SECTION 4: Site Evaluation

Overview of site evaluation process .................................................................................... (4-1)
  Purpose ................................................................................................................................. (4-1)
  Overview of requirements .................................................................................................... (4-1)

Preliminary evaluation ........................................................................................................... (4-2)

Gathering information .......................................................................................................... (4-2)
  Soil survey reports and geologic atlases ................................................................................ (4-2)
  Property Limitations ........................................................................................................... (4-10)

Field evaluation .................................................................................................................. (4-17)
  Landscape position ............................................................................................................. (4-19)
  Slope .................................................................................................................................. (4-19)
  Flooding .............................................................................................................................. (4-21)
  Vegetation ............................................................................................................................ (4-22)
  Soil observations ................................................................................................................ (4-23)
  Limiting layer identification ................................................................................................. (4-25)

Soils, impacts on system design ............................................................................................. (4-32)
  Soil texture ......................................................................................................................... (4-32)
  Soil structure – preferential movement ................................................................................ (4-33)
  Soil water movement .......................................................................................................... (4-33)
  Soil loading rate .................................................................................................................. (4-42)
  Proper protection of tested area ......................................................................................... (4-43)
  Special equipment needed ................................................................................................. (4-43)

Site evaluation reporting requirements ................................................................................... (4-44)
  Soil and site additional reporting [Over 2,500 gpd] ................................................................ (4-45)

Problem sites and soils ......................................................................................................... (4-48)

Type II, III, IV and V systems ................................................................................................ (4-48)
  Systems for rapidly permeable soils .................................................................................. (4-48)
  Small lots ............................................................................................................................. (4-48)
  Lack of unsaturated soil ..................................................................................................... (4-49)
  Disturbed soil ....................................................................................................................... (4-51)
  Flooding ............................................................................................................................... (4-52)
  Slowly permeable soils ....................................................................................................... (4-53)

Descriptions ......................................................................................................................... (4-53)
  Texture ................................................................................................................................. (4-53)
  Structure .............................................................................................................................. (4-53)
  Color .................................................................................................................................. (4-54)
  Landscape ............................................................................................................................ (4-54)

References ............................................................................................................................ (4-54)
SITE EVALUATION

Overview of Site Evaluation Process

Purpose

A good site evaluation is the first phase of the design process and provides sufficient information to select a suitable, cost-effective treatment system. To this end, a site evaluation should be a systematic process that provides information with enough detail to be useful for the design phase.

This evaluation must collect relevant data to allow a designer to determine whether or not a lot contains a sufficiently large area with suitable soil to serve the proposed uses of the lot. The landowner/client should be aware that a soil and site evaluation does not guarantee that the lot is suitable for a subsurface sewage treatment system (SSTS). Many sites present severe limitations to the proper design of a SSTS in Minnesota. A designer should present findings objectively and honestly to the client(s).

The designer is responsible for all data reported. Portions of the site evaluation may be completed by someone other than the designer, such as helpers who dig holes and carry water to percolation holes; however, the designer must select the sites for percolation tests and soil bore holes, make measurements, evaluate and describe soil profiles, and personally certify the reported data.

Evaluators must provide reports to the proper permitting authorities and to the client(s) for each site evaluation—both for sites that are suitable and those sites that are found to be unsuitable for a SSTS.

Overview of requirements

The site evaluation considers placement of the SSTS in relation to setbacks, topography, and other factors; determines the proposed elevations of the system, with accurate and complete soil descriptions and noting periodically saturated soil, bedrock, and other limiting conditions; and determines the sizing of the SSTS by accurate soil texture and structure description. Sizing can also be accomplished by percolation tests or testing using other approved methods.

The site evaluation consists of three parts: a preliminary evaluation, a field evaluation, and site evaluation reporting. This Section discusses each of these three parts. Forms have been created to report your findings and are found in Section 13 of this manual.
Section 4: Site evaluation

Preliminary Evaluation

Gathering Information

While there is certainly no substitute for a field site evaluation, a preliminary evaluation provides useful knowledge about the site and allows the designer to work more efficiently in the field.

7080.1100 Subp. 76. Site means the area required for the proper location of the ISTS.

Conducting and reporting a complete site evaluation requires collecting and summarizing many different types of information. Designers must collect the required information from various sources, which are seldom compiled at a central location, so adequate time must be allotted to gather and summarize this information for this phase of the evaluation. Table 4.1 provides common locations where critical information can be found. The determination, location, or existence of the following characteristics is part of the requirements for the preliminary evaluation (see 7080.1710 for all specific requirements).

