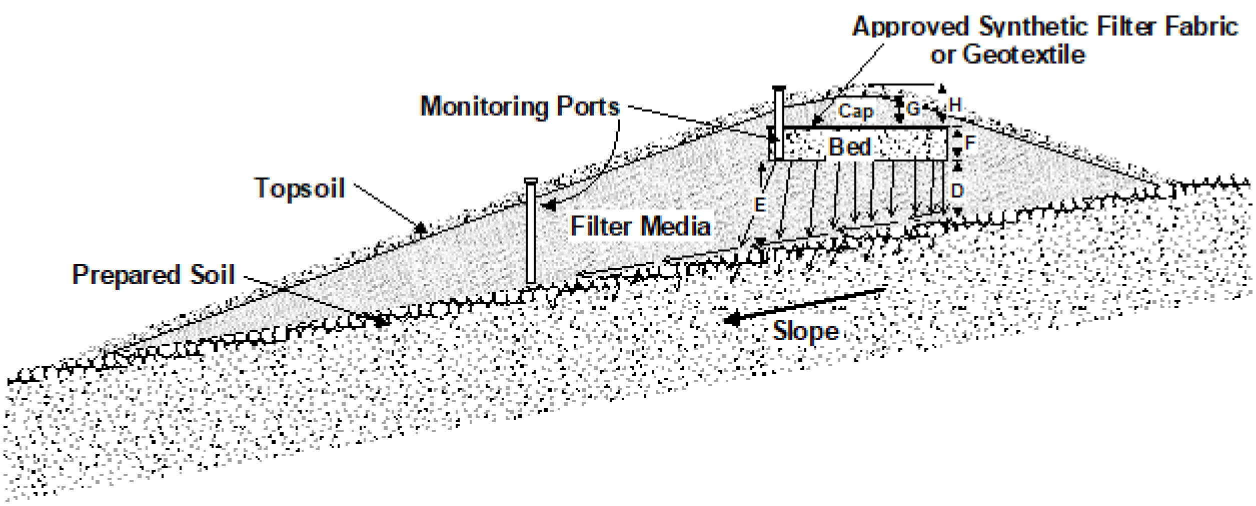


Figure 10. Plan View of Mound and Basal Area for Filter Media

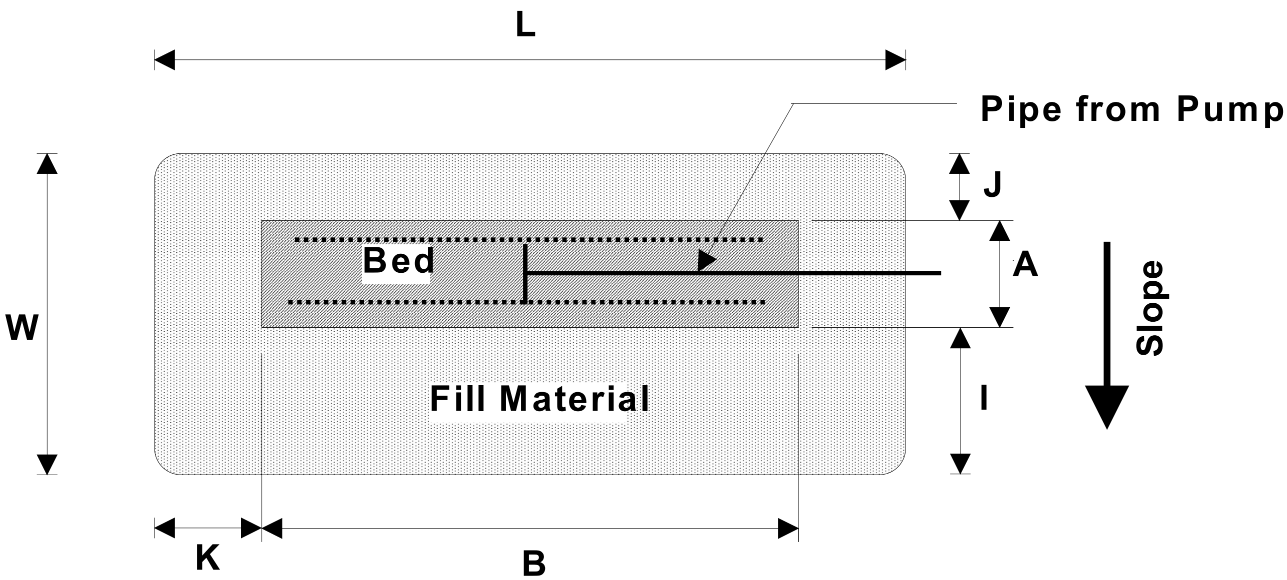
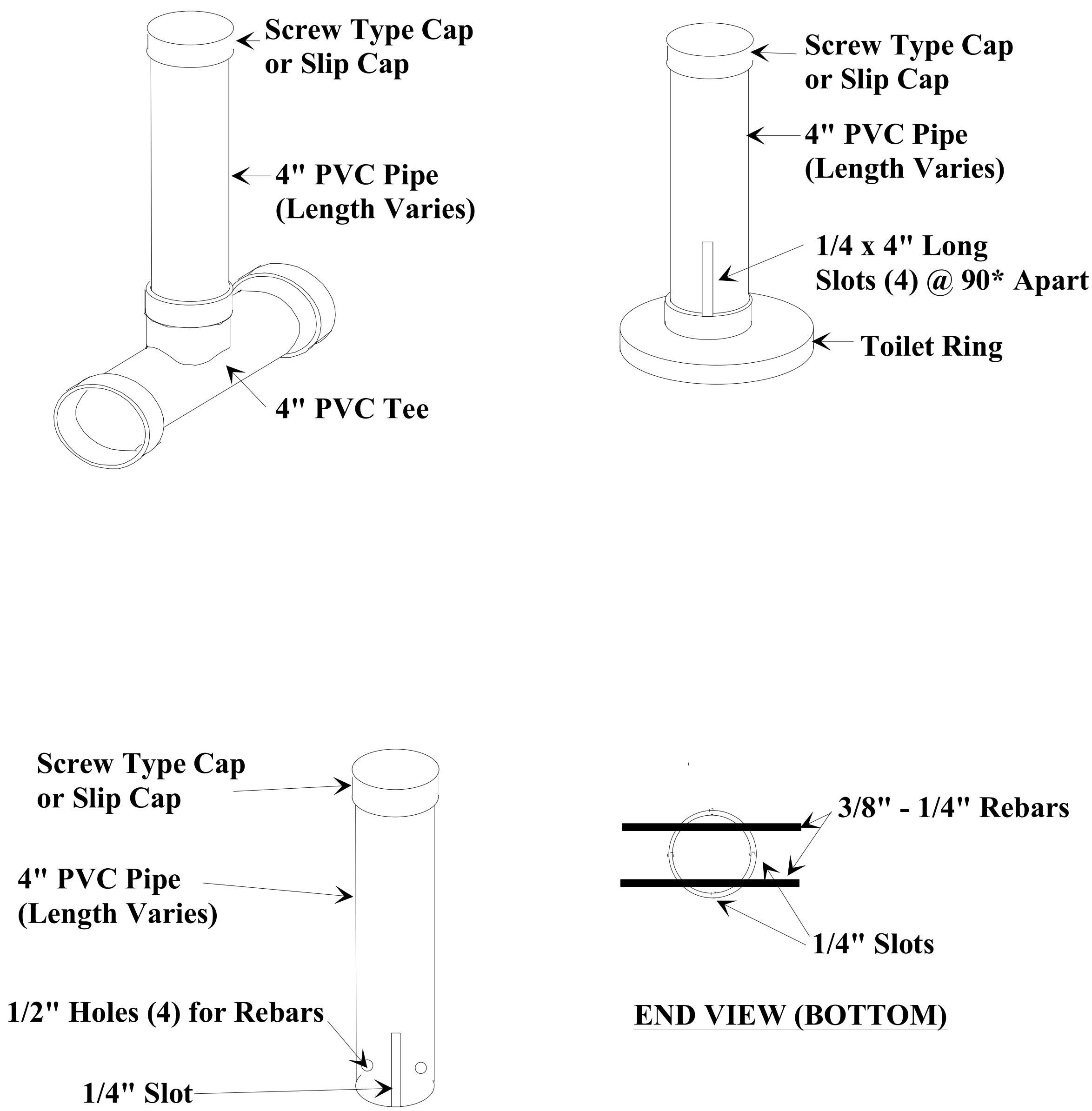


Figure 11. Inspection / Monitoring Ports



Tables

Table 1. Treatment Component Performance Levels and Method of Distribution Possible Applications for Mounds in WAC 246-272A

Vertical Separation in inches	Soil Type		
	1	2	3-6
12 < 18	**A** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with one foot of filter media for dispersal only or Mound with 2 feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Treatment Level B technology <u>plus</u> mound with one foot of filter media for dispersal only or Mound with 2 feet of filter media beneath bed)***
≥ 18 < 24	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***
≥ 24 < 36	**B** - pressure with timed dosing ***(Mound with two feet of filter media beneath bed)***	**C** - pressure **(Mound with one foot of filter media beneath bed)**	**E** - pressure **(Mound with one foot of filter media beneath bed)**

Table 2. Additional Minimum Setback Requirements

	When the item to be setback <u>from</u> is:	
	Upgradient[1]	Downgradient[2, 3]
Setback distance from **property lines**, **driveways**, **buildings**, **ditches** or **interceptor drains**, or any other development which would either impede water movement away from the mound or channel groundwater to the mound area.	10 feet	30 feet
Setback distance from **well**, **suction line** or **surface water**.	100 feet	100 feet

[1]The item is upgradient when liquid will flow away from it upon encountering a water table or restrictive layer.
[2]The item is downgradient when liquid will flow toward it upon encountering a water table or restrictive layer.
[3]The edge of required basal area.

