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SOIL TREATMENT SYSTEMS

Overview

The soil treatment system is the primary barrier between the septic tank effluent and the environment before the treated effluent is recycled back into the environment. The treatment system must be located where suitable conditions for final treatment and dispersal are available. The typical soil dispersal system consists of a piping network to receive septic tank effluent, with distribution media, rock, or manufactured media to assist in distributing effluent to the soil. Design of soil treatment systems should consider the volume of septic tank effluent, the method of distribution, and soil conditions in the treatment and distribution areas.

In a typical gravity soil treatment system, such as a trench system, effluent from the septic tank flows into large diameter distribution pipes and down through distribution media (such as rock) to the soil and media interface as shown in Figure 12.1. The rate at which effluent infiltrates to the soil depends upon the volume and character of the effluent as well as the soil properties, including texture, structure, moisture content, depth from the soil surface, micropores, macropores, and consistence. The interplay of these factors affect the formation of a biological layer, often referred to as a biomat, at the soil/media interface. The biomat is formed by microorganisms that secrete a sticky substance and anchor themselves to the soil-media interface. This biomat forms first along the trench bottom, and as liquid begins to pond, it forms along the trench sidewalls. This is a normal condition that occurs over time in nearly all soil dispersal systems, which has both positive and negative impacts.

FIGURE 12.1 Gravity Distribution

Biomat development begins when the combination of effluent flow and the load of suspended solids overwhelm the infiltrative capacity of the soil at the bottom of the trench. Effluent accumulates or ponds above the infiltrative surface, creating a zone of anaerobic conditions.

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(oxygen-deprived) conditions that lead to biomat development. The biomat acts as a valve to slow the flow of effluent into the soil, creating a "trickle" flow in the soil beneath the biomat. The biomat can slow effluent movement to as much as 100 times less than the normal flow in saturated soil (Bouma, 1975). Slowing effluent movement is necessary to maintain unsaturated, aerobic conditions below the biomat and maximize the contact time between the effluent and the soil particles. Maintaining an unsaturated zone surrounding the trenches is the single most important factor in preventing transmission of pathogens. A mature gravity-fed soil treatment system, with biomat formed on its bottom and sidewalls, will frequently have effluent ponded in the trench while the soil a few inches outside of and below the trench will be unsaturated. As ponding continues to increase, the infiltrative surfaces of the trench sidewall become involved with the biomat development and the resulting regulation of effluent flow into the surrounding soil. The balance between flow out of the trench through sidewalls and the bottom area is influenced by the vertical and horizontal hydraulic conductivities and gradient in the soil, the biomat resistance, and the soil moisture of the surrounding soil. Therefore the percentages will vary over time and from site to site (Otis et al., 1977).

Slowed by the biomat, the effluent trickles through the soil and around the soil particles, encountering air pockets and soil particles as shown in Figure 12.2. The air pockets allow aerobic bacteria, which are much more efficient than the anaerobic bacteria in the septic tank, to continue treatment. Additionally, the soil particles’ negative charge attracts positively charged pathogenic bacteria and viruses in the effluent. This process is called adsorption. Other bacteria then grow using the nutrients in the sewage, producing slimy films over the soil particles. The slime acts as a filter to grab additional bacteria and viruses, which then die off due to temperature changes and lack of moisture and food. Physical entrapment, increased retention time, and conversion of pollutants in the effluent are important treatment objectives accomplished under unsaturated conditions. Pathogens contained in the effluent are eventually deactivated through filtering, retention, and adsorption by the soil. In addition, many pollutants are converted to other chemical forms by oxidation processes.

If the bottom of the system is at or near the water table (periodically saturated zone), the soil underneath the system may be saturated, reducing oxygen availability. Lowered oxygen levels reduce treatment efficiency and increase the risk of contamination. Being at or near the periodically saturated zone without proper treatment allows pathogens to move quickly though the soil without being adsorbed, filtered, or treated, potentially contaminating surface or ground waters. These waters can then move into deeper aquifers, contaminating wells or discharging into lakes
and streams, where the public can come into contact with disease-causing organisms. The anaerobic conditions induced by the ponding effluent contribute to a thicker, denser biomat, which in turn further retards effluent flow. In most soil dispersal systems, a point of equilibrium is achieved, with a well-developed biomat that is in balance with the effluent flow into the system and the soil which surrounds the soil treatment system. Over time, however, this condition of equilibrium may be upset, resulting in soil treatment system problems.

A biomat can have positive and negative effects on a soil treatment system. On the positive side, the developing biomat retards the flow of effluent, contributing to unsaturated soil conditions below the soil treatment system, which are conducive to improving effluent treatment. Without an established biomat to regulate effluent flow into the surrounding soil, saturated flow conditions exist at and below the soil treatment system trench bottom infiltrative surface. These saturated flow conditions, as explained above, reduce the treatment efficiency of the soil below and around the soil treatment system. On the negative side, particularly in finer textured soils, the biomat can become so restrictive that the soil treatment system exhibits continual, increasing ponding conditions, possibly resulting in the soil dispersal system malfunctioning.

The last step in the treatment process is the final treatment and dispersal of wastewater recycled back into the environment through the soil as shown in Figure 12.3. Several options are available for distributing and recycling wastewater into the soil. Gravity flow distribution to below-grade soil treatment areas (STA) are the most widely used soil treatment system. These systems are typically used in areas where the soil separation distances can be met and because they are the least expensive alternative.

The type of STA utilized at a site is largely dependent on soil conditions. Each STA technology has horizontal and vertical setback distances that it must adhere too. In some areas, with shallow soil available for treatment and acceptance, the vertical separation from groundwater or restrictive layers is achieved by importing soil fill and raising the infiltrative surface above the natural grade. Pressurized distribution, which provides even distribution of wastewater, is often used to overcome a variety of site conditions such as shallow depths to limiting conditions, coarse soils with limited surface area, and clay soils with lower acceptance rates.

**General Requirements**

According to MN Rules Chapter 7080.2150 Subp. 3 (C and D), for acceptable treatment of septic tank effluent by soil such as a trench, seepage bed, at-grade, or mound, the soil treatment and dispersal systems must meet the following requirements:

1. A minimum three-foot vertical soil treatment and dispersal zone shall be designed below the distribution media where:
Section 12: Soil Treatment Systems

1. The zone must be above the periodically saturated soil and bedrock. The zone must be continuous and not be interrupted by seasonal zones of saturation;

b. Any soil layers with a sizing classification a soil texture group 1-4 must not be credited as part of the necessary three-foot zone; and

c. The entire treatment zone depth must be within seven feet from the final grade.

2. The distribution system must not place a hydraulic head greater than 30 inches over the treatment zone.

3. The system’s absorption area must be original soil.

In addition to the requirements above it is critical that surface water be dealt with as many soil treatment systems have the potential to be significantly affected by the addition of water due to site characteristics. Since it is expected that our systems will accept several hundred gallons of water a day, the addition of any other water, regardless of its source, will affect performance. In accounting for water flow, the first consideration is to determine where on the natural landscape each piece of the system should be installed. One common mistake is installing parts of the system at the base or toe of a slope. This is the point where the slope begins to flatten out and surface runoff will slow down and infiltrate. If the septic tank or pump station is installed here and all connections are not absolutely watertight, water will infiltrate into the tank, from which it will ultimately be delivered to the soil dispersal area, potentially creating hydraulic overload. Concave sloping sites are sites that have convergence of surface and subsurface drainage. Landscape topography that retains or concentrates subsurface flows, such as swales, depressions, or potholes, is considered an unacceptable above-ground system location. Over-land surface flow is to be diverted from the site, or other methods should be employed to allow surface flow around the system. Remember here to look even beyond the lot boundaries of the system you are installing for the potential for water to be added from lots up slope of where you are working. This concern is common in Midwest landscapes that are glacial in origin and can have long and gradual slopes. All soil treatment systems located in areas subject to excessive run-on must have a diversion constructed upslope from the system (7080.2150, Subp. 2).

There is no slope restriction on trench systems in Chapter 7080, but systems on slopes greater than 25% are susceptible to severe erosion, can present difficulties establishing the required cover, are more likely to have surface seepage, and can present serious safety concerns relating to equipment operation.

Locate the soil treatment system where a good vegetative cover can be established. Generally, sites with large trees, numerous smaller trees, or large boulders are less desirable for installing a system because the surface is difficult to prepare, and there is a reduced infiltration area beneath the mound. Areas that are occupied with rock fragments, tree roots, stumps, and boulders reduce the amount of soil available for proper treatment. For mounds for which no other site is available, trees in the soil treatment must be cut off at ground level (7080.2220, Subp. 3(I)).
A minimum of six inches of topsoil borrow shall be placed over the system. A close-growing, vigorous vegetative cover must be established over the soil treatment and dispersal system and other vegetatively disturbed areas. The sodding, seeding, or other vegetation establishment shall begin immediately after the placement of the topsoil borrow. The soil treatment and dispersal system must be protected from erosion and excessive frost until a vegetative cover is established. The vegetative cover established must not interfere with the hydraulic performance of the system and shall provide adequate frost and erosion protection. Trees, shrubs, deep-rooted plants, or hydrophilic plants should not be planted on the system (7080.2150, Subp. 3 (J&K)).

Setbacks
The soil treatment system provides the final treatment and dispersal of septic tank or pretreated effluent. When properly designed and installed, the soil treatment system should treat disease-causing bacteria and fine solids contained in the effluent. Some of the phosphorus and nitrogen will be utilized by vegetation, the amount depending on the rooting depth and season. Phosphorus can be adsorbed and attached to soil particles. Nitrogen will undergo nitrification, and, if an anaerobic environment is encountered below the biomat, denitrification may also occur. The remaining nitrogen will be in the nitrate-nitrogen form and transportable by water. The nitrate may then be diluted by precipitation and groundwater. The extent of the dilution is dependent upon the design of the system and the properties of the groundwater.

Refer to Section 2 for the setbacks for the soil treatment system with respect to water supply wells, bodies of water, and buildings as set by the Minnesota Department of Health (MDH), the Department of Natural Resources (DNR), and Chapter 7080.

These setbacks are measured from the absorption area of the system. In Chapter 7080.1100, Subp. 2, absorption area is defined as the design parameter that is associated with the hydraulic acceptance of effluent. The absorption area for mound systems is the original soil below a mound system that is designed to absorb sewage tank effluent. The absorption area for trenches, seepage beds, and at-grade systems is the soil area in contact with the part of the distribution medium that is designed and loaded to allow absorption of sewage tank effluent. This includes both bottom and sidewall soil contact areas. Figure 12.4 shows the an example of the absorption area in a mound system.
Distribution medium is defined in Chapter 7080.1100, Subp 22 as the material used to provide void space in a dispersal component, through which effluent flows and is stored prior to infiltration. Distribution media includes, but is not limited to: drain-field rock, polystyrene beads, chambers, and gravelless pipe. The greater the setback distance, the greater the safety provided. All soil treatment systems should be at least 50 feet away from any water supply well, unless the well is a shallow well with less than 50 feet of casing or an impervious layer of less than ten feet. In these cases, the separation distance is 100 feet. The setback distance for the soil treatment unit is 20 feet from any building and ten feet from property lines. The minimum setback distances from lakes or streams are 50, 75, or 150 feet, depending upon the lake or stream classification set by the Department of Natural Resources. Setbacks should be verified with the local unit of government (LGU) as they may be more restrictive. These setbacks are measured from the ordinary high water mark as shown in Figure 12.5. From MN Statutes 103G.005, Subd. 14, Ordinary high water level is defined as an elevation delineating the highest water level that has been maintained for a sufficient period of time to leave evidence upon the land-
Below-Grade Systems

Below-grade systems are constructed in original soil with distribution of effluent occurring below the soil surface. With below grade systems the soil treatment area is designed and installed such that the infiltrative surface is below the original ground elevation and a final cover of topsoil stabilizes the completed installation, supports vegetative growth, and sheds runoff. It is the underlying soil that treats the many harmful components in the effluent before it reaches surface or ground waters. The two types of below-grade soil treatment systems commonly used are trenches and seepage beds.

Trenches have better oxygen transfer then beds and are recommended whenever the site conditions allow although seepage beds are often more attractive due to reduced land area requirements. In addition, the cost and time of construction, trenches are preferred because they have greater infiltrative surface for the same bottom area, and less damage typically occurs to the infiltrative surface during construction (Otis et al, 1977).

Figure 12.6 shows minimum depths and separation requirements for trenches or seepage beds. For systems without pretreatment, at least three feet of soil suitable for treatment should be located below the bottom of the distribution media. The minimum depth of distribution media is six inches, followed by a minimum soil cover of twelve inches, so that the total distance from the periodically saturated or other limiting condition to the final grade is approximately 4.5 feet. Note that this total could be made up of 3.5 feet of original soil and one foot of soil (7080.2150, Subp. 3) over the distribution media of the system.
From MN Rules 7080.2260 Subp. 3. If the distribution media in a trench or a bed is in contact with soil texture group 2 through 4 (medium sand, fine sand, coarse and medium loamy sand) pressure distribution must be used. See Forms Section for more information.

**Below-Grade Systems:**

**Specifications**

**Trenches**

The trench is the most common of the soil treatment systems. According to MN Rules Chapter 7080.1100, Subp. 89 a trench is defined as a soil treatment and dispersal system, the absorption width of which is 36 inches or less. Trenches are narrower than they are wide, no wider than three feet, and are laid out along the contours of the soil. The method of distributing the septic tank effluent can be either pressure or gravity. There are a number of different
configurations by which the trenches can be connected with each other and with the septic tank: parallel, serial, and continual. A typical trench is constructed by making a level excavation 18 to 36 inches wide. A typical layout for a trench system is shown in Figure 12.7.

The soil around and beneath the trench must be neither too coarse nor too fine. A coarse soil may not adequately filter pathogens, and a fine soil may be too tight to allow water to pass through. Soils with percolation rates between 0.1 and 60 mpi or soils with a listed loading rate on Table IX in Chapter 7080.2150 are suitable for treating sewage using a Type I below-grade design. **Trench media must never be placed in contact with soils having a percolation rate faster than 0.1 mpi or soil type 1 or slower than 60 mpi. For soils with percolation rates faster than 0.1 mpi and between 61 and 120 mpi, Type I below-grade systems may not be used (7080.2150, Subp. 3).** A typical trench is constructed by making a level excavation 18 to 36 inches wide and is shown in Figure 12.7.

The trench soil treatment system consists of distribution media, covered with a minimum of 12 inches of soil and a close-growing and vigorous vegetation. Many trench systems utilize a pipe and gravel distribution system where effluent passes through the pipe and is stored within the media until it can be absorbed into the soil. Partial treatment is achieved as effluent passes through the biomat. The biomat also distributes effluent across the soil surfaces and maintains aerobic conditions outside the trench.

**Shallow Trenches**

Shallow trenches may be used in areas of periodically high water tables. **The system’s absorption area must be original soil (7080.2150, Subp. 3 (E)) and therefore placed within six inches of grade to maintain the required three-foot separation distance. To provide a suitable soil covering over the top of the trench, the soil must be mounded above the original soil surface (7080.2210, Subp 4 (E)). The portion of the distribution media delivering the effluent must be below the natural soil surface to be a Type I system 12.8. Shallow trenches follow Type I trench design, installation, and maintenance requirements.**

**Seepage Beds**

A bed system is a wide area (wider than three feet) prepared to accept septic tank effluent that is created below the surface of the soil, and built the same way as a trench system. The beds treat the effluent effectively as long as they are located in appropriate soils. **A seepage bed is defined in MN Rules Chapter 7080.1100, Subp. 67, as a soil treatment and dispersal system, the absorption width of which is greater than three feet but no greater than 25 feet.** Figure 12.9 shows design and installation specifications of a seepage bed.

Beds are more prone to problems due to reduced oxygen transfer than are trenches as trenches have more sidewall. The sidewalls are sometimes too far apart to provide suffi-
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Sufficient oxygen for the entire seepage bed bottom area, and the biomat may increase in thickness. The thicker the biomat, the more slowly the water will leave the system. Another cause of seepage bed failure is the reduced sidewall surface area available for biological growth. Therefore, sizing of beds is critical, and designers should size beds with greater surface area than trenches receiving the same flow. Alternatively, a bed system could use pressure distribution to apply the effluent to the soil. This would allow for better transfer of oxygen and would not require the seepage bed to be any larger than a trench system.

Any distribution media can be used in a seepage bed as long as it is listed for that use on the MPCA Product Registration List.

Figure 12.9 Seepage Bed Specifications

If gravity distribution pipes are used they must not be more than 30 inches from the sidewalls of the bed (7080.2050, Subp. 3 (E), 4). Very little effluent is distributed through the distribution pipe. Effluent flows through the orifices in the first length of pipe into the media and is distributed over the soil absorption area to the biomat. Distribution pipes are defined in 7080.1100, Subp 23 as the perforated pipes that distribute effluent within a distribution medium.

The construction of a seepage bed is essentially the same as that for a trench, except that the bed is wider. Chapter 7080 requires that the bottom area of seepage beds with gravity distribution be 50% greater than that of trenches to allow for the fact that there is very little sidewall with a seepage bed and low oxygen transfer. Seepage beds may not be used where soils have percolation rates slower than 60 mpi (soil textures 10-11), on slopes of greater than 6%, and must not be located in floodplains (7080.2210, Subp.2).

Pressure distribution must be used for all seepage beds where:

1. The soil percolation rate is 0.1 to 5 mpi, soil types 1-5, and where the soil has a me-
Section 12: Soil Treatment Systems

1. Accuracy of initial soil treatment system design, matching the site and soil characteristics to the anticipated facility use and wastewater generation.

2. Quality of materials and methods used in the installation of the soil treatment system.

3. Care of use (operation) and timeliness of maintenance on the system.

The selection of an appropriate effluent-to-soil application rate is critical to the soil treatment system’s performance and lifespan. Gravelless soil treatment system manufacturers commonly encourage the use of their products in reduced configurations when compared to conventional gravel-filled soil treatment systems. These smaller soil treatment systems may impact the life of the soil treatment system. Soil treatment system performance over the long-term (20 to 30 years) needs to be observed and analyzed as additional field experience with these systems is gained. In a field study conducted in Minnesota in 2006, systems from five to ten years in age which use chambers or rock as distribution me-
Section 12: Soil treatment Systems

dia were compared. There was no observed benefit in the systems evaluated that utilized chambers (Christopherson et al., 2007).

**Distribution pipe**

Distribution pipe means the perforated pipe that distributes effluent within a distribution medium according to 7080.1100 Subp. 23.

As shown in Figure D-1 from Chapter 7080.2050, Subp. 3(D), if a distribution pipe is part of a gravity trench or bed distribution system, it must:

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be at least four inches in diameter</td>
</tr>
<tr>
<td>Have a load-bearing capacity of not less than 1,000 pounds per linear foot</td>
</tr>
<tr>
<td>Have at least one row of orifices of no less than one-half inch in diameter spaced no more than 40 inches apart</td>
</tr>
<tr>
<td>Be laid level or on a uniform slope oriented away from the distribution device of no more than four inches per 100 feet</td>
</tr>
<tr>
<td>Be uniformly spaced no more than five feet apart and not more than 30 inches from the side walls in seepage beds.</td>
</tr>
</tbody>
</table>

**FIGURE 12.11 Trench Specifications**

Notes:

1. Bottom of trench must be level. Top of trench rock must be level.

2. Distribution pipe is level.

3. Distribution pipe can be perforated plastic installed with one row of holes along the pipe bottom (1/2" for gravity). Pipe must have a bearing strength of at least 1,000 lb/ft.