<table>
<thead>
<tr>
<th>TABLE 4.1 Where to Find Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Needed</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>legal location</td>
</tr>
<tr>
<td>house specifications (location, number of bedrooms, size water-using devices)</td>
</tr>
<tr>
<td>easements, utilities legal requirements of design/installation setbacks: wells, property, and roads</td>
</tr>
<tr>
<td>topography: slope, surface drainage topographic maps, soil survey information</td>
</tr>
<tr>
<td>soils information: percolation rate, water table, bedrock, flooding, colors, textures, structures, etc.</td>
</tr>
<tr>
<td>flooding information</td>
</tr>
<tr>
<td>well location and depth</td>
</tr>
</tbody>
</table>

Soil Survey Reports and Geologic Atlases

Soil Survey Vernacular

Although the county soil survey cannot be used to determine the suitability of a site for an ISTS, it is an excellent source of soil and site information for the preliminary evaluation of sites. The soil profile descriptions found in archived soil survey publications (http://soils.usda.gov/survey/online_surveys/minnesota/) are described by trained soil scientists. Some of the information included in the soil survey may not be necessary for a preliminary site evaluation; however, the following information is provided as a minimum of items to understand from the soil survey. Section 3: Soils also provides detailed discussion of soil components, textures, classification, and structures.

The following terms are used in the field of soil science and can be found in the soil survey information as well as referenced in MN Rule Chapter 7080. A brief description of each term is included.

A horizon(s) (topsoil): These are mineral (sand, silt and clay) soil horizons that form at the ground surface. They are characterized by an accumulation of decomposing organic matter mixed with the mineral fraction. They are darker in color than horizons deeper in the soil profile.

7080.1100 Subp. 87. Topsoil means the natural, in-place organically enriched soil layer with a color value of less than 3.5.

E horizon(s): These are mineral horizons in which the main feature is loss of clay, iron, and/or aluminum, leaving a concentration of resistant sand and silt particles (Glossary of Soil Science Terms, 2007). These soil colors are commonly high value and low chroma, when colored using the Munsell Soil Color Charts. (See “Soil Colors” in Section 3: Soils for more discussion of the Munsell Soil Color Charts.) Common characteristics of E horizons are as follows:
An E horizon is usually, but not necessarily, lighter in color than an underlying B horizon. In some soils the color is that of the uncoated sand and silt particles.

An E horizon is most commonly differentiated from an overlying A horizon by lighter color and generally has measurably less organic matter than the A horizon.

An E horizon is commonly near the surface below an A horizon and above a B horizon. The soil structure is commonly platy, but may be blocky or granular.

B horizons (subsoil): These horizons are formed below an A and/or E horizon and dominated by weathering of the original parent material; by concentration of organic matter, clay, iron, aluminum, carbonates or by the removal of carbonates; and has formed a platy, blocky, or prismatic structure.

7080.1100 Subp. 81. Subsoil means a soil layer that has a moist color value of 3.5 or greater and has undergone weathering and soil formation processes.

C horizons (parent material): These horizons are little affected by weathering. They have little to no structure development except for random planes of weakness. In Minnesota, the soil development ends at the start of the C horizon, which in most cases is less than five feet in depth due to freeze/thaw, wet/dry cycles and common rooting depths.

7080.1100 Subp. 57. Parent material means the unconsolidated and chemically weathered geologic mineral or organic matter from which soils are developed by soil forming processes.

Understanding the above scientific nomenclature used to designate various horizons in the soil survey will assist the designer in interpreting the soils on site for their ISTS suitability.

Soil Survey In Preliminary Site Evaluation

For the preliminary site investigation, consult the soil survey and located the property to identify the soil map unit and determine the following soil features:

- landscape,
- landform,
- parent material(s),
- landscape position,
- map unit inclusions,
- slope,
- depth to saturation,
- depth to bedrock,
- flooding potential,
- matrix colors,
- mottle colors,
- texture,
- structure,
- consistence, and
- saturated hydraulic conductivity.

Using the preliminary evaluation form found in Section 13 to record soil survey information and other information gathered in the preliminary evaluation will assure these properties have been identified and recorded for later uses.

Hard Copy Soil Surveys

Printed hard copy soil surveys are no longer supported for use by the US Department of Agriculture - Natural Resources Conservation Service (NRCS). Some counties where the map unit symbols have not changed the detailed maps at the back of these soil surveys can still be used to locate parcels and soil mapping units that may exist on the property of interest. Any soil properties or interpretations should be generated at the Soil Data Mart or the Web Soil Survey websites. The tabular information and interpretations should be
generated at the Soil Data Mart or the Web Soil Survey websites. The tabular information and interpretations from from printed soil surveys are outdated and unsupported.