Table 3. Maximum Bed Width[1]

Type of Restrictive Layer	Available Soil Depth (inches)		
	12 - < 18	18 - < 24	≥ 24
Water table or other restrictive layer, excluding non-creviced bedrock.[1]	5 feet	7.5 feet	10 feet
Bedrock, non-creviced.[1]	Not Allowed	7.5 feet	10 feet

Table 4. Infiltration/Loading Rates for Sizing Basal Area for Mound Systems (From WAC 246-272A)

SOIL TYPE	SOIL TEXTURAL CLASSIFICATION DESCRIPTION	LOADING RATE gal./sq. ft./day
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils excluding Soil types 5 & 6, all soil types with greater than or equal to 90% rock fragments.	1.0
2	Coarse sands.	1.0
3	Medium sands, loamy coarse sands, loamy medium sands.	0.8
4	Fine sands, loamy fine sands, sandy loams, loams.	0.6
5	Very fine sands, loamy very fine sands; or silt loams, sandy clay loams, clay loams and silty clay loams with a moderate structure or strong structure (excluding a platy structure).	0.4
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.	0.2
7	Sandy clay, clay, silty clay and strongly cemented firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, any soil with appreciable amounts of expanding clays.	Unsuitable

Table 5. Downslope and Upslope Width Corrections (Multipliers) for Mounds on Sloping Sites (3:1 Side Slopes)

Slope as a percentage	*Downslope (I) Correction Factor*	*Upslope (J) Correction Factor*
0	1.00	1.00
2	1.06	0.94
4	1.14	0.89
6	1.22	0.85
8	1.32	0.81
10	1.44	0.77
12	1.58	0.74
14	1.74	0.71
16	1.95	0.68
18	2.21	0.66
20	2.55	0.64

Appendix A – Filter Media Specifications

A. Particle Size Analysis

The standard method to be used for performing particle size analysis must comply with one of the following:

1. The sieve method specified in ASTM D136 and ASTM C-117.

2. The method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, US Department of Agriculture, 1984.

B. Mound Media

The filter media must meet either specification 1 or specification 2, below as determined by section A. Particle Size Analysis. Media may be either mineral sand or equivalently sized crushed glass.

1. Coarse Sand Media Specification

   The filter media must meet items a, b, and c, below: (Source: State of Oregon On-Site Sewage Disposal Rules and the State of Wisconsin Single Pass Sand Filter Component Manual)

   (a) Particle size distribution:

Sieve	Particle Size	Percent Passing
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	45 to 85
No. 30	0.6 mm	15 to 60
No. 50	0.3 mm	3 to 15
No. 100	0.15 mm	0 to 4

   (b) Effective Particle Size (D_{10}) > 0.3 mm

   (c) Uniformity Coefficient (D_{60}/ D_{10}) < 4.0

The Coarse Sand Media specification limits the amount of fines and therefore is much more clog-resistant than ASTM C-33. It is more effective in providing the needed degree of treatment when wastewater is stronger than expected, flows are high, or other unexpected factors occur that can induce clogging. The use of the Coarse Sand Media specification, while not reducing the treatment efficiency of the mounds, requires a lower dose volume and a higher dosing frequency pattern to be used. The smaller the dose the better contact the wastewater will have with the bacteria and the less saturated the sand will be, allowing for sufficient diffusion of oxygen into the system.

2. ASTM C-33 Specification

The filter media must meet items a, b, c, and d, below: (Source: ASTM C-33-99a, Specification for Fine Aggregate)

(a) Particle size distribution:

Sieve	Particle Size	Percent Passing
3/8 in	9.50 mm	100
No. 4	4.75 mm	95 to 100
No. 8	2.36 mm	80 to 100
No. 16	1.18 mm	50 to 85
No. 30	0.6 mm	25 to 60
No. 50	0.3 mm	5 to 30
No. 100	0.15 mm	0 to 10 (prefer <4)

[For No. 200 sieve, see note (d).]

(b) The sand must have not more than 45% passing any one sieve and retained on the next consecutive sieve of those shown above.

(c) The fineness modulus must not be less than 2.3, nor more than 3.1. The fineness modulus is calculated by adding the cumulative percentages of material in the sample retained in the sieves shown above and dividing the sum by 100.

Continued concerns have been expressed about the potential for premature clogging and/or failure of mounds with filter media meeting the ASTM C-33 specification. ASTM C-33 particle size distribution allows the smaller sand particles to fill the voids between large particles, resulting in smaller and more convoluted pore spaces. While this condition provides a high degree of wastewater treatment, it encourages clogging of the remaining void spaces with suspended solids and biological growth, resulting in a greater chance of a restrictive biomat forming.

Appendix B – Mound Design Process

Design of a mound system can be divided into five major steps:
(The letters for the various dimensions correlate with those in Figures 5 – 8.)

Step 1. Site / Soil Evaluation - Evaluate the site and soil characteristics to determine that a mound system is appropriate sewage treatment and dispersal technology for the site and the project.

Step 2. Daily Design Flow / Pre-treatment Device Determination - Identify the daily design flow and the needed level of wastewater pre-treatment (septic tank or other pre-treatment unit).

Daily Design Flow (gal/day) = Number of Bedrooms x 120 gal/day (minimum).

Step 3. Configuration and Dimensions of the Mound

- Size the infiltration area (bed) within the filter media,
- size the mound height components,
- size the filter media length and width, and
- size the basal area.

The configuration of the mound system responds to the slope, shape, size, and feature characteristics of the site.