4. Maintain the natural soil structure by having the rock in contact with the trench wall.

5. Bottom of rock trench must have 3' of vertical separation from saturated soil or other limiting condition.
**Rock/Geotextile**

The function of the rock in soil treatment systems is to maintain a space within the trench, bed, mound, or at-grade system. The rock holds the sides of the system apart, providing space for the effluent.

1. Be insoluble, durable rock
2. Be between three-fourths inch and 2-1/2 inches in size
3. Have no more than five percent by weight able to pass through a three-fourths inch sieve
4. Have no more than one percent by weight able to pass through a No. 200 sieve
5. Have no more than five percent by weight of materials greater than 2-1/2 inches in size.

Chapter 7083.4070 (A) requires drainfield rock distribution media shall meet requirements contained in the recommended standards and guidance for public domain distribution products before local units of government are allowed to permit its use. As shown in Figure 12.11, a soil treatment system trench is constructed by making a level excavation 18 to 36 inches wide. The bottom of the trench must be level, as must the top of the rock in the trench. A minimum of six inches of clean rock is placed in the bottom of the excavation; then, a four-inch diameter perforated distribution pipe; next, rock around and covering the pipe; finally, a layer of permeable synthetic fabric and soil backfill to a depth of 12 inches above the top of the rock. The upper six inches of the cover material must be topsoil borrow and must have the same texture as the adjacent soil (7080.2210 Subp. 4(E)).

**Geotextile Fabric**

Durable non-woven geotextile fabric must be used to cover rock distribution media. The fabric must be of sufficient strength to undergo installation without rupture. The fabric must permit the passage of water without passage of overlying soil material into the drainfield rock medium (Minn. R. 7080.2150, Subp. 3(F)).

There are also ASTM standards for the fabric:

- unit weight of at least 3.0 oz./yd2 (ASTM D-5261),
- permittivity of at least 1.0 sec-1 (ASTM D-4491),
- trapezoid tear strength of at least 35 lbs. (ASTM D-4533)
- mesh size equal to U.S. Sieve No. 70 (A.O.S.) (ASTM D-4751)

**Nonrock Soil Treatment System Media**

For nonrock distribution media, manufacturers shall register their distribution media, including gravelless distribution media and subsurface drip dispersal products, with the MPCA before local unit of government are allowed to permit their use (Chapter 7080.4070(B)). The list of registered distribution products will be maintained on the MPCA website.

1. These distribution media must be constructed or manufactured from materials that are nondecaying and nondeteriorating and do not leach unacceptable chemicals when exposed to sewage and the subsurface soil environment;
2. provide void space at least equal to the void space provided within a 12-inch layer of drainfield rock in a drainfield rock-filled distribution system. The void
space must be established by the distribution medium, system design, and installation. The density of the media must be maintained throughout for the life of the system. This requirement is allowed to be met on either a lineal foot basis or on an overall system design basis;

3. support the distribution pipe and provide suitable effluent distribution and infiltration rate to the absorption area at the soil interface; and

4. maintain the integrity of the trench or bed. The material used, by its nature and manufacturer-prescribed installation procedure, must withstand the physical forces of the soil sidewalls, soil backfill, and weight of equipment used in the backfilling. (Chapter 7083.4070 (D)).

The advantage of a gravelless soil treatment system becomes clear when and where suitable gravel is either unavailable, expensive, or where site conditions make moving gravel about difficult or time consuming. In addition to these benefits, the use of gravelless soil treatment systems addresses some of the concerns presented with gravel. Among these are:

- If the quality of the gravel washing process is poor, the silt particles remaining on the surface of the gravel may be washed off when the soil treatment system is placed into use, resulting is a silt layer on the infiltrative surface and reducing its infiltrative capacity.

- The damaging effect that the transportation of gravel across yards can have on lawns, flowerbeds, shrubs, etc. due to the weight of the material and the size of the heavy equipment needed to effectively move it from the stock pile to the soil treatment system area.

**Chambers**

The chamber system, sometimes called leaching chamber, is technology that uses something other than gravel to fill the trench or bed. A chamber refers to the open-bottom pipes used in these systems. They are commercially available and usually constructed of high-density plastic. A number of chamber systems have been developed out of plastic materials, featuring a plastic dome with orifices or slots (or both) cut in the sides (Figure 12.12). Typically, the design and construction of the chambers minimize the movement of fines into the chamber area.

Chamber technology can also be used with gravity or pressure distribution. With pressure distribution, the pipe is installed either at the top of the dome or laid across the bottom. Concerns with these applications include settling of the pipe or media, which can result in uneven loading. Freeze protection can be accomplished either by placing all the holes downwards with orifice shields or 10%
downward to assure drainage of the pipe. Scouring of the soil is another concern. Some manufacturers include splash plates or recommend paving blocks or bricks to protect the bottom of the trench from the effluent stream.

Chamber systems are excavated like standard soil dispersal systems. If any smearing of the bottom or sidewalls has occurred, they need to be raked. Chamber systems also need to be level. The chambers are then placed in the trench applying minimal foot pressure and the sidewall area is backfilled with the excavated soil. The fill is packed down by walking along the edges of the trench and chambers. The area is overfilled to allow for settling and to ensure that runoff water is diverted away from the system. The manufacturers’ requirements for installation that are required to be provided with the Product Registration Process (7080.1645, (F)) should be followed.

**Gravelless pipe**

Gravelless pipe is a corrugated pipe used in place of drainfield rock for a trench system as shown in Figure 12.13. This pipe typically has an inside diameter of eight to ten inches. The corrugations are usually 1/2-inch, with 3/4-inch separations. The corrugated pipe also has 1/2-inch orifices in the pipe bottom. Typically, manufacturers place the orifices at four o’clock and eight o’clock. Gravelless pipe systems are designed to be surrounded by soil. The excavation should not be backfilled with drainfield rock. If an excavation has been filled with rock around the pipe, the biomat will not develop at the pipe-rock interface, but will instead develop at the rock-soil interface. The manufacturers’ recommendations should be followed for installation.
**Other soil treatment media**

Expanded polystyrene is one type of manufactured distribution media designed to replace drainfield rock and pipe soil treatment systems. This type of media is typically manufactured in ten-foot sections and is comprised of four-inch corrugated polyethylene pipe surrounded by extruded polystyrene held together with durable polyethylene netting. Recycled crushed aggregate (Sherman et al., 1994) and tire chips (Burnell & McOmber, 1997) along with many other media have been used successfully across the US.
Design Basis and Operational Theory

A typical soil treatment system consists of two to five trenches that are three feet wide by one to four feet deep, installed on six to ten-foot centers. Shallow excavations are better than deeper for treatment and access. Trenches are only effective if the sidewalls do not interfere with each other in transferring oxygen. If the center-to-center distance is reduced too much, the trenches will behave like a bed.

Table 12.1 shows the soil treatment areas in square feet required for various soil properties. Note in the footnotes that, for trenches only, the bottom area may be reduced if more than six inches of distribution media is utilized for acceptance of effluent. If the soil characteristics are suitable, an increased depth of distribution media provides more soil exposed to the effluent along the side of the trench, and consequently less bottom area is required. The bottom area reduction is allowed for trenches, but not for seepage beds. Chapter 7080 requires that seepage beds using gravity distribution be sized at 1.5 times the values shown when six inches of distribution media is used without pressure distribution.

### TABLE 12.1  Square Feet of Drainfield Trench Bottom Area for Class I Dwellings\(^{(a)}\)

<table>
<thead>
<tr>
<th>percolation rate, minutes per inch</th>
<th>2-bedroom</th>
<th>3-bedroom</th>
<th>4-bedroom</th>
<th>5-bedroom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches of media(^{(b)})</td>
<td>inches of media</td>
<td>inches of media</td>
<td>inches of media</td>
</tr>
<tr>
<td>faster than 0.1(^{(c)})</td>
<td>6</td>
<td>12</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>0.1 to 5</td>
<td>250</td>
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<td>165</td>
<td>150</td>
</tr>
<tr>
<td>0.1 to 5(^{*})</td>
<td>500</td>
<td>400</td>
<td>330</td>
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<td>6 to 15</td>
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<td>16 to 30</td>
<td>500</td>
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<td>31 to 45</td>
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<tr>
<td>46 to 60(^{c})</td>
<td>660</td>
<td>528</td>
<td>436</td>
<td>396</td>
</tr>
<tr>
<td>slower than 60(^{(c)})</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

\(^{(a)}\) Class I: The total floor area of the residence divided by the number of bedrooms is more than 800 square feet per bedroom, and more than two of the following water-use appliances are installed: automatic washer, water softener, dishwasher, garbage disposal, or self-cleaning humidifier in furnace.

\(^{*}\) Soil having greater than 50% fine or very fine sand.

\(^{(b)}\) For trenches only utilizing gravity distribution, the bottom areas may be reduced if more than six inches of distribution media is available for absorption of effluent; for 12-18 inches of media the bottom area can be reduced by 20 percent; a 34 percent reduction for 19-24 inches; and a 40 percent reduction for more than 24 inches.

\(^{(c)}\) Soil is unsuitable for drainfield trenches or seepage beds.

Design of Trenches and Seepage Beds

See the “Trench and Bed Design” worksheet in the Forms Section of this manual.

The size of soil treatment the systems is based on the amount of wastewater and the characteristics of the soil. All soil has a set capacity for accepting wastewater, that depends on the soil properties and also on the strength of the waste. The greater the waste strength beyond typical residential levels, the larger the system should be sized unless advanced pretreatment treatment is designed. This is true for all system types; although each type of system introduces water into the soil differently, sizing for the system you choose is critical. If mistakes are made in design, the system will have difficulty performing properly. The configuration of the system—its layout with respect to the contour of the land—is the second consideration in sizing a soil treatment system.
All water use, and thus the total amount of wastewater, should be accounted for when sizing the system. Users of the system (household residents) should know that reductions in water use will benefit the system. It is a good idea to build some extra capacity into the system because household water use can increase as well as decrease.

1. The estimated flow rate is determined using Table 12.2, unless measure flow rates are available for other establishments. With a Class I residence, the estimated water use is equal to 150 gallons per day (gpd) per bedroom. This assumes an occupancy of two people per bedroom, each using 75 gallons per day. The footnote in Table 12.2 suggests a classification for residences according to size and number of water-using appliances. While the individuals who occupy a residence use the water, the number of bedrooms is still considered a good index of the potential water use. See Section 5: Source for a more detailed discussion of flow determination.

### Table 12.2 Estimated Sewage Flows in Gallons per Day

<table>
<thead>
<tr>
<th>Number of Bedrooms</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>300</td>
<td>225</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>450</td>
<td>300</td>
<td>218</td>
<td>256</td>
</tr>
<tr>
<td>4</td>
<td>600</td>
<td>375</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>750</td>
<td>450</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>900</td>
<td>525</td>
<td>332</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1050</td>
<td>600</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
<td>675</td>
<td>408</td>
<td></td>
</tr>
</tbody>
</table>

- **Class I:** The total floor area of the residence is over 800 square feet per bedroom or more than two of the following water-using appliances are installed: dishwasher, automatic clothes washer, water softener, garbage disposal, self-cleaning furnace.
- **Class II:** The total floor area of the residence is between 500 and 800 square feet per bedroom, and no more than two water-using appliances are installed.
- **Class III:** The total floor area of the residence is less than 500 square feet per bedroom, and no more than two water-using appliances are installed. Use this estimate only when designing a system with flow control, such as trenches and a holding tank, or a timer to dose the system at a designed volume.
- **Class IV:** Class I, II, or III home, but with no toilet wastes discharged into the system.

60% of the values in the Class I, II, or III columns.

2. Determine the maximum depth of the system by subtracting three feet from the depth to the limiting condition, or use four feet, whichever depth is less. The bottom of the system cannot be greater than 4 feet from final grade.

3. Determine the soil loading rate based on the field data collected. If difficulty arises choosing a loading rate, always go with the more conservative media used needs to be registered in Minnesota (the smaller number). Seepage beds and trenches must not be placed in soils with a sizing classification of 10-11 which have percolation rates greater than 60 mpi (Chapter 7080.2200, Subp. 3 (A)).

Please see Tables IX and IXa in the Forms section.
4. Now divide the design flow (1) by the soil loading rate (5). The result is the required bottom area (BA). This square footage BA for is based on six inches of side wall area of distribution media. The sizing of trench systems can be looked at in two ways: bottom area and sidewall area.

5. If 12-18 inches of sidewall media are used in a trench system, the BA can be reduced by 20 percent. Now, the required trench bottom area is 80 percent of the BA. The trench bottom area can be reduced by 34 percent for 19-23 inches of media sidewall pipe and by 40 percent for the maximum of 24 or more inches of media sidewall. See Figure 12.14. Using both the sidewall and the bottom for sizing allows less lawn area to be used. You will note that effluent will move through the soil sidewalls as well as the bottom no matter how the size of the system is calculated.

FIGURE 12.14 Trench Bottom Area Reduction

Reductions in trench bottom area dictated by 7080.2210 subp. 3.B

No reduction in trench bottom area
6" - 11" of distribution media
20% reduction in trench bottom area
12" - 17" of distribution media
34% reduction in trench bottom area
18" - 23" of distribution media
40% reduction in trench bottom area
24" or more of distribution media

6. If a seepage bed is the chosen design, the BA must either be multiplied by 1.5 or pressure distribution must be used. If the bed will be wider than 12 feet, pressure distribution is required.

7. Select the distribution media to be used. Refer to the MPCA product registration list to determine the appropriate bottom and sidewall sizing. For most distribution media the square footage required is based on exposed bottom and sidewall area.

8. Select the width of the trench or bed based on the design and media. Then, to determine the lineal feet required, take the required bottom area divided by the width chosen.

9. If rock is used as the distribution media, the amount of rock required is determined by adding the below-pipe depth of rock chosen and the depth of rock needed to cover the pipe. The amount of cover estimated is usually six inches. This total depth is then multiplied by the bottom area. Table 12.4 shows the calculated rock for soil treatment.
system trenches in cubic yards. The trench bottom area is presented in the first column, and the remaining column headings are the various rock depths. An additional 10% should be added for practicality in construction.

<table>
<thead>
<tr>
<th>trench bottom area (sq. ft.)</th>
<th>depth of rock below distribution pipe (total rock depth)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6&quot; (12&quot;)</td>
</tr>
<tr>
<td>50</td>
<td>1.8</td>
</tr>
<tr>
<td>100</td>
<td>3.7</td>
</tr>
<tr>
<td>150</td>
<td>5.6</td>
</tr>
<tr>
<td>200</td>
<td>7.4</td>
</tr>
<tr>
<td>250</td>
<td>9.3</td>
</tr>
<tr>
<td>300</td>
<td>11.1</td>
</tr>
<tr>
<td>350</td>
<td>13.0</td>
</tr>
<tr>
<td>400</td>
<td>14.8</td>
</tr>
<tr>
<td>450</td>
<td>16.7</td>
</tr>
<tr>
<td>500</td>
<td>18.5</td>
</tr>
<tr>
<td>600</td>
<td>22.2</td>
</tr>
<tr>
<td>700</td>
<td>25.9</td>
</tr>
<tr>
<td>800</td>
<td>29.6</td>
</tr>
<tr>
<td>900</td>
<td>33.3</td>
</tr>
<tr>
<td>1000</td>
<td>37.0</td>
</tr>
<tr>
<td>1100</td>
<td>40.7</td>
</tr>
<tr>
<td>1200</td>
<td>44.4</td>
</tr>
<tr>
<td>1300</td>
<td>48.1</td>
</tr>
<tr>
<td>1400</td>
<td>51.9</td>
</tr>
<tr>
<td>1600</td>
<td>59.3</td>
</tr>
<tr>
<td>1800</td>
<td>66.7</td>
</tr>
<tr>
<td>2000</td>
<td>74.1</td>
</tr>
</tbody>
</table>

Values of rock volume include another six inches, the depth required to cover a four-inch distribution pipe with two inches of rock. Table values include no waste. To calculate rock quantity in tons, multiply table values by 1.4.

Rock is specified by weight, rather than volume. While there is some variation in rock density, multiplying the table values of cubic yards by 1.4 will result in a reasonably accurate estimate of the rock weight in tons.

10. A vertical inspection pipe at least 4 inches in diameter must be installed and secured in the distribution media of every trench or seepage bed. The inspection pipe must be located at an end opposite from where the sewage tank effluent enters the medium. The inspection pipe must have three-eighths inch or larger perforations spaced vertically no more than six inches apart. At least two perforations must be located in the distribution medium. No perforations may be located above the geotextile cover or wrap. The inspection pipe must extend to the bottom of the distribution medium, be secured, and be capped flush with or above finished grade (7080.2150 Subp. 4 (B)). Examples of securing methods are shown in Figure 12.15.
Example Trench Design

The following example is an oversimplification for EXAMPLE CALCULATION purposes ONLY!

A trench system is being designed for a two-bedroom Class I dwelling with the following characteristics:

- Pump in the basement,
- Soil: 60 inches of vertical separation, is fine sand, single grain structure and
- Land slope of 7%

1. The estimated flow rate is 300 gallons per day.
   a. The minimum septic tank capacity is 1,500 with multiple tanks or compartments and an effluent screen and alarm.
   b. The minimum size of pump tank required is 500 gallons.
2. The maximum depth of the system is determined by subtracting: 5 feet - 3 feet = 2 feet.
3. The maximum depth of the system is determined soil loading rate is selected for the system from the texture and structure of 0.60 gpd per square feet.
4. The design flow of 300 gpd is divided by the soil loading rate of 0.60 gpd/ft² which results in a required BA of 501 ft². This square footage for a BA is based on six inches of side wall area of distribution media. If 12 inches of sidewall media are used in a trench system, the BA can be
reduced by 20 percent, which results in a BA of 401. Twelve inches of media will be installed.

5. A seepage bed is not appropriate for this site due to the 7% slope.

6. Rock is chosen as the distribution media.

7. A width of the trench is selected as three feet. The lineal feet of trench needed is found by taking the BA of 401 and dividing by the width of the trenches and is equal to 134 lineal feet.

8. The amount of rock required is determined by taking the depth of rock under the pipe of one foot, adding 0.5 feet above the pipe, and multiplying by the BA of 401 ft², which results in 602 cubic feet of rock, or 32 tons. Adding in 10% for constructability results in 35 tons of rock.

9. A vertical inspection pipe at least 4 inches in diameter must be designed and installed in each trench or seepage bed at the media/soil interface. The pipe must be located at the end of the soil treatment unit appropriate from the end where the sewage tank effluent enters and be secured to remain in place over the life of the system (Chapter 7080.2200, Subp. 4 (B).