If the site does not permit the design of a "long and narrow" mound along the contours of the site, other on-site sewage treatment and dispersal technology must be selected. Mound systems are only suitable for sites where all of the design and siting criteria can be satisfactorily met.

3a. Sizing the Infiltration Area (Bed) Within the Filter Media

$$\text{Infiltrative Surface Area (Bed)} = \frac{\text{Daily Design Flow (gal/day)}}{1.0 \text{ gal/ft}^2\text{/day (maximum)}}$$

The bed dimensions (see Figure 8) are calculated as follows:

Bed width (**A**) = Dependent on Soil Depth. See Table 2

$$\text{Bed Length } (\mathbf{B}) = \frac{\text{Required Bottom Infiltrative Surface Area}}{\text{Bed Width (A)}}$$

3b. Determining Mound Height - The mound height consists of:

- the filter media depth below the bottom of the bed (**D** & **E**),
- the infiltrative bed depth (**F**), and
- the cap and topsoil depth (**G** & **H**).

Filter Media Depth (D & E)

Filter media depth below upslope edge of bed (**D**) = 2 feet for meeting Treatment Level B or 1 foot if only for dispersal or for meeting Treatment Level C.

Filter media depth below downslope edge of bed (**E**) = D + [% natural slope as a decimal[1] x width of bed (**A**)]

[1] See Table 3

Bed Depth (F)

Bed Depth (**F**) = 9 inches (minimum for 1-inch lateral) in gravel. Other dispersal technologies can be considered, which have varying heights.

Cap and Top Soil (G & H)

Unsettled cap and topsoil depth at bed center (**H**) = 18 inches.

Unsettled cap and topsoil depth at bed edges (**G**) = 12 inches.

3c. Filter Media Length and Width

The length and width of the filter media are dependent upon the length and width of the infiltration area, filter media depth and the end and side slopes of the filter media (no steeper than 3:1).

Filter Media Length (**L**) = Length of Bed (**B**) + [2 x End Slope (**K**)]

$$\text{End Slope (K)} = \left[\left(\frac{D+E}{2}\right) + F + H\right] \times \text{Selected Horizontal Gradient of Sideslope (3 if 3:1)}$$

Filter Media Width (**W**) = Upslope Width (**J**) + Downslope Width (**I**) + Width of Bed (**A**)

Upslope Width (**J**) = Filter Media Depth at Upslope Edge of Bed (D + F + G) x Horizontal Gradient of Side Slope (3 if 3:1) x Slope Correction Factor (See Table 3).

Downslope Width (**I**) = Filter Media Depth at Downslope Edge of Bed (E + F + G) x Horizontal Gradient of Side Slope (3 if 3:1) x Slope Correction Factor (See Table 3).

These calculations should result in the filter media extending at least two feet horizontally from the top edges of the bed as noted in Figure 7. Check to see that this is done.

3d. Basal Area

For level sites, the total basal area [length of filter media (**L**) x width of filter media (**W**)] beneath the filter media is available for effluent absorption into the soil. See Figure 5. For sloping sites, the only available basal area is the area beneath the bed (**A** x **B**) and the area immediately downslope from the bed [bed length (**B**) x downslope width (**I**)]. It includes the area enclosed by [B x (A + I)]. See Figure 5. The upslope and end slopes will transmit very little of the effluent on sloping sites, and are therefore disregarded.

It is important to compare the <u>required</u> basal area to the <u>available</u> basal area. The available basal area must equal or exceed the required.

$$\text{Basal Area Required} = \frac{\text{Daily Design Flow}}{\text{Infiltration Rate of Original Soil}}$$

Basal Area Available:

Sloping Sites = B x (A + I)
Level Sites = L x W

If sufficient area is not available for the given design and site conditions, corrective action is required to increase the area of the filter media. The preferred method of increasing basal area is to lengthen the bed rather than simply extending the toe of the filter media. Again, be advised that if a mound cannot be designed and laid out "long and narrow", other enhanced treatment technologies should be selected rather than error by designing or locating a mound system inappropriately.

Step 4. Design the Time Dosed Pressure Distribution Network - Design, layout, and installation of the pump chamber-to-mound transmission line must consider, and satisfactorily address, the potential for channeling groundwater or surface water to either the mound or the pump chamber causing infiltration-related problems. The distribution network should follow the Recommended Standards and Guidance for Pressure Distribution or for Subsurface Drip. The number of doses per day is dependant on the sand media used.

Step 5. Construction Plan / Owner's Manual - Develop the site-specific construction plan and owner's manual. The mound system, including the area around the base and downslope, must be protected to prevent damage caused by vehicular, livestock, or excessive pedestrian traffic. See 3.11, 3.12, 3.13, and 3.14 of this RS&G.