**Dual Field Systems**

Dual field systems allow for the septic tank effluent to be dispersed in one of two or more systems. Dual field systems are designed with two or more soil absorption areas, used alternately. While one field is accepting effluent, the other is resting. Dual field systems can be installed as Type I systems, but when downsized below standard capacity during loading, they are considered Type III systems. Periodically a valve is switched and the second soil treatment system is placed into use while the first one is allowed to rest. This resting period allows the soil treatment system to have a break and should allow for aerobic conditions to predominate and reduce the clogging potential of the biomat and rejuvenate the soil for phosphorus removal.

Once the first section of the system has developed a mature biomat, it can be diverted to the second section. Often times, people manually turn a valve on July 4th to let the trench system that was receiving effluent recover, while the second system receives the septic tank effluent. Advantages of dual field systems:

- Relatively low cost
- Easy to install
- Allow periodic resting of infiltrative surface, increasing the soil’s absorptive ability

Disadvantages of dual field systems:

- Front end of trench can overload
- Require larger soil treatment system than do conventional systems
- Diversion valve should be evaluated every six to 12 months

In larger systems, this design has been found useful in system management. It also allows some protection in case flows become higher than those for which the system was designed. If a system has low seasonal flows, a dual field system allows for a smaller portion...
Section 12: Soil Treatment Systems

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of the system to be used. Dual field systems are sized, designed, and constructed as other standard systems are, except that:

- the soil treatment area is divided into two or more parts, and
- a device to alternate between the zones is designed and installed.

Each zone can be used for up to one year, unless the effluent level indicates that a longer duration is feasible. Managing the development and existence of the biomat in the soil treatment system can contribute greatly to both the treatment performance and the lifespan of the soil treatment system.

The use of alternating gravity soil treatment systems in coarse soils may be counter-productive, particularly in terms of effluent treatment. Systems installed in these soils are considered Type II systems and have additional design requirements (found in Chapter 7080.2260). The development of a biomat in the soil treatment system is beneficial even though too much of good thing can lead to problems. In coarse-textured soils, the biomat is much slower to develop than in fine textured soils. During the time it takes the biomat to develop a biomat in coarse soils, effluent flow in the soil below the soil treatment system is often in saturated flow conditions, which reduces the effluent treatment capacity of the system. If alternating soil treatment systems are used in this setting, an annual succession of slowly developing biomat can ensue in each of the soil treatment systems. The two soil treatment systems perform well hydraulically (disposing of the effluent) but poorly in terms of treating the effluent.

One approach to addressing the slow or poor development of a flow-restricting biomat in medium-to-coarse soils is the use of pressure distribution. The design of pressurized soil treatment systems, with frequent dosing of small volumes of effluent uniformly throughout the soil treatment system, simulates the flow-restrictive nature of a well-developed biomat. This is why, for coarse soils, the on-site rules require the use of pressure distribution: the mechanical system of pressurizing and dosing replaces the biomat as a flow regulator in soils where the natural development of a biomat is slow and uncertain. For long-term management of effluent treatment and dispersal, alternating soil treatment systems link well with pressure distribution.

In all soil conditions, the frequency of valve switching depends upon the rate of biomat development, which in turn is dependent upon the biological load and hydraulic flow of the effluent being treated and disposed at the site. In any case, proper management of the biomat—development, existence, and resting/drying—is based upon observations of the soil treatment system ponding levels. These routine observations will lead the operator to select a valve switching schedule or frequency that matches the particular system site, soil, and effluent characteristics. Such an approach, depending upon conditions, could result in a relatively frequent valve switching cycle (every six months) to a relatively infrequent valve switching cycle (every three or four years).

Zoning of Cluster Systems

In some applications it is advantageous or required to zone a soil treatment system into several separate components. The goal may be to facilitate management, keep pump size reasonable or be due to site limitations. Regardless of the reason there are control panels and splitting devices a designer may choose to facilitate a zoned system.
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Type II – V Trenches and Seepage Beds
Many times the site available for onsite wastewater treatment will not allow a Type I system. In other instances, the designer or property owner may be interested in utilizing technology beyond those allowed under Type I systems. Chapter 7080 classifies these systems as Type II, III, IV or V. The reasons may include:

1. installing the system in rapidly permeable soils (Type II)
2. locating the system in a floodplain (Type II)
3. reducing the bottom area beyond what is allowed in Chapter 7080 (Type III)
4. designing and installing all or part of the system in non-natural/disturbed soil, including installing the system so not all the distribution media is in native soils (Type III)
5. using pretreatment with a registered product and pressure distribution (Type IV) with difficult soil and site conditions
6. pretreating with a reduced-size trench or bed with a registered product (Type IV)
7. using non-registered pretreatment to a trench system located in fill (Type V) and
8. using non-registered distribution media (Type V)

MN Rules Chapter 7080 allows the reduction in vertical separation in 7080.2350, Subp. 2, provided that certain conditions are met as shown in Table 12.5.

<table>
<thead>
<tr>
<th>Vertical Separation (inches)</th>
<th>Soil Group</th>
<th>Sands, fine sands</th>
<th>Loams</th>
<th>Clay loams and clays</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 17</td>
<td>1,000 Fecal</td>
<td>Pressure distribution</td>
<td>1,000 Fecal</td>
<td>Pressure distribution</td>
</tr>
<tr>
<td></td>
<td>Timed dosing</td>
<td></td>
<td>Timed dosing</td>
<td></td>
</tr>
<tr>
<td>18 to 23</td>
<td>10,000 Fecal</td>
<td>Pressure distribution</td>
<td>10,000 Fecal</td>
<td>Pressure distribution</td>
</tr>
<tr>
<td></td>
<td>Timed dosing</td>
<td></td>
<td>Timed dosing</td>
<td></td>
</tr>
<tr>
<td>24 to 36</td>
<td>10,000 Fecal</td>
<td>Pressure distribution</td>
<td>10,000 Fecal</td>
<td>Pressure distribution</td>
</tr>
<tr>
<td></td>
<td>Timed dosing</td>
<td></td>
<td>Timed dosing</td>
<td></td>
</tr>
</tbody>
</table>

Above–Ground Systems
Above-ground systems are used when the natural soil will not accomplish the necessary acceptance or treatment below grade. The construction of these systems is a more exacting process than construction of below-grade systems. Many times, an above-ground system is the only choice for proper treatment on a site. When we think of above-ground systems, we usually think of either a sewage treatment mound system or an at-grade system. Unless the soil under the above-ground system has the ability to transmit liquid both vertically and horizontally, it will not function properly. If the site has unnatural soil or does not have 12” inches for a mound or 36 inches for an at-grade of unsaturated soil, a mound or at-grade may still be an option for the site; however, it will be a Type III system, which dictates additional permitting and management requirements. Above-ground systems ap-
Applications include sites with high water tables, bedrock, excessively permeable soils and slowly permeable soils.

Above-ground systems are designed based on the principle of an absorption area. The absorption area is the area necessary to treat and accept the wastewater before dispersal into the natural soil conditions. This principle was first seen in the literature in a 1977 paper by Converse et al.

**Above-Ground Rule Requirements**

All above-ground systems must utilize a pump and pressure distribution (7080.2050, Subp. 4 (1 &2)). Flow measurement is also required (7080.2220, Subp. 1 (D) and 7080.2230, Subp. 1 (D)).

**Above-Ground System Siting**

When possible, above-ground systems should be located on the summit or shoulder of a slope. On a crested site, the distribution system can be situated such that the effluent can move laterally down both slopes. A level site allows lateral flow in all directions, but may present problems as the water table beneath the absorption bed may rise in slowly permeable soils. Sloping sites allow the liquid to move only in one direction away from the absorption bed. On sloping sites and sites with slowly permeable soils, soil components rely on lateral effluent movement through the upper soil horizons. Lateral movement becomes more important as soil permeability decreases. It is best if these systems are sited in open areas with exposure to sun and wind, which increases the assistance of evaporation and transpiration in the dispersal of the effluent. In fact, locating above-ground systems on some slope is preferable. The upslope edge of the absorption bed must be installed along the natural contour (Chapter 7080.2230, Subp. 3(D)).

The setbacks specified for soil subsurface treatment/dispersal component apply to mound and at-grade systems. The distances are measured from the absorption area.

**At-grades**

**Definition and Description**

An at-grade, as its name implies, is a system installed with the distribution media placed at the original soil surface. It is designed to solve similar problems as the mound, but where the soil conditions are somewhat more favorable. According to Minnesota Rules Chapter 7080.1100, Subp. 6 an at-grade system is a pressurized soil treatment and dispersal system where sewage tank effluent is dosed to an absorption bed that is constructed directly on original soil at the ground surface and covered by loamy soil materials. The operation of the at-grade component is a two-stage process involving both effluent treatment and dispersal into the underlying soil. Treatment is accomplished predominately by physical and biochemical processes within the soil. These processes are affected by the physical characteristics of the effluent wastewater, influent application rate, temperature, and the nature of the receiving soil.

The at-grade system is an option to consider as a Type I system when there are between 36 and 42 inches to the limiting condition, or when you have soils you do not want to excavate, such as clay. Chapter 7080.2230, Subp. 2 (A) requires that the upper 12 inches of the absorption area of the at-grade must be original soil with a loading rate of 0.45 gallons per day per square foot as shown in Table IX or IXa in 7080.2150,
Subp. 3(E). One of the advantages of using an at-grade system compared to a mound is the potential for cost savings on material. The material used to cover the media bed should be a loamy material and need not be the same clean sand used below the media in the construction of a mound. At-grades can also be used as part of a Type III – V system with reduced areas and vertical separations allowed with additional permitting and management requirements. Another advantage of an at-grade system is that the effluent is spread out across the slope (long and narrow), offering better potential treatment of the nutrients and other contaminants found in the effluent as well as better acceptance of the effluent. Type I at-grade systems cannot be used if the distance to the limiting condition is less than three feet.

**General Specifications**

The at-grade component contains a distribution system that consists of distribution media and a pressure distribution system, which is installed directly on top of the plowed natural soil and covered by loamy or sandy cover material and topsoil borrow, as shown in Figure 12.16. Effluent flows into the soil, where it undergoes biological, chemical, and physical treatment and disperses into the environment. The natural soil serves as the treatment medium and disperses the effluent into the environment.

**Design of At-Grade Systems**

The design of the at-grade system is based on sewage flow as estimated for other systems, soil flow patterns as dictated by the contour loading rate (CLR), and the general geometry of a system built above-ground. CLR refers to potential horizontal and vertical flow patterns in the soil. MN Rules Chapter 7080 does not provide CLRs; therefore, it is the professional responsibility of the designer to choose the appropriate CLR for a system. Taking
into account soil texture, soil structure, and any limiting layers existing in the soil, the University of Minnesota has developed recommended CLRs (see Table 12.6), which range from two to 12 gallons per foot. The two-gallon per foot minimum accounts for nearly all horizontal flow of effluent. This minimum should be used for a system limited by impermeable bedrock or very heavy clay soils, or in any situation where horizontal movement of contaminants is a concern. The twelve gallon per foot loading rate (the maximum) would be used when water moves down through the soil much faster than it moves sideways, as in a sandy soil profile. Design values should be somewhere between these two. For a “typical” soil horizon made up of a variety of soil textures, a CLR of four to 12 gallons per foot should be used. Using the soil texture, structure and percolation rate, if available, a CLR should be chosen based on the most limiting condition. Sites with steep slopes may also want to consider lower CLRs as horizontal movement is more likely.

### Table 12.6 Contour Loading Rates

<table>
<thead>
<tr>
<th>perc rate (mpi) at 12 inches</th>
<th>soil texture (0-12 inches)</th>
<th>other characteristics in the upper 48”</th>
<th>contour loading rate (CLR) gpd/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>faster than 0.1</td>
<td>course sand</td>
<td>no change layers of other textures saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>6 <strong>6</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>layers of other textures saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>5 <strong>5</strong></td>
</tr>
<tr>
<td>0.1 to 5</td>
<td>sand loamy sand fine sand (50% or more fine sand plus very fine sand)</td>
<td>no change layers of other textures saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>8 <strong>7</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>layers of the same texture, banding saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>5 <strong>5</strong></td>
</tr>
<tr>
<td>6 to 15</td>
<td>sandy loam</td>
<td>strong to moderate structure, no textural change weak structure layers of other textures strong to moderate structure, no textural change weak structure layers of other textures</td>
<td>7 <strong>6</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>saturated soil (&lt;3’) bedrock (&lt;4’) saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>6 <strong>6</strong></td>
</tr>
<tr>
<td>16 to 60</td>
<td>loam silt loam silt sandy clay loam silt clay loam clay loam</td>
<td>strong to moderate structure, no textural change weak structure layers of other textures saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>3 <strong>2</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>saturated soil (&lt;3’) bedrock (&lt;4’) saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>6 <strong>5</strong></td>
</tr>
<tr>
<td>16 to 20 slower than 120</td>
<td>sandy clay clay silt clay</td>
<td>strong to moderate structure, no textural change weak structure layers of other textures saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>3 <strong>2</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>saturated soil (&lt;3’) bedrock (&lt;4’) saturated soil (&lt;3’) bedrock (&lt;4’)</td>
<td>6 <strong>5</strong></td>
</tr>
</tbody>
</table>

* Design Condition II Total CLR < 12 gal/ft  
** Design Condition III Total CLR < 8 gal/ft

Discussion of CLRs first began appearing in the literature with regards to large or cluster effluent absorption systems. Tyler and Converse (1984) describe CLRs as being important design criteria for large systems from which system width and length are calculated, and
Converse and Tyler (1987) showed that mounds can be placed on much more restrictive sites if the system is designed using CLRs that fit the site, provided the installer follows correct construction and siting procedures. When laying out soil treatment areas it is critical to make the systems long and narrow along the contour when soil and site conditions encourage lateral movement of effluent. Two systems can have the same square footage, but one can have a CLR much greater if the system is not situated appropriately as shown in Figure 12.18.

Table 12.7 highlights the appropriate loading rates used to determine the required area for a soil treatment system.
TABLE 12.7 Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Level C and Absorption Ratios for Determining Mound Absorption Areas Using Percolation Tests

<table>
<thead>
<tr>
<th>Percolation Rate in Minutes per Inch (mpi)</th>
<th>Gallons per Day per Square Foot or Trench Bottom</th>
<th>Mound Absorption Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faster than 0.1*</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5*</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5 (soil texture groups 3 and 5)</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>6 to 15</td>
<td>0.78</td>
<td>1.3</td>
</tr>
<tr>
<td>16 to 30</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>31 to 45</td>
<td>0.5</td>
<td>2.4</td>
</tr>
<tr>
<td>46 to 60</td>
<td>0.45</td>
<td>2.6</td>
</tr>
<tr>
<td>61 to 120**</td>
<td>0.24</td>
<td>5</td>
</tr>
<tr>
<td>Slower than 120</td>
<td>0.00</td>
<td>–</td>
</tr>
</tbody>
</table>

* See part 7080.2260 for requirements for these soils.
** Exceeds allowable percolation rates for at-grade systems.

Design of the at-grade system includes the following three steps (described in more detail below), (1) calculating the design wastewater flow, septic tanks, and dosing tanks (2) design of the absorption bed, including the pressure distribution system and (3) design of the entire at-grade component. See the At-Grade Design, Pressure Distribution, Pump Tank, and Pump Selection worksheets in Section 13: Forms.

1. The estimated flow rate is determined using Table 12.8, unless measured flow rates are available for other establishments. With a Class I residence, the estimated water use is equal to 150 gallons per day (gpd) per bedroom. This assumes an occupancy of two people per bedroom, each using 75 gallons per day. The footnote in Table 12.8 suggests a classification for residences according to size and number of water-using appliances. While the individuals who occupy a residence use the water, the number of bedrooms is still considered a good index of the potential water use. See Section 5: Source for a more detailed discussion of flow determination.
12-30 ■ SECTION 12: Soil Treatment Systems

### Table 12.8 Estimated Sewage Flows in Gallons per Day

<table>
<thead>
<tr>
<th>Number of Bedrooms</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>300</td>
<td>225</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>450</td>
<td>300</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>600</td>
<td>375</td>
<td>256</td>
<td>60% of the values in the Class I, II, or III columns.</td>
</tr>
<tr>
<td>5</td>
<td>750</td>
<td>450</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>900</td>
<td>525</td>
<td>332</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1050</td>
<td>600</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
<td>675</td>
<td>408</td>
<td></td>
</tr>
</tbody>
</table>

**Class I:** The total floor area of the residence is over 800 square feet per bedroom or more than two of the following water-using appliances are installed: dishwasher, automatic clothes washer, water softener, garbage disposal, self-cleaning furnace.

**Class II:** The total floor area of the residence is between 500 and 800 square feet per bedroom, and no more than two water-using appliances are installed. Use this estimate only when designing a system with flow control, such as trenches and a holding tank, or a timer to dose the system at a designed volume.

**Class III:** The total floor area of the residence is less than 500 square feet per bedroom, and no more than two water-using appliances are installed. Use this estimate only when designing a system with flow control, such as trenches and a holding tank, or a timer to dose the system at a designed volume.

**Class IV:** Class I, II, or III home, but with no toilet wastes discharged into the system.

---

a. Determine the required septic tank capacity, compartments, effluent screen, and alarm based on bedrooms and use of garbage disposal and pump in the basement, as shown in Table 12.9. For more information on septic tanks, see Section 7.

b. Determine the minimum size pump tank required. See Section 9 for more information on pump tank.

2. Determine the width and length of the at-grade absorption bed. This begins by selecting the appropriate soil loading rate (Table 12.7) and CLR/absorption ratio. According to 7080.2230 Subp. 3. (A), the at-grade bed absorption width must be determined by the relationship between the vertical and horizontal water movement (CLR) based on the following soil conditions:

1. the permeability difference between the original soil absorption area and slower permeability horizons below the original soil absorption area

2. the depth between the original soil absorption area and the change in permeability described in subitem (1); and

3. the land slope

The University of Minnesota has developed recommended at-grade CLRs, which are provided in Table 12.6.

---

### Table 12.9 Septic Tank Capacities for Dwellings (gallons)

<table>
<thead>
<tr>
<th>number of bedrooms</th>
<th>septic tank capacities (gallons)</th>
<th>*Septic tank with garbage disposal and/or pump in basement capacities (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 or less</td>
<td>1,000</td>
<td>1,500</td>
</tr>
<tr>
<td>4 or 5</td>
<td>1,500</td>
<td>2,250</td>
</tr>
<tr>
<td>6 or 7</td>
<td>2,000</td>
<td>3,000</td>
</tr>
<tr>
<td>8 or 9</td>
<td>2,500</td>
<td>3,750</td>
</tr>
</tbody>
</table>

* must include either multiple compartments or multiple tanks and an effluent screen with an alarm
Figure 12.19 above demonstrates various CLR for different soil texture conditions. In both at-grades and mounds the required absorption area based the contour loading rates can be split into several parts. The total CLR must be less then 12 gallons per foot to be considered a Type I system. Figure 12.20 represents a system with a total CLR of eight split between two sections. It is critical if these parts are at different elevations that the design of the pressure distribution system account for the difference.
a. The at-grade absorption width is calculated by dividing the soil loading rate for the upper 12 inches of soil by the CLR. This width cannot exceed 15 feet. The at-grade bed absorption width for slopes of one percent or greater does not include the width of the media necessary to support the upslope side of the pipe.

b. The CLR is also used to size the length of the system. System length is calculated by dividing the design flow by the CLR.

c. The total amount of distribution material should be specified in the design. If drainfield rock is used as the distribution material, the amount of rock is determined by:

i. Determine the area covered by rock by taking the rock layer length multiplied by the rock layer width, adding in an additional foot on the upslope portion to support the pipe.

ii. Determine the volume of rock by taking the area calculated above (i) times the height of rock (one foot) and dividing in half since the shape of the distribution area is triangular. This will give you the amount of rock in square feet. The volume can be converted to tons by multiplying by 0.052. Ten percent of additional rock for constructability should be added in.

d. Design the pressure distribution system. **At-grade systems located on slopes of one percent or greater require only one distribution pipe located on the upslope edge of the distribution media, with the absorption bed width being measured from the distribution pipe to the down slope edge of the media. Multiple distribution pipes may be used to provide even distribution, if necessary, based on site conditions (Chapter 7080.2230, Subp. 3 (C)).**

3. Design the entire at-grade component, including landscaping.

a. The total height of an at-grade is the height of the distribution media plus the cover material. Rock is typically the distribution media in at-grades. For most at-grades the total height of two feet is assumed. **Six inches of loamy or sandy cover material must be installed over the distribution media and be covered by six inches of topsoil borrow.** Cover must extend at least five feet from the ends of the distribution material and be sloped to divert surface water (Chapter 7080.2230, Subp. 3 (G)).
b. To determine the upslope berm, start by selecting an upslope berm multiplier based on the land slope. See Table 12.10. Side slopes must not be steeper than four horizontal units to one vertical unit (Chapter 7080.2230, Subp. 3(G)).

i. If land slope is greater than 1%, the upslope berm width is calculated by taking the at-grade height (two feet) multiplied by the upslope multiplier.

ii. If land slope is less then 1%: due to the absorption width being split equally on both sides, the upslope berm width is calculated by taking half of the absorption width and adding five feet.

c. To determine the downslope berm, start by selecting the downslope berm multiplier based on the land slope. See Table 12.10. The downslope width is then calculated by multiplying the downslope multiplier by the height (two feet) or by adding five feet to the absorption width (calculated in 2a).

i. For slopes greater than 1%, the downslope width equals the larger value calculated above.

ii. If land slope is less than 1%: due to the absorption width being split equally on both sides, the downslope berm width is calculated by taking half of the absorption width and adding five feet.

d. The total at-grade width is then calculated by adding the upslope berm (b) and the downslope berm (c).

e. The total at-grade length is the sum of two times the upslope berm (b) and the downslope berm (c).

f. One vertical inspection pipes of at least 4 inches in diameter must be installed and evenly spaced along the downslope portion of the absorption bed. The inspection pipes must have three-eighths inch or larger perforations spaced vertically no more than six inches apart. Perforations must not exist above the distribution medium. The inspection pipes must extend to the absorption bed/soil interface and must be secured and capped flush with or above finished grade (Chapter 7080.2230, Subp. 3 (H)).

g. The setbacks specified in MN Rules Chapter 7080 for soil subsurface treatment and distribution components apply to at-grade components. The distances are measured from the absorption area.

### Example at-grade design

The following example is an oversimplification for EXAMPLE CALCULATION purposes ONLY!

An at-grade system is being designed for a four-bedroom Class I dwelling with the following characteristics:

- Garbage disposal
- Soil: 38 inches of vertical separation, loam soil with a platy structure, using a CLR of four gallons per foot
- 8% land slope

1. The estimated flow rate is 600 gallons per day.

a. The minimum septic tank capacity is 2,250 with multiple tanks or compartments and an effluent screen and alarm.

### Table 12.10 Bermslope Multipliers

<table>
<thead>
<tr>
<th>% Slope</th>
<th>Upslope Multiplier</th>
<th>Downslope Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>1</td>
<td>3.85</td>
<td>4.17</td>
</tr>
<tr>
<td>2</td>
<td>3.70</td>
<td>4.35</td>
</tr>
<tr>
<td>3</td>
<td>3.57</td>
<td>4.54</td>
</tr>
<tr>
<td>4</td>
<td>3.45</td>
<td>4.76</td>
</tr>
<tr>
<td>5</td>
<td>3.33</td>
<td>5.00</td>
</tr>
<tr>
<td>6</td>
<td>3.23</td>
<td>5.26</td>
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<tr>
<td>7</td>
<td>3.12</td>
<td>5.56</td>
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<tr>
<td>8</td>
<td>3.03</td>
<td>5.88</td>
</tr>
<tr>
<td>9</td>
<td>2.94</td>
<td>6.25</td>
</tr>
<tr>
<td>10</td>
<td>2.86</td>
<td>6.67</td>
</tr>
<tr>
<td>11</td>
<td>2.78</td>
<td>7.14</td>
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<td>12</td>
<td>2.70</td>
<td>7.69</td>
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<td>8.26</td>
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<td>14</td>
<td>2.55</td>
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<td>15</td>
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<td>16</td>
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<td>17</td>
<td>2.35</td>
<td>10.94</td>
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<td>2.29</td>
<td>11.67</td>
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<td>2.23</td>
<td>12.42</td>
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<tr>
<td>20</td>
<td>2.18</td>
<td>13.19</td>
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<td>21</td>
<td>2.13</td>
<td>13.99</td>
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<tr>
<td>22</td>
<td>2.08</td>
<td>14.02</td>
</tr>
<tr>
<td>23</td>
<td>2.03</td>
<td>15.67</td>
</tr>
<tr>
<td>24</td>
<td>1.98</td>
<td>16.54</td>
</tr>
<tr>
<td>25</td>
<td>1.93</td>
<td>17.44</td>
</tr>
</tbody>
</table>

### Table 12.11 “F” Factors for Pipe with Multiple Outlets

<table>
<thead>
<tr>
<th>Number of Perforations</th>
<th>“F” Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.432</td>
</tr>
<tr>
<td>8</td>
<td>0.409</td>
</tr>
<tr>
<td>10</td>
<td>0.396</td>
</tr>
<tr>
<td>12</td>
<td>0.387</td>
</tr>
<tr>
<td>14</td>
<td>0.380</td>
</tr>
<tr>
<td>16</td>
<td>0.376</td>
</tr>
<tr>
<td>18</td>
<td>0.372</td>
</tr>
<tr>
<td>20</td>
<td>0.370</td>
</tr>
<tr>
<td>30</td>
<td>0.360</td>
</tr>
</tbody>
</table>
b. The minimum size pump tank required is 500 gallons.

2. Choose a CLR and find the size of the adsorption bed. The CLR for this site was chosen to be 4 gallons/feet and the soil loading rate is 0.60 gallon per day per square foot. The at-grade absorption width is therefore 0.60 gpd/ft² / 4 gal/ft² = 6.7 feet. System length is 600 gpd / 4 gal/ft = 150 feet. So, the absorption bed would be seven feet by 150 feet. If the necessary length cannot be found on the slope in one continuous section, this system can be broken into smaller pieces using the same dimensions. When the system is divided into pieces, the total CLR should be calculated. The total CLR is the sum of the pieces (see Figure 12.20) which can not be greater then 12 gallons per foot for the entire system.

3. The total amount of distribution material by determining the area covered by rock = (6.7 + 1) feet x 150 feet = 1152 ft²

4. The volume of rock is calculated by taking 1152 ft² x 1 foot / 2 = 576 ft³, dividing in half as the shape of the distribution area is triangular. Multiplying by 0.052 and adding in 10% for constructability yields 33 tons of rock.

5. Designing the pressure distribution system with one pipe results in a pipe length of 150 feet – 2 feet (one foot from each end) = 148 feet. A three foot spacing and ¼ perforations are selected, which yields 50 orifices and 37 gallons per minute. In order to achieve even distribution, this system must be center-fed with two-inch pipe. There must be a clean out provided for the lateral.

6. Design the entire at-grade component as shown in Figure 12.21.
a. The total height is two feet.
b. To determine the upslope berm, start by selecting an upslope berm multiplier of 3.03. Since the land slope is greater than 1%, the upslope berm width is 2 feet x 3.03 = 6.1 feet.
c. To determine the downslope berm, start by selecting the downslope berm multiplier of 5.85. The downslope width is then calculated by taking 5.85 x 2 feet = 11.7 feet or 6.7 + 5 feet = 11.7.
d. The total at-grade width is 6.1 + 11.7 = 17.8.
e. The total at-grade length is the sum of (2 x 6.1ft) + 150ft = 162.2 feet.
f. Specify one, four inch inspection ports.
g. Assure that the layout of the system meets all setbacks.

Mound Systems

Mound Systems are defined in Chapter 7080.1100, Subp. 50, as a soil treatment and dispersal system designed and installed such that all of the infiltrative surface is installed above grade, using clean sand between the bottom of the infiltrative surface and the original ground elevation, utilizing pressure distribution and capped with suitable soil material to stabilize the surface and encourage vegetative growth. A sewage treatment mound is nothing more than a seepage bed elevated by clean sand fill to provide adequate separation between where sewage effluent is applied and a limiting soil layer as shown in Figure 12.22. Mounds were developed in the early 1970s to overcome soil and site conditions, which limit the use of trenches and beds (Converse et al., 1977). Limiting conditions include high water tables, shallow soil depth to bedrock, slowly permeable soil, or soil too coarse for treatment.
A mound system is a two-stage process involving both effluent treatment and dispersal. Treatment is accomplished predominately by physical and biochemical processes within the clean sand material and native soil. The physical characteristics of the influent wastewater, influent loading rate temperature, and the nature of the receiving fill material and in situ soil affect these processes.

Physical entrapment, increased retention time, and conversion of pollutants in the effluent are important treatment objectives accomplished under unsaturated conditions. Pathogens contained in the effluent are eventually deactivated through filtering, retention, and adsorption by the fill material. In addition, many pollutants are converted to other chemical forms by oxidation processes.

The mound system addresses high water table conditions by elevating the infiltration bed to achieve the needed vertical separation. By using uniform distribution and adequate vertical separation in the selected sand media, vertical unsaturated flow is maintained,
thus ensuring the maximum treatment permitted by this technology. On sites with slowly permeable soils, the mound system helps assure a known level of effluent treatment before effluent is discharged to the native. These soils are subject to severe damage from smearing and compaction, especially during the construction of conventional systems, 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 soil treatment systems to provide adequate infiltration area. For these sites, mound systems provide the following advantages:

- 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.
- The bio-mat that develops at the bottom of the media/sand 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, yet the total mound area is probably larger than it would be for a conventional soil treatment 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. Fifteen mound systems in Wisconsin were found to have a total nitrogen reduction of at least 55% from the pretreatment effluent to mound toe effluent (Blasing and Converse, 2004). Sufficient numbers of mounds have been installed in Minnesota and elsewhere to prove that the mound treatment system is a Type I technology. There are more than 50,000 single-family mounds successfully treating sewage in Minnesota.

Dispersal is primarily affected by the depth of the unsaturated receiving soils, their hydraulic conductivity, land slope, and the area available for dispersal. The mound consists of sand material, an absorption bed, and cover material. Effluent is dispersed into the absorption bed, where it flows through the fill material and undergoes biological, chemical, and physical treatment. It then passes into the underlying soil for further treatment and dispersal to the environment as shown in Figure X (D-30 absorption width).

Clean sand is required for mounds to effectively treat and disperse effluent. Clean sand is defined in Table 12.12 (7080.1100, Subp. 16).

Cover material consists of material that provides erosion protection, a barrier to excess precipitation infiltration, and allows gas exchange. The native soil serves, in combination with the fill, as treatment media, and it also disperses the treated effluent.

### Locating Mounds

Suitable soil provides excellent treatment of sewage tank effluent, and the natural topsoil should be utilized for treatment wherever possible. However, some locations do not have soils or soil profiles suitable for treatment of sewage using below-grade or at-grade systems. For instance, some soils do not have the ability to accept effluent, an ability that is necessary for the proper operation of the soil treatment system. In other soils, there is seasonal saturation at depths closer than three feet to the ground surface, such that adequate vertical separation of the soil treatment system is not possible under “natural” conditions. Soils with a hardpan layer that restricts down-

<table>
<thead>
<tr>
<th>Sieve Number</th>
<th>Sieve Size (mm)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4.75</td>
<td>95 to 100</td>
</tr>
<tr>
<td>8</td>
<td>2.0</td>
<td>80 to 100</td>
</tr>
<tr>
<td>10</td>
<td>0.85</td>
<td>0 to 100</td>
</tr>
<tr>
<td>40</td>
<td>0.425</td>
<td>0 to 100</td>
</tr>
<tr>
<td>60</td>
<td>0.212</td>
<td>0 to 40</td>
</tr>
<tr>
<td>200</td>
<td>0.075</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>
ward movement of liquid, or with fractured or permeable bedrock, present problems for adequate treatment and/or acceptance of septic tank effluent.

Mounds should be located on slopes whenever possible, because as a slope increases, the ability of the topsoil to accept and treat effluent increases. A sewage treatment mound will operate more effectively if it is relatively long and narrow as shown in Figure 23. Mounds are designed with CLR of up to 12 gallons per foot resulting in a ten-foot-wide absorption beds. When difficult soil conditions are present, the CLR should be reduced to narrow the beds and lengthen the mound.

The upper 12 inches of the original soil absorption area can be any soil texture as long as it has a mound absorption ratio of greater than zero on 7080.2150 subpart 3 item E Tables IX or IXa.

Please see Table IX in the Forms section.

### TABLE 12.13 Loading Rates for Determining Bottom Absorption Area for Trenches and Seepage Beds for Effluent Treatment Level C and Absorption Ratios for Determining Mound Absorption Areas Using Percolation Tests

<table>
<thead>
<tr>
<th>percolation rate in minutes per inch (mpi)</th>
<th>gallons per day per square foot or trench bottom</th>
<th>mound absorption ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>faster than 0.1*</td>
<td>* 0.0</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5*</td>
<td>* 1.20</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5 (soil texture groups 3 and 5)</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>6 to 15</td>
<td>0.78</td>
<td>1.3</td>
</tr>
<tr>
<td>16 to 30</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>31 to 45</td>
<td>0.5</td>
<td>2.4</td>
</tr>
<tr>
<td>46 to 60</td>
<td>0.45</td>
<td>2.6</td>
</tr>
<tr>
<td>61 to 120**</td>
<td>0.24</td>
<td>5</td>
</tr>
<tr>
<td>slower than 120</td>
<td>0.00</td>
<td>–</td>
</tr>
</tbody>
</table>

* See part 7080.2260 for requirements for these soils.

** Exceeds allowable percolation rates for at-grade systems.

The upper 12 inches of the absorption area must also be above the periodically saturated soil or bedrock (Chapter 7080.2220, Subp. 2 (A)). On slopes of one percent or greater and where the original soil absorption area sizing classification is eleven, 13, or 15 in Table 12.13. **Mounds must never be located in swales or draws where the radius of curvature of the contour lines is less than 50 feet. On slopes of one percent or greater and where the original soil mound absorption is 5.0 or greater in Table IX or IXa in part 7080.2150, subpart 3, item E, mounds must not be located where the ground surface contour lines that lie directly below the long axis of the distribution media bed represent a swale or draw, unless the contour lines have a radius of curvature greater than 100 feet (7080.2220, Subp. 2 (C)).
It is recommended that mounds should be trapezoidal in shape as it lies on the slope, narrower at the top and wider at the bottom, as shown in Figure 12.24. This shape can be modified to fit with landscaping plans if necessary, as long as adequate absorption area is provided for the sewage effluent. The total lawn area for the mound will depend on the size of the bed, the height of the mound, and the side slopes of the mound landscaping. In any case, the side slopes should be no steeper than a 3:1. The “rectangular” mound, with parallel upslope and downslope sides, is the most commonly used shape, since it is the easiest to construct, but several shapes are possible, including C or S curves. While the mound location depends upon soil suitability, every effort should be made to fit the mound into the landscape plan. Mounds can be used as privacy berms or to highlight a certain portion of the outdoor living area. While the mound must be functional for sewage treatment, the location and shape should also be functional in the landscape plan.

According to Minnesota Rules Chapter 7080.215, setbacks shall be measured from the absorption area. “Absorption area” means the area on original soil below a mound that is designed to absorb sewage tank effluent. The absorption area is not the total footprint of the mound but only the area that was designed to accept sewage. As can be seen in Figure 12.26, on slopes greater than 1%, the sewage will travel vertically and horizontally downslope, in the sand on the native soil. Therefore, on the upslope edge, the setback should be measured from the absorption bed, and on the downslope edge, from the clean sand layer, which extends past the absorption bed to the required absorption area. On flat sites, the effluent will move equally in both directions; therefore, the absorption width is split equally on each side as shown in Figure 12.25.
**General Specifications**

A vertical separation of at least three feet is required between the bottom of the absorption bed and any restricting layer in order to maintain aerobic conditions and treat the effluent. When aerobic conditions exist in the clean sand, the long-term acceptance rate will be 1.2 gallons per day per square foot. If the depth to the restricting layer is inadequate or the absorption bed is too wide, anaerobic conditions may exist and cause a much slower acceptance rate. The possibility of anaerobic conditions occurring in the clean sand, and subsequent hydraulic failure, is a major design consideration when mounds larger than those required for single-family residences are required for the system. Figure 12.27 shows the recommended design and construction techniques for clean sand in the system. MN Rules Chapter 7080 does allow the sand to just come to the bottom of the distribution media as shown in Figure 12.27, though UMN OSTP does not recommend this technique.
Mound absorption beds are being constructed with alternative distribution media, such as chambers or gravelless pipe. The distribution media in a mound has historically been drainfield rock, but other media may be approved for use in under the product registration process.

**Mound Design**

Design of a mound system includes the following three steps, which are detailed below:

1. **Calculate design wastewater flow, septic tanks, and dosing tanks.** The estimated flow rate is determined using Table 12.14 unless measure flow rates are available for other establishments. (Measured values are multiplied by a safety factor of 1.5 to determine the flow rate.) With a Class I residence, the estimated water use is equal to 150 gallons per day (gpd) per bedroom. This assumes an occupancy of two people per bedroom, each using 75 gallons per day. The footnote in Table 12.14 suggests a classification for residences according to size and number of water-using appliances. While the individuals who occupy a residence use the water, the number of bedrooms is still considered a good index of the potential water use. See Section 5: Source for a more detailed discussion of flow determination.
Section 12: Soil Treatment Systems

**TABLE 12.14 Estimated Sewage Flows in Gallons per Day**

<table>
<thead>
<tr>
<th>Number of Bedrooms</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>300</td>
<td>225</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>450</td>
<td>300</td>
<td>218</td>
<td>60% of the values in the Class I, II, or III columns.</td>
</tr>
<tr>
<td>4</td>
<td>600</td>
<td>375</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>750</td>
<td>450</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>900</td>
<td>525</td>
<td>332</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1050</td>
<td>600</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
<td>675</td>
<td>408</td>
<td></td>
</tr>
</tbody>
</table>

Class I: The total floor area of the residence is over 800 square feet per bedroom or more than two of the following water-using appliances are installed: dishwasher, automatic clothes washer, water softener, garbage disposal, self-cleaning furnace.