Appendix C – Mound Design Examples

EXAMPLE 1: SHALLOW PERMEABLE SOIL

Site Conditions:

Slope	-	6%
Parcel Size	-	2 Acres
Native Soil	-	Silt Loam, 27 Inches Deep To Hardpan
Water Table	-	25 Inches
Home Size	-	3 Bedrooms

Step A: Daily Design Flow

Daily Design Flow = # Bedrooms x Recommended 120 gal/day = 3 x 120 gal/day = 360 gallons

Step B: Design of the Infiltration Area

1. **Size the Infiltration Area**

a. Infiltration Rate of Required Filter Media = 1.0 gal/ft^2/day

b. Infiltrative Surface Area (Bed) = $\dfrac{\text{Daily Design Flow (gal/day)}}{1.0\ \text{gal/ft}^2\text{/day (maximum)}}$

$$= \frac{360}{1.0\ \text{gal/ft}^2\text{/day}}$$

$$= 360\ \text{feet}^2$$

2. **System configuration**

a. Bed Width (**A**) = Dependent on Soil Depth. Select 6 feet. 10 feet could have been selected but wasn't due to concerns of the tight soils and relatively shallow slope.

b. Bed Length (**B**) = $\dfrac{\text{Required Bottom Infiltrative Surface Area}}{\text{Bed Width (A)}}$

$$\mathbf{B} = \frac{360\ \text{ft}^2}{6\ \text{ft}}$$

$$\mathbf{B} = 60\ \text{feet}^2$$

Step C: Design the Entire Mound

1. **Filter media height**

a. Depth of Filter Media

1) Depth at Upslope Edge of Bed (**D**) = 1 foot (1 f foot selected to meet Treatment Level C because the native soil was not excessively permeable, there was no creviced bedrock below the top 24 inches, and there were at least 24 inches of original soil.

2) Depth at Downslope Edge of Bed (**E**) = 1 feet + [% of natural slope as a decimal] x [width of bed (A)]

$$\mathbf{E} = 1 + (.06)\,(6)$$

$$\mathbf{E} = 1.4 \text{ feet}$$

b. Bed Depth (**F**) = 0.75 feet (anticipate 1 inch lateral)

c. Cap and Top Soil

1) Unsettled cap and topsoil depth at center of bed (**H**) = 18 inches

2) Unsettled cap and topsoil depth of bed edges (**G**) = 12 inches

Approximately 6-8 inches of each of the above original unsettled cap and topsoil depths would consist of topsoil, with the remainder being suitable cap material.

End Slope (**K**) = (Filter Media Depth at Center) x (Horizontal Gradient of Selected Side Slope)

End Slope (**K**) = $\left[\left(\frac{D+E}{2}\right)+F+H\right]$ x Selected Horizontal Gradient of Sideslope (3 if 3:1)

$$\mathbf{K} = \left[\left(\frac{1+1.4}{2}\right)+0.75+1.5\right]\times 3$$

$$\mathbf{K} = 10.4 \text{ feet}$$

Filter Media Length (**L**) = Length of Bed (**B**) + [2 x End Slope (**K**)]

L = 60 + [(2) (10.4)]

L = 80.8 feet

b. Filter Media Width

Upslope Width (**J**) = Filter Media Depth at Upslope Edge of Bed (D+F+G) x Horizontal Gradient of Side Slope x Slope Correction Factor (Table 3)

J = (1.0 + 0.75 + 1.0) (3) (0.85)

J = 7.0 feet

Downslope width (**I**) = Filter Media Depth at Downslope Edge of Bed (E+F+G) x Horizontal Gradient of Side Slope x Slope Correction Factor (Table 3)

I = (1.4 + 0.75 + 1.0) (3) (1.22)

I = 11.5 feet

Filter Media Width (**W**) = Upslope Width (J) + Downslope Width (I) + Width of Bed (A)

W = 7.0 + 11.5 + 6

W = 24.5 feet

2. **Check the basal area**

On sloping sites the effective basal area is considered to be that area below and downslope of the bed [B x (A+J)].

a. Basal Area Required = $\frac{\text{Daily Design Flow}}{\text{Infiltration Rate of Original Soil}}$

$$= \frac{360}{0.45 \text{ gal/ft}^2\text{/day}}$$

$$= 800 \text{ feet}^2$$

b. Basal Area Available = B x (A+I)

$$= (60)\ (6 + 11.5)$$

$$= 1050 \text{ feet}^2$$

Sufficient area is available. If it were not, the length of the mound would need to be increased in order provide sufficient basal area. Where the soil is highly permeable, it may be possible to increase the downslope width (I) to create the necessary basal area.

Step D: Design of the Distribution Network. See Recommended Standards and Guidance for Pressure Distribution or Recommended Standards and Guidance for Subsurface Drip Systems.

Appendix C Mound Design Examples (cont'd)

EXAMPLE 2: SHALLOW PERMEABLE SOILS

Site Conditions:

Slope	-	8%
Parcel Size	-	5 Acres
Native Soil	-	20 Inches of Sandy Loam to Consolidated Glacial Till
Water Table	-	None Noted - water flows downslope on the till layer during periods of high rainfall
Home Size	-	3 Bedrooms

(After careful and detailed investigation, justification was provided which indicated that the effluent would satisfactorily flow away from site in the 20 inches of soil and that breakouts would not occur downslope that could cause any nuisance or public health hazard potential. A long narrow system parallel to the slope contours is necessary because of the slope and the shallow soil.)