Class II: The total floor area of the residence is between 500 and 800 square feet per bedroom, and no more than two water-using appliances are installed.

Class III: The total floor area of the residence is less than 500 square feet per bedroom, and no more than two water-using appliances are installed. Use this estimate only when designing a system with flow control, such as trenches and a holding tank, or a timer to dose the system at a designed volume.

Class IV: Class I, II, or III home, but with no toilet wastes discharged into the system.

a. Determine the required septic tank capacity, compartments, effluent filter, and alarm based on bedrooms and use of garbage disposal and pump in the basement as shown in Table 12.15. For more information on septic tanks, see Section 7.

**TABLE 12.15 Septic Tank Capacities for Dwellings (gallons)**

<table>
<thead>
<tr>
<th>number of bedrooms</th>
<th>septic tank capacities (gallons)</th>
<th>*Septic tank with garbage disposal and/or pump in basement capacities (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 or less</td>
<td>1,000</td>
<td>1,500</td>
</tr>
<tr>
<td>4 or 5</td>
<td>1,500</td>
<td>2,250</td>
</tr>
<tr>
<td>6 or 7</td>
<td>2,000</td>
<td>3,000</td>
</tr>
<tr>
<td>8 or 9</td>
<td>2,500</td>
<td>3,750</td>
</tr>
</tbody>
</table>

* must include either multiple compartments or multiple tanks and an effluent screen with an alarm.

b. Determine the minimum size pump tank required. See Section 9 for more information on pump tanks.

2. **Design the mound distribution media system bed and pressure distribution system.** Determine the area, length, and width of the bed. The mound distribution media bed area should be as long and narrow as practical. The bed must completely encase the top and sides of the distribution pipes to a depth of at least one inch above the pipe. The bed must have at least six inches of storage below the pipe. The sidewalls of the mound distribution media bed must be as vertical as practical and not intentionally sloped. The top of the bed must be level in all directions and on slopes of one percent or greater; the upslope edge of the bed must be placed on the contour.
a. The mound distribution media bed area consists of bottom area only and is calculated by multiplying the estimated flow rate by 1.2 gpd/square foot square feet per gallon per days as is shown in Table 12.16.

b. The width of the bed of a mound is the width of soil under the sand layer that receives effluent (Figure 12.28) where the soil receiving effluent must have the capability to absorb this effluent; otherwise, berm toe surfacing will occur. Mound absorption media bed widths must be determined by the relationship between the vertical and horizontal water movement (CLR) based on the following soil conditions:

Figure 12.28  Effluent Movement Through a Mound Absorption Width

1. the permeability difference between the original soil absorption area and slower permeability horizons below the original soil absorption area;
2. the depth between the original soil absorption area and the change in permeability described in (1); and
3. the land slope.

The mound bed width is calculated by dividing the CLR by 1.2 gal/square foot. The width of the bed is designated as W in Figure 12.29. A CLR of 12 is typically chosen for sites which do not have soil layers that would cause likely lateral movement of effluent and results in the maximum bed width of ten feet. On challenging sites where lateral movement is a concern, this width should be reduced. This will reduce the CLR. To achieve sufficient bed width, it is occasionally necessary to use a narrower and longer length.
c. The mound length is calculated by taking the area and dividing by the width.

d. The total amount of distribution media should be specified in the design. If drain- 
field rock is used as the distribution media the amount of rock is determined by 
taking the area calculated above in (a) times the height of rock (one foot). This will 
give you the amount of rock in square feet. The volume can be converted to tons 
by multiplying by 0.052. 10% for constructability should be added in.

e. Design the pressure distribution system. Mound systems can not have spacing on 
laterals or perforations greater then three feet. Cleanouts are required on the pres- 
sure distribution laterals. See Section 11: Distribution of Effluent for more infor-
mation on the design of pressure distribution systems.

3. Determine the absorption area of the mound. Adequate absorption area is essential 
to the successful operation of a mound system. The required absorption area depends 
upon the allowable loading rate of the soil under the clean sand layer of the mound. 
The allowable loading rate depends upon soil texture, structure, and the percolation 
rate of the soil in contact with the clean sand layer of the mound. Allowable soil
loading rates for various soil textures and structures are presented in Table 12.16 and Tables IX and XII in the Forms Section. The distribution media bed is sized on the basis of 1.2 gal/square foot of effluent per day, so unless the soil under the mound has the same properties and absorption capability as clean sand, the effluent must be spread out over additional soil area.

Another way to express the absorption width requirement is to use the absorption width ratio, which is defined as the area of soil required to absorb the effluent percolating downward from one square foot of the distribution media layer. As long as sufficient mound width is available so that all of the liquid is accepted into the soil and pressure distribution is used, berm toe surfacing should not occur. One of the major causes of berm toe surfacing has been inadequate down slope berm widths. Another cause is compaction of the soil, which changes its ability to accept effluent.

The required original soil absorption width for mounds constructed on slopes from zero to one percent must be centered under the mound distribution media bed width. with the absorption width is equal to the sum of the upslope berm width, the distribution bed width, and the downslope berm width. The required original soil absorption width for mounds constructed on slopes greater than 1% must be measured downslope from the upslope edge of the mound distribution media bed in the direction of the original land slope and perpendicular to the original contours. On ground sloping more than 1%, all of the effluent is assumed to move down slope and absorption width the rock layer width plus the down slope berm width (Table IX and IXa).

<table>
<thead>
<tr>
<th>percolation rate in minutes per inch (mpi)</th>
<th>gallons per day per square foot or trench bottom</th>
<th>mound absorption ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>faster than 0.1*</td>
<td>* 0.0</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5*</td>
<td>* 1.20</td>
<td>1</td>
</tr>
<tr>
<td>0.1 to 5* (soil texture groups 3 and 5)</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>6 to 15</td>
<td>0.78</td>
<td>1.3</td>
</tr>
<tr>
<td>16 to 30</td>
<td>0.6</td>
<td>2</td>
</tr>
<tr>
<td>31 to 45</td>
<td>0.5</td>
<td>2.4</td>
</tr>
<tr>
<td>46 to 60</td>
<td>0.45</td>
<td>2.6</td>
</tr>
<tr>
<td>61 to 120**</td>
<td>0.24</td>
<td>5</td>
</tr>
<tr>
<td>slower than 120</td>
<td>0.00</td>
<td>–</td>
</tr>
</tbody>
</table>

* See part 7080.2260 for requirements for these soils.
** Exceeds allowable percolation rates for at-grade systems.

The soil absorption width is calculated by multiplying the mound distribution media bed width by the absorption ratio. The absorption ratio of the upper 12 inches of soil in the proposed absorption area can be determined according to Table 12.16.

4. Landscaping and finishing of the mound. The side slopes on the mound must not be steeper than three horizontal units to one vertical unit (3:1) and shall extend beyond the required original soil absorption area, if necessary. A slope ratio of three
indicates three feet horizontal to one foot vertical, and is equivalent to a slope of 33 percent. A side slope ratio of 4:1 (four feet horizontal, one foot vertical) is recommended, particularly for mounds constructed on soils having a percolation rate of 61 to 120 mpi, in order to expose sufficient soil to effluent. A 4:1 berm slope ratio or flatter, however, is desirable for landscaping and maintenance. A slope ratio of four is a flatter slope, and is equivalent to a 25 percent slope.

<table>
<thead>
<tr>
<th>Land % Slope</th>
<th>Upslope Multipliers for Common Slope Ratios</th>
<th>Land % Slope</th>
<th>Downslope Multipliers for Common Slope Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3:1</td>
<td>4:1</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>3.00</td>
<td>4.00</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2.91</td>
<td>3.85</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2.83</td>
<td>3.70</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2.75</td>
<td>3.57</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2.68</td>
<td>3.45</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>2.61</td>
<td>3.33</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>2.54</td>
<td>3.23</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>2.48</td>
<td>3.12</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>2.42</td>
<td>3.03</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>2.36</td>
<td>2.94</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>2.31</td>
<td>2.86</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>2.25</td>
<td>2.78</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>2.21</td>
<td>2.70</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>2.17</td>
<td>2.62</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>2.13</td>
<td>2.55</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>2.09</td>
<td>2.48</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>2.06</td>
<td>2.41</td>
<td>16</td>
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<tr>
<td>17</td>
<td>2.03</td>
<td>2.35</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>2.00</td>
<td>2.29</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>1.97</td>
<td>2.23</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td>1.95</td>
<td>2.18</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>1.93</td>
<td>2.13</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>1.91</td>
<td>2.08</td>
<td>22</td>
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<tr>
<td>23</td>
<td>1.89</td>
<td>2.03</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>1.87</td>
<td>1.98</td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td>1.85</td>
<td>1.93</td>
<td>25</td>
</tr>
</tbody>
</table>
Table 12.17 presents multipliers used to determine upslope and downslope berm widths. It will also allow calculation of downslope berm width for distribution media bed widths narrower than ten feet. A minimum of six inches of sandy to loamy soil material must be placed on the top of the mound distribution media bed and sloped upwards toward the center of the mound a minimum of one horizontal unit to one vertical unit. A minimum of six inches of topsoil borrow must be placed over the entire mound.

a. Calculate the downslope absorption width (area beyond distribution media bed required to be covered with clean sand).
   - On slopes greater than 1%, the downslope absorption width is equal to the absorption width calculated above (in 3) minus the distribution media bed width.
   - On slopes less than 1%, the downslope absorption width is split equally on both sides of the mound and is calculated by taking the absorption width minus the distribution media bed width and dividing by two.

b. To determine the upslope berm:
   - Determine the height of the mound at the upslope by the depth of clean sand to meet separation requirements, plus the height of distribution material (typically one foot), plus the amount of cover material (typically one foot). The height of the mound above the original soil at the upper edge of the distribution media layer is designated as $h_1$ in Figure 12.26. The dimension $h_1$ at a minimum is usually three feet, consisting of one foot of clean sand, one foot of distribution media, and one foot of soil cover over the distribution media. Select an upslope multiplier based on slope (a 4:1 multiplier is recommended).
   - Calculate the upslope width by taking the height of the mound times the multiplier. Dimension $d_1$ is the upslope berm width.

c. To determine the downslope berm:
   - To determine the height of the mound at the downslope, you need to determine the amount of sand at the downslope edge of the distribution media bed, which is greater if there has been a drop in elevation over the width. This depth is calculated by taking the height at the upslope and adding in the distribution media bed width times the slope across the width. Then the total height is equal to depth of clean sand at the downslope portion of the distribution media bed, plus the height of distribution material (typically one foot), plus the amount of cover material (typically one foot). The height at the downslope edge of the distribution bed is designated as $h_2$. On level ground, $h_2$ equals $h_1$, but on sloping ground, $h_2$ is greater than $h_1$ because the top of the sand layer and the bottom of the distribution bed layer must be level.
   - Selected an downslope multiplier based on slope (a 4:1 multiplier is recommended).
   - Calculate the downslope berm by taking the height of the mound times the multiplier. Dimension $t_2$ is the downslope berm width. As shown in Figure 12.26, on level ground, $t_1$ equals $t_2$. On sloping ground, $t_2$ becomes longer than $t_1$ when the slope ratio is the same for both berms.
d. The total width is calculated by adding the upslope berm, the distribution media bed width, and the downslope berm and is shown on Figure 12.26.

e. The total length of the mound is found by adding the upslope berm, the distribution media bed length, and the upslope berm. The length can vary depending upon where it is measured as shown in Figure 12.24 in the plan view. The mound shape can be installed as a trapezoid. The berms located at the short ends of the distribution bed are necessary for mound construction, but the soil area under these berms is not considered part of the total absorption area.

f. A vertical inspection pipe at least 4 inches in diameter must be installed and secured at the distribution media and sand interface. The inspection pipe must have three-eighths inch or larger perforations spaced vertically no more than six inches apart. At least two perforations must be located in the distribution medium. The perforation must not be located above the permeable synthetic fabric, if used. The inspection pipe must extend to the bottom of the distribution medium, be secured, and be capped, flush with or above finished grade.

Example mound system design

The following example is an oversimplification for EXAMPLE CALCULATION purposes ONLY as shown in Figure 12.30! A mound system is being designed for a four-bedroom Class I home with the following characteristics:

- No garbage disposal or pump in the basement
- The soil has a sandy clay loam texture with moderate structure. Soil with redoximorphic features is located at the two-foot depth.
- 8% land slope

1. The estimated flow rate is 600 gallons per day.
   a. The minimum septic tank capacity is 1,500.
   b. The minimum size pump tank is 500 gallons.

2. The CLR for this site was chosen to be 12 gallons/feet, and the absorption ratio is 2.6 square feet per gallon per day. To determine the area of distribution media bed, divide the flow rate by the sand soil loading rate:
   a. \[ \frac{600 \text{ gpd}}{1.2 \text{ gpd/ft}^2} = 498 \text{ft}^2 \text{ approximately } 500 \text{ft}^2 \]
   b. Distribution media bed width = \[ \frac{12 \text{ gal/ft}}{1.2 \text{ gpd/ft}^2} = 10 \text{ feet} \]
   c. Distribution media bed length = \[ \frac{500 \text{ft}^2}{10 \text{ feet}} = 50 \]
   d. If rock is used as the distribution media, the rock must be at least six inches deep below the distribution pipe and two inches above. Find the total amount of distribution material by determining the area covered by rock: \[ 1 \text{ foot} \times 500 \text{ ft}^2 = 500 \text{ ft}^3, \text{ multiplying by } 0.052, \text{ and adding in } 10\% \text{ for constructability yields } 29 \text{ tons of rock.} \]

   e. Designing the pressure distribution system with one lateral results in a pipe length of 50 feet – 2 feet (1 foot from each end) = 48 feet. A three foot spacing and \( \frac{3}{4} \) perforations are selected, which yields 51 orifices and 38 gallons per minute. In order to achieve even distribution this system can be fed with a manifold either in the center or at the end with 1.5 inch pipe. There must be cleanouts provided for the laterals.
3. Landscaping and finishing the mound.
   a. Determine the total absorption width by taking the absorption ratio times the distribution media bed width = 2.6 x 10 feet = 26 feet.
   b. On a landslope greater than 1%, only the width of the rock layer and the downslope berm are included in determining the distribution bed width. So, the width of the downslope berm past the distribution bed is: 26 - 10 = 16 feet.
   c. Determine upslope berm:
      i. Determine height of mound along upslope
         1. Depth of sand = 3 feet – distance to restricting layer = 3 feet – 2 feet = 1 foot
         2. Total height = depth of sand (fi) + depth of distribution media + cover depth = 1 foot + 1 foot + 1 foot = 3 feet
      ii. Select upslope berm multiplier based on slope of 3.03 and 4:1 sideslopes. Upslope width = upslope berm multiplier (fi) x height (fi2) = 2.42 x 3 feet = 9.1 feet
   d. Determine downslope berm:
      i. Determine height of the mound along downslope
         1. Drop in elevation = rock layer width x slope = 10 x 0.08 = 0.8 feet
         2. Downslope mound height = 3 feet + 0.8 feet = 3.8 feet
         3. Select downslope berm multiples of 5.88 based on slope and 4:1 sideslopes = 5.88 x 3.8 feet = 22.3 feet
      e. Total mound width is the sum of upslope + distribution media bed width + downslope width = 9.1 + 10 + 22.3 = 41.4 feet.
   f. Total mound length is the sum of two times the upslope width + length = 2 x 9.1 + 50 = 68.2 feet.
   g. Specify an inspection pipe of at least 4 inches with a method for securing specified.

**Type III Above-Ground**

A Type I above-ground systems must have 12 inches of natural unsaturated soil without bedrock with approval permeability. If a system is being installed on a site where the soil has been impacted or where 12 inches are not available, the system would be classified as a Type III system. It is recommended that the design of these systems use CLRs less than 12 gallons per foot.

If two above-ground systems are going to be placed side by side, the total absorption width of each system must be installed. The resulting system will be a Type III because the site will have a CLR greater than 12 gallons per foot. The use of two ten-foot wide distribution media beds installed side by side is not recommended particularly if the soil has a large percentage of clay or has a depth of less than 24 inches of natural unsaturated soil due to issues of groundwater mounding and acceptance of the effluent. If two absorption areas are installed side by side, one downslope from the other, the distribution media beds should be separated by at least four feet of clean sand. The reason for this requirement is to provide adequate absorption width and a sufficient depth of permeable soil to allow the liquid to move laterally.
**Box Mounds**

A box mound is a vertical sidewall mound design based on the perceived over-design of the absorption area and the additional unnecessary area needed to accommodate mound side-slopes. The design of these systems has two defining characteristics: the addition of pretreatment to decrease the size requirement and the corresponding reduction in needed landscaping area. If pretreatment is installed before a mound system, much of the treatment requirement will not occur in the mound. In this design, the mound will primarily serve as dispersal mechanism. When a box mound is constructed, the landscaping berms of 3:1 or 4:1 can be cut off, and the remaining area is the absorption area. Hybrid systems have been installed which use both of these options. Care should be taken so that the treated effluent is still provided sufficient area to disperse into the soil. These systems would be classified as a Type III or V, depending on the design.

**Replacing Mounds**

If the distribution media bed of the mound is no longer accepting effluent at an acceptable rate, can the old distribution media bed be removed and replaced? The answer is maybe, depending on the reason for the malfunction. If the ponding were due to dirty sand, then a good portion of the sand would need to be removed and added back. Rather than doing this, it may be better to construct a new mound on the second site. If the excessive ponding occurred due to dirty rock or dirty sewage, then a few inches of the plugged sand should be removed and replaced when the new distribution media bed is installed.

If a new mound is going to be placed in close proximity to an existing mound that is longer performing, it is recommended that the absorption width of the new mound be on natural soil as shown in Figure 12.31.

**Installing Soil Treatment Systems (STA)**

**General Soil Treatment Installation Principles**

1. **Keep the installation dry (KID)**

Compaction and smearing are more likely to occur with installations on sites with high water tables and soil textures with high clay content; therefore, the soil surface must be treated carefully. The surface should be maintained in as natural condition as possible because soils that are wet at the time of construction are more likely to have problems with acceptance of wastewater due to compaction and smearing. Compaction is the compression of soil particles, which closes the pore spaces. Smearing is spreading and smoothing soil particles by sliding pressure.

Excavation is only allowed when the soil moisture content is at or less than the plastic limit and is not frozen or freezing. The exposed areas must be immediately covered with media or the designed coverage materials. If the areas are exposed to direct rainfall, they must be allowed to dry and must be re-prepared accordingly.

The soil surface should be treated very carefully. It needs to be maintained in as natural
SECTION 12: Soil Treatment Systems ■ 12-51

condition as possible. This means that the system be constructed only when the soil is dry enough to work. If the soil is wetter than the plastic limit, or if considerable construction activity has caused compaction, then the ability of the soil to transmit liquid will have been seriously reduced due to compaction and smearing. The plastic limit is the soil moisture content below which the soil may be manipulated for purposes of installing a soil treatment system, and above which manipulation will cause compaction. **In 7080.1100, Subp. 60 the plastic limit is defined as the soil moisture content above which manipulation will cause compaction or smearing.**

Check the moisture content of the soil to the depth you will be digging or eight inches for an above-ground system. If a fragment of soil can easily be rolled into a wire 1/8 inch in diameter, the moisture content is above plastic limit. If the soil is dry enough to be friable and falls apart when rolling it into wire, the moisture content is below the limit and soil may be manipulated. The standard method of determining the plastic limit is specified American Society for Testing and Materials, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D4318 (2005).

During repair and replacement of system components on sites with existing dwellings, construction can damage landscaping and driveways, particularly if the construction occurs in wet conditions. This may result in unsightly tire ruts and compaction. For general site construction, soil must be dry enough so equipment for site preparation, installation, and materials handling can safely and effectively access and operate on the site.

The higher the clay content of the soil, the greater the likelihood that the soil will hold water. Soils that are saturated, meaning all the pore spaces are filled with water, or nearly saturated have lower soil strength, and they will compact and smear more than the same soil under dry conditions. To limit impacts to the natural soil structure, excavation is only advisable when the soil is below the plastic limit and when the soil is dry enough to be worked. If considerable construction activity has caused compaction, then the ability of the soil to transmit liquid will be seriously reduced and failure is more likely.

**2. Keep the installation natural (KIN)**

All excavation into the absorption area, or surface preparation of the upper 12 inches of absorption area, must be done so that the original soil structure is exposed in an unsmeared and uncompacted condition. Excavation equipment or other vehicles must not be driven on the excavated or prepared absorption area. Foot traffic on these areas must be minimized and not cause undue compaction. Care should be taken when media is being placed to avoid compaction due to the heavy weight of some distribution and treatment materials.

Maintaining natural soil structure is critical when installing the STA. All excavation to the infiltrative surface or surface preparation must be done so that the original soil structure is not smeared or compacted. Generally, the soil located at or near the soil surface is the best soil for treatment and dispersal due to its structure and oxygen-transfer potential. In addition, evapotranspiration and natural biological activity is greatest near the surface. Compacted soil has reduced void space; therefore, compacted sites are less permeable and are more likely to have problems with water movement.

To limit compaction in the STA, do not drive excavation equipment or other vehicles on the infiltrative surface. Foot traffic on these areas must be minimized to reduce the risk of compaction. Raking sidewalls of trenches and beds may help expose the natural soil structure which may have been slightly smeared by the bucket. Place media working upslope of the
system with low ground pressure to avoid compaction due to the heavy weight of distribution and treatment materials. This distributes the weight over as large an area as possible.

**Installing Systems in Cold Climates**

In cold climates, installers must pay special attention to several issues to ensure proper system installation and performance. Special care must be taken with placement of components to ensure all piping drains. Shallow pipes, tanks, and pretreatment components may require insulation. The soil infiltrative surface should not be frozen when the system is being constructed, as smearing and construction problems may result due to the large clumps of soil. These large clumps should not be used to backfill around system components as they can cause settling and result in improper support. Due to the reduced void space, freezing issues are more common in compacted soil. In areas of known compaction such as driveways, insulation should be installed over or around components. See Section 8 for insulation methods for piping and tanks. STAs installed late in the fall may need protection from frost by covering the area with loose straw or mulch.

Sheet insulation should never be placed permanently above a STA as it will limit oxygen transfer and evaporation.

**3. Keep the installation level (KIL)**

The top and bottom of the distribution medium must be level in all directions. Sidewalls must be as vertical as practical and not intentionally sloped.

Several of the components in an onsite wastewater treatment system must be installed level for the system to properly treat and disperse wastewater:

- Tanks must be installed level to achieve the necessary treatment and drainage out of the tanks.
- Advanced treatment systems must be level to achieve even distribution and drainage out of the component.

In the STA:

1. In gravity systems, the distribution device and bottom of the distribution medium should be level in all directions to achieve even distribution of effluent. Along the length of a trench or bed, the maximum recommended difference in elevation is 1 inch per 25 feet. The difference in elevation across an entire level system should be no more than 2 inches. This is to ensure that, for a system at a level site, the entire system will be completely loaded before any back-up occurs into the septic tank.

2. In pressure distribution systems, the bottom of distribution media and piping must both be installed level to achieve even distribution across the site. A maximum of \( \frac{1}{2} \)-inch across the entire pressure system network is recommended. Verify the maximum allowable difference in your local code.

**4. Keep the installation shallow (KIS)**

Generally the soil located at or near the soil surface is the best soil for treatment and dispersal due to its structure and oxygen transfer. In addition, evapotranspiration and natural biotic activity is greatest near the surface.

On sloping sites, you must identify the elevation(s) of the bottom of the trench or bed in relation to the limiting condition before construction begins. These elevations are then used throughout the excavation of the trenches to ensure the required separation is maintained.
If tracked equipment is used, you need a pad in order to dig a level excavation. Wheeled backhoes can self-level through the use of stabilizers. The construction techniques for these sites are greatly impacted by the depth of soil available for excavation. If the soil is deep, you can make a bench by cutting out soil on the upslope of the first trench and placing the excavated material downslope to create a bench for the second trench excavation.

**Cover, Topsoil and Vegetation Requirements**

Whenever above-ground systems are located on slopes, a diversion must be constructed immediately upslope from the above-ground system to intercept and divert runoff.

A minimum of six inches of topsoil borrow should be placed over all soil treatment systems. In Minnesota Rules Chapter 7080.1100, Subp. 88, topsoil borrow means a loamy soil material having:

- less than five percent material larger than two millimeters, no. 10 sieve
- no material larger than 2.5 centimeters
- a moist color value of 3.5 or less
- adequate nutrients and pH to sustain healthy plant growth

The soil cover must be placed over the system with minimal compaction.

A close-growing, vigorous vegetative cover must be established over the soil treatment and dispersal system; other vegetation establishment should begin immediately after the placement of the topsoil borrow. The soil treatment and dispersal system must be protected from erosion and excessive frost until a vegetative cover is established. The vegetative cover established must not interfere with the hydraulic performance of the system and should provide adequate frost and erosion protection. Trees, shrubs, deep-rooted plants, or hydrophilic plants should not be planted on the system. See Landscaping Septic Systems (AG-FO-6986) for more information about plantings on soil treatment systems.

It is good to determine before installation begins who is responsible (in the contract) for the seeding of the system. Either the property owner or the contractor can seed the site, but the property owner will be responsible for assuring that vegetation is established.

If the system is installed late in the year, frost and erosion protection may be needed throughout the first winter.

**Trench and Seepage Bed Installation**

Care should be taken when a trench or bed absorption area is being constructed to assure the natural structure of the site is maintained. Trenches or seepage beds must be backfilled and crowned above finished grade to allow for settling. The top six inches of the backfill must have the same texture as the adjacent soil. The minimum depth of soil cover over the distribution medium, including topsoil borrow, is 12 inches. The top six inches of the backfill must have the same texture as the adjacent soil and be considered topsoil borrow.

When excavating the trench or bed infiltrative surface minimize foot traffic on infiltrative surface and avoid equipment traffic on or over infiltrative surface. During the planning process, you will determine the equipment or method to use for the excavation. When constructing the trench/bed bottom, be sure it is graded to the specifications in the design. Excavate the trench or bed to the correct bottom elevation(s) taking care not to smear the infiltrative surface. If the infiltrative surface is smeared, loosen it with the use of a rake or similar device. The infiltration surface can be left rough and should not be raked smooth.
If rock trenches are being installed: Table 12.18 shows the depth that the soil replaced by the trench rock would be if it were spread over and between the trenches. For example, if 30-inch trenches are installed on eight-foot centers with a total of 18 inches of rock, there will be a 5.6-inch depth of soil spread over each eight-foot wide strip. This value should be added to the total soil cover over the trench rock. If the trench were excavated 24 inches deep, the top of the rock would be six inches below the original soil surface. The additional 5.6 inches of soil replaced by the rock would provide a total cover of 11.6 inches over the rock in the trench.

**TABLE 12.18 Amount of Soil Replaced by Rock (inches)**

<table>
<thead>
<tr>
<th>Trench width (inches)</th>
<th>Trench spacing on centers (feet)</th>
<th>6.0</th>
<th>8.0</th>
<th>10.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inches of rock below pipe (12 inches total):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>4.0&quot;</td>
<td>3.0&quot;</td>
<td>2.4&quot;</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>5.0&quot;</td>
<td>3.8&quot;</td>
<td>3.0&quot;</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>6.0&quot;</td>
<td>4.5&quot;</td>
<td>3.6&quot;</td>
</tr>
<tr>
<td>12 inches of rock below pipe (18 inches total):</td>
<td></td>
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<td>24</td>
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<td>6.0&quot;</td>
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<td>7.5&quot;</td>
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<td>36</td>
<td></td>
<td>9.0&quot;</td>
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<td>5.4&quot;</td>
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<td>18 inches of rock below pipe (24 inches total):</td>
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<td>24</td>
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<td>36</td>
<td></td>
<td>12.0&quot;</td>
<td>9.0&quot;</td>
<td>7.2&quot;</td>
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<tr>
<td>24 inches of rock below pipe (30 inches total):</td>
<td></td>
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<td>10.0&quot;</td>
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<td>6.0&quot;</td>
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</tr>
<tr>
<td>36</td>
<td></td>
<td>15.0&quot;</td>
<td>11.2&quot;</td>
<td>9.0&quot;</td>
</tr>
</tbody>
</table>

**Above-Ground System Installation**

Installation considerations are very similar for all above-ground systems. Important factors to consider include location on the landscape, size and shape of the system, soil surface preparation, construction procedures, distribution of effluent, and dosing quantity.
Construction Equipment

While a rubber-tired tractor can be used in the initial surface preparation, it is necessary to use a crawler or tracked-type tractor for mound and at-grade construction to protect the soil surface and keep it as natural as possible.

Wheeled equipment has greater ground pressure than tracked equipment due to the reduced ground contact area and therefore should not be used in areas where compaction is a concern. Wheels do provide quicker movement and do not damage roads as much as tracks, but they provide less traction in muddy soils. Tracked equipment has lower ground pressure due to the larger footprint of the tracks and is more stable. Tracked equipment can be driven over a small spoil pile, whereas the material has to be moved out of the way with wheeled equipment.

When installing STA on sites with significant slopes, care must be taken to ensure the safety of the operator and laborer while achieving a level excavation. Check your local codes for maximum slope installation requirements. No matter what method is used to install the system, it is critical to maintain the required vertical separation and in some instances the installation can only be performed by hand.

Soil Surface Preparation

For proper hydraulic performance, there should be at least three feet of unsaturated natural soil or clean sand above the limiting soil condition. This could be three feet of natural soil above a saturated layer in an at-grade, two feet of natural soil plus one or two feet of clean sand plus one or two feet of natural soil in a mound system. A Type I mound needs at least 12 inches of unsaturated and natural soil, while an at-grade requires 36 inches, as shown in Figure 12.32.

First, lay out the system on the contour. Establish the original grade elevation (surface contour) along the up slope edge of the absorption bed. This elevation is used throughout
the mound construction as a reference to determine the bottom of the absorption bed, lateral elevations, etc., and is the permanent bench mark for the project.

If any trees are present on the site, they should be cut off at the soil surface and the stumps left. Removing the stumps will likely result in damaging the soil. The surface area taken up by the stumps is relatively small, so they will not affect the water infiltration under the system. If there is long grass, it should be cut off and removed so that the remaining grass is no taller than four inches. All vegetation in excess of two inches in length, as well as any dead organic debris, must be removed from the surface of the total area under the above-ground system (see Figure 12.33). Trees must be cut nearly flush with the ground and stumps not removed.

Soil surface preparation should be carefully studied. A soil surface that has been smeared, compacted, or otherwise made unsuitable for the movement of liquid it will never recover its capacity to transmit liquid. For instance, effluent will probably seep out of the above-ground system at the berm toe or at the distribution media edge. Once the clean sand layer is in place, it will be extremely difficult for the inspector to determine how the soil surface was prepared prior to sand placement. It is required that the soil only be plowed when it is not frozen.

Determine where the supply from the pump tank will connect to the distribution system in the absorption bed. The supply line from the pump to the above-ground system area should be installed prior to soil surface preparation. The trench excavated to install the discharge pipe should be carefully backfilled and compacted to prevent seepage of effluent.

The total area selected for the above-ground system, including that under the berms, should be roughened to thoroughly break up any existing sod layers and to provide a suitable transition zone between the original soil and the soil that will be placed to construct the above-ground system. Prepare the site by breaking up, perpendicular to the slope, the top seven to eight inches so as to eliminate any surface mat that could impede the vertical flow of liquid into the in situ soil. The best way to do this is to work around the perimeter of the system with the backhoe, using the bucket teeth to leave the surface rough. It is important that the grass be turned over so there is not a lot of grass at the surface. This grass can “slime off” and create a pathway for water to flow out of the mound dike. Surface preparation or roughening may be performed with a moldboard plow, a disk plow, or a backhoe using only the teeth. Moldboard plow furrows should be at least eight inches deep, should be thrown upslope, and should run perpendicularly to the slope. There should be no dead furrow under the above-ground system. Never use a rototiller to prepare the surface. Disking may be used to roughen the soil surface and break up the sod layer. Care must be taken not to compact or puddle deeper soil layers. In no case should any surface soil be excavated and moved more than one foot from its original location.

Above-ground system construction should proceed immediately after surface preparation is completed. The prepared surface should be kept free of all traffic, and every effort should be taken to prevent rain from falling on the prepared soil surface. Above-ground system construction should not take place when rain is expected. Cover the area with media to
protect the soil as soon as possible. If it rains after the tilling is completed, wait until the soil dries out before continuing construction, and contact the LGU for a determination regarding the damage done by rainfall. At least six inches of sand should be kept under the tracks of the transport vehicle to minimize compaction of the plowed layer. Maintaining the soil’s ability to accept effluent is a critical piece of the installation procedure.

**Media Placement**

The next step in the construction of a mound system is placement of the sand and, in an at-grade, the distribution media. If a mound is being constructed, a minimum of 12 inches of clean sand must be placed where the absorption bed is to be located and must cover the entire absorption area. A crawler tractor with a blade or bucket should be used to move the sand in to place. The sand layer upon which the absorption bed is placed must be level in all directions (see Figure 12.34). On level sites, the media should initially be placed around the perimeter of the site with a low-ground pressure machine. On sloping slights, the media should be installed from the upslope side.

Clean sand, described as such the basis of a sieve analysis, is a soil texture composed by weight of at least 25 percent very coarse, coarse, and medium sand varying in size from 2.0 to 0.25 millimeters, less than 50 percent fine or very fine sand ranging in size between 0.25 and 0.05 millimeters, and no more than five percent of particles smaller than 0.05 millimeters. Clean sand can be verified using the jar test (Figure 12.35).

**Conducting a Jar Test**

1. Place exactly two inches of sand in the bottom of a quart jar and then fill the jar three-fourths full of water.
2. Cover the jar and shake the contents vigorously.
3. Allow the jar to stand for 30 minutes and observe whether there is a layer of silt or clay on top of the sand.
4. If the layer of these fine particles is more than 1/8 of an inch thick, the sand is probably not suitable for use in mound construction, because too many fine particles tend to cause the soil to compact during the construction process and future operation. Also, the long-term acceptance rate of this soil will be slower than the long-term acceptance rate of clean sand, which is used for sizing the absorption bed area.

When evaluating various sources for clean sand, it is worthwhile to observe the moisture line in the sand piles. A sand pile with a high moisture line has more fine particles due to the capillary forces in the soil pore space wicking moisture up. In addition, wet soil weighs significantly more then dry soil; therefore, the moisture content of materials must be considered when ordering media.
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A rubber-tired tractor may be used for plowing or disk ing to prepare the soil surface, but after the surface preparation is completed, only a crawler or track-type tractor should be used. Move the fill material into place using a small track-type tractor with a blade or a large backhoe that has sufficient reach to prevent compaction of the tilled area. Do not use a tractor or backhoe with tires. Always keep a minimum of six inches of fill material beneath tracks to prevent compaction of the in situ soil. Place the sand material to the required depth and then form the absorption bed.

On slopes of one percent or greater, the upslope edge of the level absorption bed must be placed on the contour. Construction vehicles must not be allowed on the absorption bed until backfill is placed. The distribution media must completely encase the top and sides of the distribution pipes. In a mound, the top of the media must be level in all directions. Hand level the bottom of the absorption bed. See Figure 12.34.

The next step is to excavate/construct the trench or bed infiltrative surface. Minimize foot traffic on infiltrative surface and avoid equipment traffic on or over infiltrative surface. This is typically a bed constructed in/on top of the sand material. During the planning process, you will determine the equipment or method to use for the excavation. When constructing the trench/bed bottom, be sure it is graded to the specifications in the design. Excavate the distribution cell(s) to the correct bottom elevation(s) taking care not to smear the infiltrative surface. If using chambers, hand tamp fill where chambers will be located. Install the leaching chambers and pressure distribution piping as instructed by the leaching chamber manufacturer’s instructions and the pressure distribution design.

If rock is used as a distribution medium, it should be igneous rock or a similar insoluble, durable, and decay-resistant material between three-fourths of inch and 2.5 inches in size, with no more than five percent by weight passing a three-fourths inch sieve and no more than one percent by weight passing a No. 200 sieve. Materials greater than 2.5 inches in size should not exceed five percent by weight. The rock bed must be covered with a durable nonwoven geotextile fabric designed for this purpose, of sufficient strength to undergo installation without rupture. In addition, the fabric must permit passage of water, without passage of overlying soil material, into the soil treatment system rock bed. This should be done with a front-end loader on a track-type tractor. At least nine inches of rock should be placed under the distribution pipe and two inches of rock above.

The pressure distribution laterals can be placed in the absorption bed with the orifices down or with orifice shields; whichever method is chosen, make sure that all the effluent drains from the pipe. An orifice should be placed three-fourths of the way up the end cap to allow air to flow back into the pipe after the pump turns off.

Typically, the inspection ports are installed next. The inspection ports provide a location for the monitoring of ponding in soil treatment systems and are typically installed at the infiltrative surface (interface where effluent moves from distribution media or a distribution device into treatment media). Inspection ports extend from the infiltrative surface to a point at or above finished grade. The portion of the observation pipe below the distribution pipe for rock systems is slotted, while the portion above the distribution pipe is solid wall. The inspection port can be placed in a valve box without a cover. However, if a slip cap is used on the inspection port, it must be secured so the pipe does not come out when the cap is removed. Inspection ports for chamber systems are attached to the chambers. With rock systems, a 12-18 in section of rebar can be placed in the pipe, a pipe T installed or a toilet flange installed at the end to hold it in place.
**Cover Material**

Sandy loam soil should be placed over the absorption bed with a 10:1 slope from the center of the media bed to the edges. In a ten-foot wide media bed, this is 12 inches in the center and six inches at the sides. The purpose of this sandy loam cap is to avoid undue soil compaction so that the pore spaces are maintained and soil air and moisture can move freely. At least six inches of the cap must be topsoil borrow, which is a loamy soil material having less than five percent material larger than 2.0 mm (#10 sieve); no material larger than 2.5 cm; a moist color value of 3.5 or less; and adequate nutrients and pH to sustain healthy plant growth. Figure 12.36 indicates what type and where each type of media must be installed in a mound.