Step A: Daily Design Flow

Daily Design Flow = # Bedrooms x Recommended 120 gal/day = 3 x 120 gal/day = 360 gallons

Step B: Design of the Infiltration Area

1. **Size the Infiltration Area**

   a. Infiltration Rate of Medium Sand = 1.0 gal/ft^2/day

   b. Infiltrative Surface Area (Bed) $= \dfrac{\text{Daily Design Flow (gal/day)}}{1.0 \text{ gal/ft}^2\text{/day (maximum)}}$

$$= \frac{360}{1.0 \text{ gal/ft}^2\text{/day}}$$

$$= 360 \text{ feet}^2$$

2. System configuration

a. Bed Width (**A**) = Dependent on Soil Depth. Select 3 feet. 5 feet could have been selected but wasn't due to concerns of surfacing downslope. The narrower bed width puts less load on the receiving soil for each foot of bed length.

b. Bed Length (**B**) = $\frac{\text{Required Bottom Infiltrative Surface Area}}{\text{Bed Width (A)}}$

$$\mathbf{B} = \frac{360 \text{ ft}^2}{3 \text{ ft}}$$

B = 120 feet

<u>Step C</u>: Design the Entire Mound

1. **Filter media height**

   a. Depth of Filter Media

      1) At Upslope Edge of Bed (**D**) = 2 feet
      (Because only 20 inches of original soil exist, vertical separation between 18 and 24 inches for soil type 4 requires Treatment Level B with pressure and timed dosing.)

      2) At Downslope Edge of Bed (**E**) = 2 feet + [% of Natural Slope as a Decimal] x [Width of Bed (**A**)]

$$\mathbf{E} = 2 + (0.08)(3)$$

$$\mathbf{E} = 2.3 \text{ feet}$$

   b. Bed Depth (**F**) = 0.75 feet (anticipate 1 inch lateral)

   c. Cap and Topsoil

      1) Unsettled depth at center of bed (**H**) = 18 inches

      2) Unsettled cap at bed edges (**G**) = 12 inches

2. **Filter Media Length and Width**

   a. Filter Media Length

End Slope (**K**) = (Filter Media Depth at Center) x (Horizontal Gradient of Selected Side Slope)

End Slope (**K**) = $\left[\left(\frac{D+E}{2}\right) + F + H\right]$ x Horizontal Gradient of Selected Side Slope (3 if 3:1)

$$\mathbf{K} = \left[\left(\frac{2.4+2}{2}\right) + 0.75 + 1.5\right] \times 3$$

$$\mathbf{K} = 13.4 \text{ feet}$$

<u>Filter Media Length</u> (**L**) = Length of Bed (**B**) + [2 x End Slope (**K**)]

$$\mathbf{L} = 120 + [(2)(13.4)]$$

L = 146.8 feet

b. Filter Media Width

Upslope Width (**J**) = Filter Media Depth at Upslope Edge of Bed (D+F+G) x Horizontal Gradient of Side Slope x Slope Correction Factor (Table 3)

J = (2+ 0.75 + 1.0)(3)(0.8)

J = 9 feet

Downslope Width (**I**) = Filter Media Depth at Downslope Edge of Bed (E+F+G) x Horizontal Gradient of Side Slope x Slope Correction Factor (Table 3)

I = (2.4 + 0.75 + 1.0)(3)(1.32)

I = 16.4 feet

Filter Media Width (**W**) = Upslope Width (**J**) + Downslope Width (**I**) + Width of Bed (**A**)

W = 9 + 16.4 + 3

W = 28.4 feet

3. **Check the Basal Area**

On sloping sites the effective basal area is considered to be that area below and downslope of the bed [B x (A+J)].

a. Basal Area Required = $\frac{\text{Daily Design Flow}}{\text{Infiltration Rate of Original Soil}}$

$= \frac{360}{0.6 \text{ gal/ft}^2\text{/day}}$

$= 600 \text{ feet}^2$

b. Basal Area Available = B x (A+I)

= (120)(3 + 13.3)

= 2328 $feet^2$

There is sufficient area available. If it were not, the length of the mound would need to be increased in order provide sufficient basal area. Where the soil is highly permeable, it may be possible to increase the downslope width (**I**) to create the necessary basal area.

<u>Step D</u>: Design of the Distribution Network. See Recommended Standards and Guidance for Pressure Distribution or Recommended Standards and Guidance for Subsurface Drip Systems.

Appendix D – Mound Worksheet / Checklist

_______ A. **DAILY DESIGN FLOW**

Daily Design Flow = # Bedrooms x 120 gal/day/bedroom (minimum)

= __________ x 120

= __________ gal/day

_______ B. **DESIGN OF THE INFILTRATION AREA**

1. **Size the Infiltration Area**

   a. Infiltration Rate of Filter Media: 1.0 gal/ft^2/day

   b. Infiltrative Surface Area (Bed) = $\frac{\text{Daily Design Flow (gal/day)}}{1.0\ \text{gal/ft}^2\text{/day (maximum)}}$

   $= \frac{\_\_\_\_\_\_\_\_\_\_}{1.0\ \text{gal/ft}^2\text{/day (maximum)}}$

   = ____________ feet^2

2. **Bed Configuration**

   a. Bed Width (**A**) = __________________ ft (Dependent on Soil Depth. See Table 2)

   b. Bed Length (**B**) = $\frac{\text{Required Bottom Infiltrative Surface Area}}{\text{Bed Width (A)}}$

   $= \frac{\_\_\_\_\_\_\_\ \text{ft}^2}{\_\_\_\_\_\_\_\ \text{ft}}$

   = ____________ feet

_______ C. **DESIGN THE ENTIRE MOUND**

1. **Filter Media Height**

   a. Filter Media Depth (D + E)

1) Depth Below Upslope Edge of Bed (**D**) = 2 feet or 1 foot if mound is only for dispersal following Treatment Level B.

= ____________ feet

2) Depth at Downslope Edge of Bed (**E**)

Filter Media Depth Below Downslope Edge of Bed (**E**) = D + [% Natural Slope as a Decimal x Width of Bed (**A**)]

= ____________ ft + (____________ x ____________) ft

= ____________ feet

b. Bed depth (F) = 9 inches (minimum for 1-inch lateral) in gravel.
Other dispersal technologies can be considered, which have varying heights.

= ____________ feet

c. Cap and Topsoil

1) Depth at Bed Center (**H**) = 18 inches

2) Depth at Bed Edges (**G**) = 12 inches

2. **Filter Media Length**

a. End Slope Width (**K**) = Total Filter Media Depth at Bed Center x Horizontal Gradient of Side Slope.

$$\mathbf{K} = \left[\left(\frac{D+E}{2}\right) + F + H\right] \text{ x Selected Horizontal Gradient of Side Slope (3 if 3:1)}$$

$$\mathbf{K} = \left[\left(\frac{\_\_\_\_ft + \_\_\_\_ft}{2}\right) + \_\_\_\_ft + \_\_\_\_ft\right] \times \_\_\_\_$$

K = __________

b. Filter Media Length (**L**) = Bed Length + [2 x End Slope Width]

L= B + 2K

L= _____ ft + (2 x _____ ft)

L = ______ feet

3. **Filter media width**

a. Upslope Width (**J**) = Filter media Depth at Upslope Edge of Bed (D + F + G) x Horizontal

Gradient of Side Slope (3 if 3:1) x Slope Correction Factor (see Table 3)

J = (D + F + G) x Horizontal Gradient x Slope Correction Factor

J = (_____ ft + _____ ft + _____ft) x _____ x _____

J = ______ ft x _____ x _____

J = ______ feet

b. Downslope Width (**I**) = Filter Media Depth at Downslope Edge of Bed (E + F + G) x
Horizontal Gradient of Side Slope (3 if 3:1) x Slope Correction Factor (See Table 3).

I = (_____ ft + _____ ft + _____ft) x _____ x _____

I = ______ ft x _____ x _____

I = ______ feet

c. Filter Media Width (**W**) = Upslope Width + Bed Width + Downslope Width

W = J + A + I

W = _____ ft + _____ ft + _____ft

W = ______ feet

4. **Check the Basal Area**

a. Basal Area Required = $\frac{\text{Daily Design Flow}}{\text{Infiltration Rate of Original Soil}}$

$= \frac{\_\_\_\_\_\_ \text{ gal / day}}{\_\_\_\_\_\_ \text{ gal / ft}^2 \text{ / day}}$

= ____________ feet^2

b. Basal Area Available = B x (A+I)

1) Sloping Site = Bed Length x (Bed Width + Downslope Width)

= B x (A + I)

= ______ ft x (_____ ft + _____ ft)

= ______ ft x ______ ft

= ______ feet^2

2) Level Site = Filter Media Length x Fill Width

= L x W

= ______ ft x _____ ft

= ______ feet^2

Compare basal area available with the basal area required. Is there sufficient basal area?

YES____ NO_____

Appendix E – Site Preparation and Construction

Construction Procedures - The following is a step by step procedure for mound system construction that has been tried and proven. If these procedures are followed, the potential for future problems should be minimized and the mound system should function properly. Other techniques may also work satisfactorily, but the basic principles of mound system design, construction and operation should not be violated.

1. Check the moisture content of the soil at 7-8 inches deep. If it is too wet, smearing and compaction will result, reducing the infiltration capacity of the soil. Soil moisture can be determined by rolling a soil sample between the hands. If it rolls into a wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. **If the site is too wet to prepare, do not proceed until the soil moisture decreases.**

2. Stake out the mound area on the site according to the system design, so the infiltration bed runs parallel to the contours. Reference stakes offset from the corner stakes are recommended in case corner stakes are disturbed during construction. If the site conditions do not allow for layout according to the approved design, contact the designer and/or the local health officer.

3. Measure the average ground elevation along the upslope edge of the bed or the upper trench and reference this to a benchmark for future use. This is necessary to determine the bottom elevation of the bed.

4. Determine where the pipe from the pump chamber connects to the distribution system in the filter media. The location and size of this transport pipe is determined from the pressure distribution guideline.

5. Trench and lay the effluent pipe from the pump chamber to the mound. Cut and cap the pipe one-foot beneath the ground surface. Lay pipe below frost line or sloping uniformly back to the pump chamber so that it drains after dosing.

6. Backfill and compact the soil around the pipe to prevent back seepage of effluent along pipe. This step must be done before plowing to avoid compaction and disturbance of the surface.