**FIGURE 12.36 Mound Cross-Section**

Side slopes of four feet horizontal to one foot vertical (4:1) are suggested for the berms of the above-ground system. This gentle slope will allow easy mowing of the grass cover. If area is limited, steeper side slopes of 3:1 can be used. In no case, however, should the berm slope be steeper than 3:1.

**Inspection of Soil Treatment Systems**

**New Systems**

During an inspection of a new installation there are several key items to check:

1. Proper construction techniques - observe the excavated trench or bed for evidence of compromised soil conditions such as excavation during plastic conditions or compac-
tion due to excessive foot traffic. Check the absorption area preparation: vegetation removal, soil moisture content below plastic limit, and proper rough-up techniques.

2. Verify the system was sited/located properly along the contour and not in a swale or drainageway.

3. Design verification - verify that the design is being followed, particularly that the distribution media installed matches the design sizing requirements.

4. Verify system depth and elevations. It is important that the system not be too deep. “Too deep” for trenches and beds means three feet of cover or four feet to the bottom of the system. Soil treatment systems should be relatively shallow to maximize oxygen transfer to the bottom of the system. “Too deep” for mounds may mean that 12 inches of unsaturated soil is not present or not enough sand is installed to meet the three foot requirement. The bottom elevation of the system should be verified as specified in the design.

5. Examine material used in installation, paying particular attention to rock and sand quality. A jar test or sieve analysis can be requested if questionable materials are on-site (see process above).

6. Examine the building sewer materials. If existing pipe is used, be sure to verify that it does not have cracks or root infiltration in the piping.

7. Verify proper distribution system:
   a. Verify that the distribution media is level at the top and bottom
   b. Proper sizing and connections (i.e., properly primed and glued, pressure fittings where needed, etc.).
   c. If a drop or distribution box is used to distribute effluent to individual lines in a soil treatment system, and if it is accessible, inspection should include levelness of the inverts of outlets of the d-box.
   d. Verify pipe size, orifice size, spacing, and orifice shields as per design.
   e. Verify proper installation of drop or distribution boxes if required in the design.
   f. Be sure to check that the inspection pipes are secured properly.
   g. Clean-outs, as required, and covers.
   h. Verify squirt height, equal distribution.

8. Soils verification - many local units of government perform a field verification of the soil conditions at the time of inspection to verify that the proper soil interpretation was made.

9. Verify cover, topsoil depth, and presence of erosion control protection prior to establishment of vegetative cover.

10. Check setback distances. Figure 12.5 shows the critical setbacks from a trench system. The most critical, in terms of possible contamination, are the setbacks from the well. The setback from the well to the system is based on the construction of both well and system. Setbacks from lakes, rivers, and streams should be verified as well as from buildings or property lines and any other local requirement such as wetlands, easements, or roads.

Existing Systems

With existing systems the soil treatment unit does not need to meet all the requirements of
Chapter 7080. The system does need to have a watertight septic/pump tank, should not be surfaced, must have a least two to three feet of vertical separation (depending on when and where the system was built), and be in compliance with management requirements for the system. An inspection should verify the following:

1. Septic tank verification – the septic tank must be verified for watertightness. If the septic or pump tank leaks effluent, it is considered to be failing to protect groundwater and the upgrade timeline is set in the local ordinance.

2. Soil separation – verify the soil limiting condition, either redoximorphic features or bedrock. Check the distance from the bottom of the system to the limiting layer (bedrock or saturated soil). The system should have been designed and constructed with a “design depth” of at least three feet of soil between the system and the limiting layer. Take a boring of soil and use the Munsell color book to classify the soil. This boring should be located near but not in the system, because the system can change the soil colors, giving a false reading of the separation depth. If a system was built after 1996, is located in shoreland, a wellhead protection area, or serves a food, beverage, or lodging establishment, the required separation is three feet. For all other Type I systems, the required separation it is two feet.

Once the system has been constructed and has begun accepting effluent, the depth to saturated soil will change is why the boring is performed outside the area of influence. The new separation is called the “operating depth”: the actual depth of the water table under the working system. Operating depth is always less than design depth (see Figure 12.37). How much less depends on a number of factors, including surface water drainage and system application rates. However, if a system is properly designed with three feet of separation, the operating depth should be sufficient to maintain treatment. Although shallower systems perform better, a deep system is not necessarily failing.

**FIGURE 12.37 Groundwater Mounding Below Soil Treatment**

Soil treatment area

Designed separation

Operating separation

Clay soils will produce a higher “mound” than sandy soils.

Ground water mounding

Original depth of saturated soil or other limiting condition
If a system lacks separation, it is considered to be failing to protect groundwater and the upgrade timeline is set in the local ordinance.

In the past under certain conditions, the installation of agricultural draintile was allowed as a way to deal with excessive moisture on a site. These systems were designed to increase the separation from redoximorphic features to the bottom of the system to at least three feet. That being said, studies (Nieber et al., 1998, Goff et al., 2001) have shown performance issues due to limiting soil conditions (restrictive textures, structures, bedrock, etc.) and new systems are now required to get an NPDES permit to be installed.

Existing SSTS currently employing drainage systems which are lowering the groundwater in an attempt to meet the required vertical separation distance do not need to obtain a NPDES permit. However, if water quality monitoring of the discharge indicates a violation or surface water quality standards, the system must replaced within 10 months as the agency considers the system to be an imminent threat to public health or safety. If monitoring of groundwater elevations indicates a violation in the required vertical separation distance, the system is considered failing to protect groundwater and must be upgraded per local ordinance requirements. These systems are not be confused with those that have a diversion which intercepts groundwater as an enhancement, but whose function is not relied upon to provide the required unsaturated treatment zone, and is placed at least ten feet upslope of the soil dispersal system.

3. Verify system hydraulic performance. If the soil treatment system is overly full, effluent will come to the soil surface. If effluent is surfacing, the system is failing and is an imminent public health threat. Odor and spongy ground over the top of the system are indicators. Check for cattails or other landscaping that may hide surfacing effluent. The property owner or agent should verify in writing that the system has not backed up into the home or surfaced in the yard, as these types of failures can be cleaned up and hidden by a creative owner.

Dye testing is one way to identify failures, but because it will miss some failing systems, its result cannot be used as the only criterion. There are a number of new dyes that are available for use. They include the use of optical brighteners for the identification of sewage. The process for using brighteners includes collecting a sample on a cotton swab and having the cotton analyzed. This method is still being researched.

It is important to identify the cause of the failure. It may be due to plugging of soil pores, sewage flows in excess of the soil's ability to accept effluent, soil compaction, or malfunction or plugging of the distribution system. You may already have found the cause of the problems in your inspection of the tank or lift station.

Look at the impact of surface water on the system. Another issue in terms of surface water is the location of the system in the landscape. Trenches should be located along contours. They should not be located in drainage areas such as the bottom of a drainageway, or in the middle of or transecting a drainage swale.
**Troubleshooting Below-Ground Systems**

As shown in Figure 12.38 (system inspection) there are several parameters to evaluate when troubleshooting below ground soil treatment systems. Inspect the distribution system that brings effluent to the soil treatment area, either drop boxes, valve boxes, or distribution boxes. (These are also good places to check the performance of the tank.) Verify that drop boxes have solid walls and bottoms. Although drop boxes need not be absolutely watertight, they should be constructed in such a way as to minimize outflow. They should have minimal side seepage, so the presence of roots may indicate a problem. (Figure 12.38.) Check distribution boxes for structural soundness and watertightness. Root infiltration is a definite indication of a problem. Inspect piping for bows, drops, or ponding water, which indicate possible settling of the soil.

If the distribution system is overly full, it’s an early sign of problems, possibly due to lack of maintenance or sludge flow-through. There may be sludge in the maintenance box or plugging in the soil system itself. If possible, note the percentage of the soil treatment system being used, and make a record of it. How much of the system is used can be observed through the inspection pipes, which are, therefore an important component of the soil treatment system. They must be watertight and have watertight lids to minimize the addition of water to the system.

The maximum upgrade time period for a system that is an imminent threat to public health and safety (ITPHS) is ten months and may be reduced in the local ordinance.

4. Verify system operation and maintenance – the users of the system should understand that proper maintenance of their tank and protection of their soil treatment site in terms of drainage, mowing, and avoiding compaction is very important. The system’s owners should also make an effort to protect the
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If the management requirements for the system are not being followed, the system is out of compliance, and the timeline and requirements necessary to bring it back into compliance are determined by the local unit of government.

Troubleshooting Above-Ground Soil Treatment Systems

It has been estimated that mounds and at-grade systems should perform hydraulically for 25 to 35+ years. However, some systems do not perform as they should for that long. Soil treatment system problems are often traced to improper design and construction practices, but improper operation and maintenance of the system also contribute to problems with systems.

In a 2004 study in Wisconsin, Blasing and Converse investigated mound toe seepage. Their results indicated that 80.8% of the samples had fecal coliform levels of less than 200 col/100ml, which is the standard for swimable and fishable waters. This data raises the question of whether mounds with minimal and seasonal toe seepage are an environmental health problem.

Reasons for system malfunctions

The materials with which systems are constructed can lead to malfunction. Systems’ siting, design, construction, and homeowner misuse also commonly contribute to malfunction. Some common problem situations are described below, including, in parenthesis, where the seeping problem occurs (toe or side/top) in the system. Figure 12.40 shows a mound on a sloping site which is leaving out the toe.
Malfunction due to poor-quality materials

Common cause for seeping mounds is poor-quality materials.
- Sand with too many fines: there should not be over 5% silts and clays (side/top).
- Sand with too much fine sand. This is a problem when there is more than 5% fines (side/top).
- Soil treatment system rock with too many fines: there should not be more than 1% fines (side/top).

Malfunction due to poor siting

Poor siting is the second most common cause for seeping mounds. Common siting problems are:
- Mounds placed on soils that do not have one foot of soil above the periodically saturated soil or bedrock (toe).
- At-grades, trenches, and beds placed on soil that does not have three feet of soil above the periodically saturated soil or bedrock (toe).
- Systems placed on disturbed or compacted soils (top/toe).
- Soil treatment systems not placed on the contour (top/toe).
- Soil treatment systems placed in swales/upland drainageways (top/toe).

Malfunction due to errors in design

Errors in system design can result in seepage. The errors include:
- Mis-estimation of the soil texture and structure or percolation rate (top/toe).
- Miscalculation of slope (a system designed for a flat site instead of a sloping site) (toe).
- Miscalculation of the bottom area/absorption area — the area where sewage enters original soil (top/toe).
- Upslope drainage not designed; soil treatment systems receives upslope runoff (top/toe)

Malfunction due to construction errors

- Construction errors are of two types: (1) poor-quality materials (discussed previously) and (2) errors in installation. Installation-related construction errors include:
  > Sewage absorption area compacted during construction, reducing infiltration (toe).
  > Sewage absorption area smeared during excavation or scarification because the soil moisture was over the plastic limit (toe).
  > Excess vegetation was not removed, reducing infiltration from vegetative mat (toe).
  > Cracked pipe or pipe that became disconnected (toe or side)
  > Nonwatertight joints in tanks (excess infiltration) (toe).
  > Incorrect float adjustment (toe or side/top).
  > Water stands in sagging pipe and freezes in winter (side or problems at pump tank).

Malfunction due to system misuse by homeowners

- Excessive water use or leaky fixtures (toe.)
Clean-water source hookups to the septic system, such as the sump pump (toe).
- Lack of pumping solids from septic tank or other cause of high-strength waste (side/top).
- Improper landscaping causing compaction of area around system (toe).
- Rooftops or impervious areas draining to the tank or system areas (toe).
- Disposal of chemicals in system (side/top).

Management of All Soil Treatment Systems

Management Plans
According to MN Rules Chapter 7080.1100 Subp. 46, every system designed since the enactment of the 2008 Rules must have a management plan. A management plan requires the periodic examination, adjustment, testing, and other operational requirements to maintain system performance expectations, including a planned course of action in the event a system does not meet performance expectations.

In Minnesota Rules Chapter 7082.0600, Subp.(1), local units of government (LGUs) shall require management plans for all new or replacement systems. These plans must be submitted and approved before issuance of a construction permit. It is recommended that the management plan be reviewed and signed by the owner.

Management plans must include:
1. maintenance requirements, including frequency of assessment
2. operational requirements, including which tasks the owner can perform and which tasks a licensed service provider or maintainer must perform
3. monitoring requirements
4. requirements that the owner notify the LGU when management plan requirements are not met
5. disclosure of the location and condition of the additional soil treatment and dispersal area on the lot or serving the residence
6. other requirements as determined by the LGU

For Type I soil treatment systems, the management plan should include:
1. A assessment frequency of at least every three years.
2. Recommendations for water usage, conservation, and other key behaviors within the house or establishment that will help assure that the at-grade component will not be overloaded.
3. Recommendations for vehicle and animal traffic across the system.
4. An evaluation of usage if a water meter, event counter, or running time clock is available.
5. Evaluation of septic and dose tanks along with related screens, pumps, and alarms.
6. An evaluation of the liquid levels in the observation pipes and examination for any seepage around the soil treatment component.
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7. Evaluation to verify that surface water is not collecting on the soil treatment system site.
8. Evaluation to verify that the site is not being driven on or compacted in any other manner.
9. Evaluation of a suitable, non-invasive, shallow-rooted vegetative cover over the soil treatment system site.

Example management plans for trench, bed, and mound systems are provided in Section 13: Forms.

For a Type II-V soil treatment system, the management plan should include all the components above, in addition to an evaluation of any additional features such as piezometers.

Site planning, preparation, documentation, and contracting

Reading a Drawing

The first step in constructing any onsite system is reading the system plan and locating the components. Measure the site locations using tapes and the elevations using a laser. The elevation of each component must be related to or measured from a fixed point. This point can be designated as your laser elevation (but this is hard to locate again) or set in relationship to a benchmark, a permanent reference point.

Component locations must be measured in three dimensions and be located from a fixed reference point (called the benchmark) which should appear on the plans. Because this point is key for all measurements, it has to be a permanent location. Often the benchmark is a dedicated lot corner stake or even an official survey point. Be sure that this point can be readily found and will remain after construction. A piece of lath stuck in the middle of the construction site is not a good choice for a benchmark because it will certainly be lost.

On existing sites, the wellhead or electrical box can be a good benchmark because these structures typically do not move.

Be sure to place the laser out of the way of construction equipment and at a elevation where you can read the rod from all locations onsite. Do not set the laser so tall that the rod is always stretched past the maximum. If you do this, you will not have enough rod to complete the measurement when you dig a deeper excavation for installing the tank.

A few tips to remember: When the numbers are getting larger on the rod, you are going downhill. And, for your laser to work, you need good batteries. It is a good practice to check your equipment on a regular basis. With the right tools and a little planning, you can easily and quickly complete the all-important act of surveying the site.
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Equipment
To properly survey and install the system, you need a number of tools:

1. Tape measures to determine horizontal measurements.
2. A laser level or a surveyor’s level and a surveyor’s rod for elevations.
3. Twelve-inch stakes, four-foot lath and wire flagstone to mark the locations for the components being installed. Sometimes these are also helpful for identifying setback distances.

Tapes should measure at least 100 feet. They come in a variety of materials. Non-metal tapes seem to be the most typical choice, but over time the numbers can become unreadable from wear and weathering. Make sure your tapes are readable. Also, take note of the units on tapes. Some measure in inches and others in tenths of a foot. A tape with units that match those used on the design plan minimizes the number of calculations you’ll have to do at the site. It is a good idea to have two tapes: you’ll have a spare if one gets lost, and using two tapes can speed up the surveying job. By laying one tape on a reference point, such as along the property line, and using the other to measure setback distances and system component locations, you can quickly and easily create a grid. This makes recording and drawing the system much easier and faster.

Another critical tool is the surveying rod, a graduated rod used to measure elevation differences. You will use it with the level or laser target to establish component elevations. The units are identified on the rod. Typically they are in tenths of a foot, but some are in inches. Just be careful not to confuse the units in which you are working. In setting elevations, a laser level delivers a level plane of light, and a target picks up the light, allowing you to determine when you are reading the same elevation.

The laser light can be visible (typically red) or invisible to your eye but picked up by the receiver. Set the laser at an elevation that is not at your eye height during your working day. This will avoid exposing your eyes to excessive laser light.

The laser is set atop a tripod and adjusted to level by setting the legs and using the fine adjustment system. Newer self-leveling models can make life easier for your crew. Another useful feature is the ability of the laser to set a desired grade or slope on the piping and to allow that grade to be followed without changing the location of the receiver. (Be careful and double check that the grade feature is not on when you are trying to level the system.) The big advantage of a laser level is that the level portion does its work with no help so that one person can check the elevations. When a surveyor’s level is used, a second person must operate the rod. A number of manufacturers provide laser levels. When choosing one, look beyond price to the features that will make your work easier. Once you are accustomed to using a laser level, you will hardly be able to imagine working without it.

A surveyor’s level has a scope and a crosshair. To use this device, one person sights through the level and another operates the rod. This can be an effective layout tool, but the laser is more efficient.

Survey Techniques
Stake out the system area on the site according to the system design, so the system 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 LGU.

In establishing elevations, remember that even though water runs downhill and gravity distribution is used, there must be enough drop in the system to move the effluent between the system parts. Be sure you take into account the two to three-inch elevation drop from the inlet pipe to the outlet pipe inside the septic tank. Sluggish flow out of the septic tank can result in freezing problems. Component locations must be measured in three dimensions and must be located from a fixed reference point—called the benchmark—which should appear on the plans. Because this point is key for all measurements, it has to be a permanent location. Often, the benchmark is a dedicated lot corner stake or even an official survey point. Be sure that this point can be readily found and will remain after construction. A piece of lath stuck in the middle of the construction site is not a good choice for a benchmark, because it will certainly be lost. On existing sites, the wellhead or electrical box can be a good benchmark, since these structures typically do not move.

Once you set the benchmark, you can start the installation.

If you were not the designer of the system be sure to discuss expectations the property owner may have about the installation. The designer may have promised protection of trees, plantings, or out buildings. These are important points address before construction begins.

The installer should verify that the site conditions are appropriate for construction and lay out the system. The installation plan should be thought of before construction begins to avoid problems with material delivery and spoil pile storage. During the installation the installer should be watching for any unusual soil or obstructions. Often the designer will have performed only a few soil borings across the site and may not have had a good view of the variability across the site. If, for any reason there are questions regarding the appropriateness of the design for the site, the designer should be contacted.