7. Cut trees to ground level, remove excess vegetation by mowing. Rake cut vegetation if it is, or will become, matted. Prepare the site using a spring-loaded agricultural chisel plow and plowing parallel to contours.

The function of this preparation is to provide a cleared ground surface with a series of vertical channels to enhance transfer of moisture from the sand fill to the original soil, while inhibiting lateral movement at the sand-soil interface. In addition the vertical furrows aid in stabilizing the sand at the sand-soil interface in an inter-locking fashion.

The site should be plowed using a spring loaded agricultural chisel plow, or other acceptable apparatus or method to prepare the soil before constructing the mound system. Shallow hand spading the surface is also an acceptable alternative and may be the preferred method on some sites. Rototilling is <u>not</u> an acceptable substitute and <u>must not</u> be done.

The important point is that a rough, unsmeared surface should be left, especially in fine textured soils. Careful observation is required to assure that the soil moisture content is not so high that the soil surface is smeared by the action of the plow. Plowing should not proceed until the soil is sufficiently dry so as not to smear in the plowing process.

If stumps remain, care must be taken in preparing the site. The sod layer should be broken up, yet the topsoil should not be pulverized. The objective of this step is to break up any surface mat that could impede the vertical flow of liquid into the native soil.

Immediate construction after plowing is desirable. Avoid rutting and compaction of the plowed area by traffic. If it rains after the plowing is completed, wait until the soil dries out before continuing construction.

8. Reset the corner stakes, if necessary, using the offset reference stakes and locate the bed or trench areas by staking their boundaries.

9. Extend the transport pipe from the pump chamber (which had previously been cut off) to several feet above the ground surface.

10. Install one or more standpipes (4 inch PVC with the bottom foot perforated, rebar and with gravel or a geotextile around the perforations). At least one must be in the downslope portion of the mound with the bottom at the original surface and the top extending above final grade where it can be capped. Another could be located in the bed extending only from the bottom of the bed to above the final grade. The standpipes allow observations to be made of the water levels. Slotting the caps will facilitate removing the caps to allow access.

11. Place the filter media that has been properly selected around the edge of the plowed area. Keep the wheels of trucks off plowed areas. Avoid traffic on the downslope side of the mound system. Work from the end and upslope sides. This will prevent compaction of the soils on the downslope side, which, if compacted, would affect lateral movement away from the mound and possibly cause surface seepage at the toe of the mound.

12. Move the filter media into place using a small track-type tractor with a blade. Do not use a tractor/backhoe having rubber-tired wheels. Always keep a minimum of 6 inches of filter media beneath tracks to prevent compaction of the natural soil.

13. Place the filter media to the required depth, i.e., to the top of the bed. Shape sides to the desired slope.

14. With the blade of the tractor form the infiltration bed. Hand level the bottom of the bed to within ± ½ inch.

15. Place the coarse aggregate, gravelless product, or dripline in the bed. Level the aggregate to the design depth.

16. Place the distribution pipes, as determined from the pressure distribution guidelines, on the aggregate. Connect the manifold to the transport pipe. Slope the manifold to the transport pipe. Lay the laterals level, removing rises and dips.

17. Pressure test the distribution system for uniformity of flow.

18. Place 2 inches of aggregate over the distribution pipe. Place 6 inches of sand over drip lines.

19. Place an approved geotextile material over the aggregate.

20. Place the soil for the cap and topsoil on the top of the bed. This may be a subsoil or topsoil. An initial depth of 18 inches in the center and 12 inches at the outer edge of the bed is desired. This creates a slope that assists the surface run-off of precipitation. Also, this layer provides some frost protection. Do <u>not</u> drive over the top of the bed as the distribution system may be damaged.

21. Seed or sod the mound system.

Appendix F - Disposal of Contaminated Filter Media

Whenever filter media is removed from a used filter, removing and disposing of contaminated filter medial is to be done in a manner approved by the local health officer. Handle this material carefully by using adequate protective sanitation measures. Thoroughly was hands and any other exposed skin with hot water and soap, following contact with contaminated sand filter media.

The contaminated filter media can be buried with a least 6 inches of cover on a site approved by the local health officer. If the material is to be placed at grade, it must be stabilized with at least 6 inch soil cap. Sloping sites should be avoided.

For either of these methods, the drainfield setbacks and vertical separations are per WAC 246-2724 must be met and material must not be used in agronomic applications for 12 months.

If the material is to be disposed of that local sanitary landfill, contact them for their requirements.

The material may be used for agricultural production, in accordance with the following guidance, when approved by the local health officer.

	APPLICATION	RESTRICTIONS/TIMETABLE
1.	Root crops, low-growing vegetables, fruits, berries used for human consumption.	Contaminated material must be stabilized and applied 12 months prior to planting.
2.	Forage and pasture crops for consumption by dairy cattle.	Forage and pasture crops not available until one month following application of stabilized material.
3.	Forage and pasture crops for consumption by non-dairy livestock.	Forage and pasture crops not available until two weeks following application of stabilized material.
4.	Orchards or other agricultural area where the material will not directly contact food products. Or where stabilized material has undergone further treatment, such as pathogen reduction or sterilization.	Less severe restrictions may be applicable.

Stabilization may be accomplished by increasing the pH to 12 with the addition of a supplement such as lime.

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