As-Builts

After any system has been constructed, an as-built is required to be completed by the installer and submitted to the local unit of government. Chapter 7083.0020, Subp. 4, defines as-builts as the drawings and documentation specifying the final in-place location, elevation, size, and type of all system components. These records identify the results of materials testing and describe conditions during construction. Information provided must be verified by a certified statement. Chapter 7080.1100, Subp. 15, defines a Certified statement as statement signed by a certified individual, apprentice, or qualified employee under Chapter 7083, certifying that the licensed business or qualified employee completed work in accordance with applicable requirements.

The as-built must include drawings and documentation specifying:

- the final in-place location of all system components, including maintenance, access, and location
- the size of all system components (this should include the pump gpm and tdh)
- the type of all system components
- the results of materials testing
- the construction conditions

Chapter 7083.0760, Subp. 2, (C) requires that the as-built drawings be provided to the owner and local unit of government within 30 days of system installation. An example as-built form is provided in Section 13.
Photographing Installation
A camera can be used as part of a designer’s and installer’s equipment. It is recommended that photographs be taken showing features of the system before and during construction. These photographs may be valuable in the future, in case there is a question about the proper siting or construction of the system.

Notating Your Photographs
Make notes of the following:

- elevations of the outlet from the house
- elevation going into the septic tank
- elevation of the manhole on the septic tank
- elevation of the first drop box or pressure distribution system
- elevation of the top and bottom of distribution media
- elevations of subsequent drop boxes and cover material

Building Sewer and Tanks
First, photograph the building sewer area. This should include the placement of the building sewer, the connection to the house, the cleanout location, the connection to the tank, and if possible, the type of pipe used for the connection. Photograph the building sewer and tanks in the same manner as in the previous section.

Pump Tank
The series of photographs for the dosing chamber will include:

- all wiring
- the control panel
- the lift pump with both gpm and tdh recorded
- the connection of the pipe to the pump
- the wiring of the floats onto the pipe
- the entire set-up before placing it into the tank
- the pump in place, so you can have a record of where it was located in the tank

Soil Treatment Site
Take pictures of the construction site as a whole. Begin by taking photos before construction begins, so that an overall view of the site will be available. Next, photograph the site after the vegetation has been cleared. Be sure to include any trees (before and after), highlighting that they were cut off and not grubbed.

Soil Separation
If a soil pit or boring is evaluated during construction of the system, photos should be taken, including tape measures alongside the soil to indicate where the limiting condition was identified.
Site Preparation
Your next set of photographs should depict the site preparation. These photos should include the staking, but more importantly, should show the site after the ground has been roughened by backhoe or plow. One of the shots of this portion of the construction should include the equipment actively engaging in work.

Sand
Photograph the clean sand if it is part of the installation. Take a picture of the sand itself, and include a photo of the jar test after it has been run. Photograph the placement of the sand; include a photo of the equipment used for placing it.

Distribution Media
Take photos of the placement of the media. Your photos should show the depth of the media and how it was placed. If rock is used, a close-up of the rock should be taken to show the size and quality.

Pressure Laterals
Photograph the placement of the pressure laterals. Be sure to include a picture of the gluing and a picture of the orifices.

Special Considerations
Were there any unusual or special considerations on the site? If so, photograph them. These may include tile drainage, special sloping for placements, and special soil conditions. Another concern may be identifying and protecting a second site. Take a picture of that site when all work is completed. Photos showing setbacks, such as those from wells, buildings, and property lines, may also be appropriate.

The goal is to complete a good record of the construction job. This record can be a benefit to you and your client for years to come.

Finished Product
Now you are ready to photograph the finished product. In these pictures, include how the soil treatment system was finished. Take pictures of equipment to show what the system looks like in its completed state.

Contracts
First and foremost, recognize that any contract or agreement should be reviewed by your attorney. Business contracts are too important to enter casually. The scope-of-service document should begin where you propose to start and needs to spell out the general terms, conditions, and limitations of the agreement. You may want a separate agreement about your expectations for the client—this would be contained in a separate client consent form. If you will do the site evaluation and design work as well as the installation, this needs to be made clear. It is probably advantageous in most areas to keep this separate, also. That is, have a separate scoping document for what it will cost to do the preliminary survey, soil borings, and percolation tests that result in a system design and layout. It makes sense to provide a separate price solely for this work because, during the site evaluation, you may find conditions that alter the system design and in turn affect the installation price.
Once you have a design or plan in hand (whether it’s done by you or someone else) the scope of services can cover what happens at installation. The plan should be specific to the site and should include a to-scale drawing of the system location and detailed specifications of what will be installed. Specifications include the type and size of the septic tank or tanks, the presence of a pump chamber and pump (if necessary) any additional pretreatment devices (such as a media filter or ATUs), and a description of the final treatment and soil dispersal system: trenches, mound, at-grade, or drip irrigation. These specifications can be referred to in the specific agreement. For example: “I will install 300 lineal feet of 3-foot wide trench with 18 inches of clean 3/4-inch to 2-inch diameter rock, with 4-inch schedule 3034 distribution pipe, covered with a filter fabric, and backfilled with existing soil.”

There should also be provisions to cover the potential for additional work, how the cost of added tasks will be determined, and whether the client will pay for them. For example, consider stumps. Usually, you can visually estimate the cost to remove a stump, but it is important to be specific about what happens to the stumps after they come out of the ground. We’ve heard more than one homeowner complain, “I came home to find a pile of stumps next to my driveway, and now what am I supposed to do?” The time to negotiate this point is before the contract is signed. Large rocks are sometimes not so easy to detect. In areas where rocks might be located, it’s a good idea to decided with the customer up front on what will be done about them and who will pay any removal expenses. Your agreement should also describe what the area will look like at completion of the job. Will topsoil be added? Will the site be smoothed and seeded? Will sod be laid? How will the cleanup be handled? In some areas, particularly on heavily wooded sites, it once was a common practice to install trenches or beds and simply let the natural vegetation grow back. Today, however, when more attention is given to system longevity, operation, and maintenance, this practice is not acceptable. If the client is expected to do the finishing work, it needs to be documented in your agreement.

The agreement also should specify payment terms. Is some of the money due up front, before work begins? Or is the entire sum due when the work is completed? Usually, payment is split, with some (but not the entire) amount paid up front to cover the cost of materials. Final payment is often made after system has been issued a Certificate of Compliance (COC) by local unit of government, and work approved by the client.

Your agreement should include a disclaimer statement covering what you are obligated to fix if problems develop with the system and over how long a time you are responsible. In many states, this statement is part of the onsite treatment or building code, and the period involved is often one year. In addition, be sure to specify problems for which you are not responsible, such as those caused by owner misuse. If your company also maintains systems, you should offer another agreement covering the operation and maintenance of the system. Again, this agreement should describe clearly what you will and will not do for the stated price.

By having these agreements in place at the start of the design or installation process, you get the project off to a good start. A good agreement increases the likelihood that your client will be happy and will give you good word-of-mouth advertising for many years.
Landscaping Septic Systems

Introduction

Landscaping near, around, and on septic systems is of concern to many homeowners. This anxiety can be eased by involving the homeowner in the placement of the septic system and by what is appropriate to plant.

To ensure a properly functioning soil-based septic system, whether below-grade or mound, a suitable vegetative cover must be established. The right vegetation cover helps keep the soil stay in place, lets the septic system function at its best by removing moisture and nutrients from the soil, provides as an insulating layer, and makes the area more attractive. However, planting the wrong cover can do irreparable damage to the area. Trees, shrubs, and any herbaceous plants that have extensive root systems should not be placed on or near the system. These roots can interfere with and possibly destroy the distribution system. Herbaceous plants such as turf grasses, wildflowers, and native grasses are suitable cover for septic systems in Minnesota (see Table X for specific suggestions). Turf grasses have fibrous root systems that hold soil in place, require maintenance similar to a lawn, and are available in numerous varieties, including shade-tolerant, to suit site conditions. Wild flowers and native grasses are an attractive alternative to turf grass and provide, many of the same benefits, including fibrous roots, low maintenance (once established), and tolerance of dry soil conditions. Careful consideration should be given to planting any vegetation so that the soil does not get compacted; when the soil is compacted, it loses its structure and therefore loses free water movement.

The correct landscaping of mound systems can minimize the aesthetic intrusion and maximize protection of the system. The actual shape of the mound can be changed to incorporate individual landscaping desires. Landscaping around the mound can serve as a privacy barrier, a windbreak, or as a screen to block unsightly views.

Guidelines for Planting On and Near Septic System

- Topsoil on the mound should be a minimum of six inches and a maximum of 30 inches.
- Use minimal tilling when planting and establish a cover as soon as possible to limit erosion.
- Always wear gloves when working around a septic system to minimize your contact with soil.
- Use plants that prefer dry soils near the septic system. This will prevent their root systems from interfering with the septic system. The larger the plant, the more extensive (through not necessarily deeper) the root system.
Do not place trees and shrubs on the mound; they may be planted at the foot or on the side slopes. Frame the mound with trees and shrubs at a distance, but use only herbaceous (non-woody) plants on the mound itself. Trees should be planted a minimum of 20 feet from the edge of the mound. Trees known for seeking water reservoirs, such as poplar, maple, willow, and elm, should be planted at least 50 feet from the mound. Shrubs should not be planted on top of the mound.

Minimize traffic on the mound, both human and animal, to avoid soil compaction. Do not exercise pets or allow them to play on septic mounds. Never drive a car or other vehicle across the mound, and do not mow when the soil is wet. Compacted soil can lead to soil erosion and impedes the flow of air around the systems. In winter, activities on a mound can cause frost to penetrate, resulting in freezing problems.

Do not plant edible plants such as vegetables and herbs on the mound or drainfield.

Annually inspect the mound for animal damage such as burrowing and tunneling. Control animals at the first sign of tunneling or burrowing before damage is extensive.

Root barriers (geotextile impregnation with a long-lasting herbicide that kills plant roots) have been used around mounds. Installation is expensive and can be avoided with proper plant selection.


Frequently working the soil on the septic area is not a good idea. The plants in the following tables are low maintenance, grow well on dry soil, and have a fibrous root system to help hold the soil in place. Use the tables to chose plants that are right for your preferences and needs.
### Vegetation tables

#### TABLE 12.19 Wild Flowers/Native

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Height</th>
<th>Color</th>
<th>Bloom Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prairie onion</td>
<td>Allium stellatum</td>
<td>1-2'</td>
<td>Purple</td>
<td>late</td>
<td>Flower heads 1 to 2&quot; wide</td>
</tr>
<tr>
<td>Pussytoes</td>
<td>Antennaria neglecta</td>
<td>3-6&quot;</td>
<td>White</td>
<td>mid</td>
<td>Flower heads resemble compact tufts of white hair</td>
</tr>
<tr>
<td>Butterfly weed</td>
<td>Asclepias tuberosa</td>
<td>2-3'</td>
<td>orange</td>
<td>late</td>
<td>Butterfly favorite</td>
</tr>
<tr>
<td>Heath aster</td>
<td>Aster ericodes</td>
<td>1-3'</td>
<td>white/purple</td>
<td>mid</td>
<td>One of the last flowers lasting in Fall</td>
</tr>
<tr>
<td>Prairie clover</td>
<td>Delea spp.</td>
<td>1-2.5'</td>
<td>white</td>
<td>late</td>
<td>Dainty stems</td>
</tr>
<tr>
<td>Purple coneflower</td>
<td>Echinacea purpurea</td>
<td>2-4'</td>
<td>purple</td>
<td>late</td>
<td>Showy flowers</td>
</tr>
<tr>
<td>Prairie smoke</td>
<td>Genum triflorum</td>
<td>6-12&quot;</td>
<td>pink</td>
<td>early</td>
<td>Attractive foliage and unique flower</td>
</tr>
<tr>
<td>Oxeye, false sunflower</td>
<td>Helianthus helianthoides</td>
<td>3-5'</td>
<td>yellow</td>
<td>mid</td>
<td>Easy to grow</td>
</tr>
<tr>
<td>Blazing star, Gayfeather</td>
<td>Liatris aspera</td>
<td>2-5'</td>
<td>purple</td>
<td>late</td>
<td>Butterfly favorite</td>
</tr>
<tr>
<td>Wild bergamont, Bee balm</td>
<td>Monarda fistulosa</td>
<td>2-4'</td>
<td>pink/lavender</td>
<td>mid</td>
<td>Distinct showy flowers</td>
</tr>
<tr>
<td>Pasqueflower</td>
<td>Pulsatilla pentens</td>
<td>6-8&quot;</td>
<td>white/lavender</td>
<td>early</td>
<td>Showy flowers</td>
</tr>
<tr>
<td>Penstemon, Beardtongue</td>
<td>Penstemon spp.</td>
<td>2-3'</td>
<td>white</td>
<td>mid</td>
<td>Favorites for bees and hummingbirds</td>
</tr>
<tr>
<td>Rattlesnake master</td>
<td>Eryngium yacccifolium</td>
<td>3-4&quot;</td>
<td>bluish/silver</td>
<td>late</td>
<td>Unique looking</td>
</tr>
</tbody>
</table>

#### TABLE 12.20 Ornamental

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Height</th>
<th>Color</th>
<th>Bloom Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daylily</td>
<td>Hemerocallis spp.</td>
<td>1-3'</td>
<td>several colors</td>
<td>mid</td>
<td>Minimal care</td>
</tr>
<tr>
<td>Sedum</td>
<td>Sporobolus heterolepis</td>
<td>1-3'</td>
<td>several colors</td>
<td>late</td>
<td>Tough plant for dry sites</td>
</tr>
<tr>
<td>Peonies</td>
<td>Paeonia spp.</td>
<td>2-3'</td>
<td>several colors</td>
<td>early</td>
<td>Large showy fragrant flowers</td>
</tr>
</tbody>
</table>
TABLE 12.21 Shade Tolerant

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Height</th>
<th>Color</th>
<th>Bloom Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigleaf aster</td>
<td>Aster macrophyllus</td>
<td>2-3'</td>
<td>white/purple</td>
<td>late</td>
<td>Hardy</td>
</tr>
<tr>
<td>Pennsylvania sedge</td>
<td>Carex pensylvanica</td>
<td>6-12&quot;</td>
<td>green and brown</td>
<td>late</td>
<td>Low clumped grass</td>
</tr>
<tr>
<td>Wild geranium</td>
<td>Geranium maculatum</td>
<td>1-2'</td>
<td>purple/pink</td>
<td>mid</td>
<td>forms large clumps of flowers</td>
</tr>
<tr>
<td>Violets</td>
<td>Violets spp</td>
<td>6&quot;</td>
<td>purple/white</td>
<td>mid</td>
<td>Will multiply</td>
</tr>
</tbody>
</table>

TABLE 12.22 Native Grasses

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Height</th>
<th>Color</th>
<th>Bloom Time</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sideoat grama</td>
<td>Bouteloua curtipendula</td>
<td>1-2'</td>
<td>light tan</td>
<td>mid</td>
<td>Tolerates hot and dry</td>
</tr>
<tr>
<td>Blue grama</td>
<td>Bouteloua gracilis</td>
<td>6-18&quot;</td>
<td>bluish purple</td>
<td>fall</td>
<td>Tolerates hot and dry</td>
</tr>
<tr>
<td>Little bluestem</td>
<td>Schizachyrium scoparium</td>
<td>2-4'</td>
<td>bronze/orange</td>
<td>fall</td>
<td>Native</td>
</tr>
<tr>
<td>Prairie dropseed</td>
<td>Sporobolus heterolepis</td>
<td>2-3'</td>
<td>yellowish/orange</td>
<td>fall</td>
<td>Native, forms cloud-like flowers</td>
</tr>
<tr>
<td>June grass</td>
<td>Koeleria macrantha</td>
<td>2-3'</td>
<td>bluish/green</td>
<td>early</td>
<td>Tufted</td>
</tr>
</tbody>
</table>


While the plants are establishing (first two years after planting) it is important that either mulch or an erosion-control blanket is placed on the mound to reduce soil runoff. Mulch should be chosen if the mound is not too step, but if the mound has steep, sloping sides, an erosion blanket should be used. Erosion-control blankets are composed of straw or coconut fiber layers, between two jute mesh layers. The blanket is staked in place, covering the entire surface of the mound; then, holes can be cut through the layers to create spots for the plants. The blanket is biodegradable, so it can be left in place. The material can be purchased at landscape supply stores.

Turf grasses have fibrous root systems that hold soil in place, require maintenance similar to a lawn, and are available in numerous varieties, including shade-tolerant, to suit site condition. Low maintenance lawn grasses such as fine fescues make a dense cover and only need to be mowed a few times a year. Fine fescues such as creeping red, hard, sheep’s, and chewing fescues (Festuca rubra, Festuca longifolia, Festuca ovina, and Festuca rubra var. commetata) are shade tolerant. Fine fescues are often sold in mixes with Kentucky bluegrass for shady sites.

There are two primary means of establishing a new lawn: seeding and sodding. The following are advantages and disadvantages to seeding and sodding from the University of Minnesota Sustainable Urban Landscape Information Site (http://www.sustland.umn.edu):
Seeding
Advantage: More grass types and varieties to chose from; Less expensive than sodding; Stronger root system development initially
Disadvantages: Initial establishment is longer; For best results, time of seeding is limited mainly to late summer and early fall; Moisture is critical for the young seedlings

Sodding
Advantages: Rapid establishment and relatively weed-free in the beginning; Good for slopes or areas prone to erosion; Can be laid anytime during the growing season
Disadvantages: Expensive; Less selection or control over kinds of grass, especially shade or drought tolerant

Erosion control is also important when establishing grass, particularly when seeding is the method. Again, an erosion-control blanket can be laid after the seeds have been put down. This will help retain moisture and protect the seeds and soil. Another product that can be found in landscape supply stores is an erosion-control blanket with seed. These are blankets made of organic material such as straw or coconut, which will decompose as the vegetation matures.

Vegetative cover is critical to insulating the system over the winter. Well-established vegetation helps hold snow close to the soil surface where it insulates the septic tank, piping, and soil treatment area. Snow helps keep the heat of the sewage and soil from escaping, keeping the frost depth shallow. In the absence of snow cover, a dense vegetative cover acts as an insulating layer, helping prevent the septic system components from freezing.

Trees and Shrubs
Shrubs and trees on and around septic systems in Minnesota present numerous limitations to the treatment and proper functioning of system components. For instance, they fail to provide adequate year-around erosion control, require additional homeowner maintenance (mulching, disease prevention, etc.), and interfere with septic system infrastructure with varying root depths and rooting structure that depends on site, soil, origin of the tree/shrub and tree/shrub species. The OSTP does not recommend planting trees or shrubs on or around septic systems due to these stated reasons, although the layout of new soil treatment systems often considers saving and protecting existing trees as shown in Figure 12.41. For additional recommendations and proper maintenance of septic systems, please refer to the Septic System Owner’s Guide (Olson et al., 2008) or the University of Minnesota Onsite Sewage Treatment Program web site.
FIGURE 12.41 Trench Layout to Conserve Existing Trees
References


Wedekind, Tim. 2007. 30 Tough Sites-Septic Mound Plants.