**Online Soil Surveys**

Soil surveys have entered a new era across Minnesota and the United States. The official soil survey information and documentation now resides online at http://websoilsurvey.nrcs.usda.gov (verified 4/20/07) or http://soildatamart.nrcs.usda.gov/ (verified 1/5/09). While users may choose to print off information, the information on this site is subject to change, so the site should be checked frequently for updates.

Online soil surveys still present soil lines on a photographic background indicating the boundaries between different soil types. These maps show the occurrence and distribution of each kind of soil.

For counties that do not have published soil surveys, the county Soil and Water Conservation District or USDA NRCS office can often provide soils information. For an updated status of each county in Minnesota visit: http://www.mn.nrcs.usda.gov/technical/soils/images/maps/mnstatus.pdf (verified 1/5/09).

Locate the site on the survey (GPS coordinates, county, address, township, range, section, or use the zoom function) and, following these steps, determine what soil map units exist on the parcel:

1. Outline the desired parcel/area using the Define AOI (Area of Interest) tool, which is located in the legend along the top of the map window.
2. Once the AOI has been defined, select the tab for “Soil Map” near the top of the browser window.
3. You will now see a display of the aerial photograph with soil lines over the top. In the map's legend, you will see a summary of map units, map unit names, acres in the AOI, and percent composition of the AOI. Map units are denoted by symbols such as 401C.
4. List the map unit symbols found at your location.
5. Select the third tab, entitled “Soil Data Explorer,” to map selected soil properties over the AOI.
6. Now select the “Suitabilities and Limitations for Use” tab.
7. Select the “Sanitary Facilities” tab.
8. Under this rating, there are numerous interpretations. The five interpretations we are interested in are:
   - Septage Application - Incorporation or Injection (MN)
   - Septage Application - Surface (MN)
   - Septic Tank Absorption Fields - At-Grade (MN)
   - Septic Tank Absorption Fields - Mound (MN)
   - Septic Tank Absorption Fields - Trench (MN)

These interpretations were developed based on MN Rule Chapter 7080 and are accurate on a regional scale. They are not meant to be a substitute for field site evaluation work.
9. Select the “View Ratings” button to view map of ratings with tables of soil map units and their individual suitabilities.

10. Note: this does not replace recording specific soil properties, which are required by Minnesota Rule Chapter 7080.1700 (as discussed above). To determine these properties, select the “Soil Reports” tab and access the desired/required information from the selected reports. The Map Unit Description (MN) report under the AOI tab also provides some desired/required preliminary soil site information. Alternatively, you may search individual soil series’ properties by accessing the Official Soil Series Descriptions (OSD) website (http://soils.usda.gov/technical/classification/osd/index.html, verified 4/23/2007) and searching for soils by their specific soil series name as determined from the AOI legend on the web soil survey.

**Detailed Soil Survey Maps**

In order to make site evaluation interpretations accurately from soil survey information, it is necessary to have a basic understanding of how the detailed soil survey is created and what is represented on these soil maps.

Soils vary continually across a landscape. The soil survey represents how soils occur on this landscape by investigating the causes of soil variation within landscapes. This soil survey process then identifies areas with similar soils and landscape properties and delineates these areas as unique soil mapping units. While differences still exist within these map unit areas, the soil differences are understood. Soil characteristics, such as percent organic matter, depth of top soil, texture, and depth to water table or bedrock, differentiate soil map units and relate to different use and management across landscapes.

The soil scientist making a soil map uses limited and well-defined ranges in soil properties to classify soils and for development of soil map units. To accomplish this, the soil scientist studies and traverses landscapes, investigating and recording not only at soil borings, pits, and excavations, but also slope and vegetation characteristics.

These observations not only aid in predicting how soils vary across the landscape, but also in determining the suitability of a soil for a specific intended use. An experienced soil scientist maps between 300 and 600 acres of soil a day. Soil descriptions are conducted during the process to confirm and refine the predictions made about the occurrence of soils on the landscape.

During the survey process, data is collected on the physical and chemical properties of the soils as well as on the depth to saturated soil.

The finished product of a detailed soil survey is a series of soil maps prepared on a photographic base for an entire county. The size of the soil mapping unit that can be delineated on these maps is dependent on the final scale of the map. A soil map completed at a scale of 1:15,840 (one inch = 1,320 feet) will have the smallest delineation, covering about 2.5-5 acres on the land surface. This scale limitation is still present, even in the modern digital versions of the soil surveys. Soil surveys are not created to generate reliable information for a specific site.

Scale limitations impact the composition of soils within the mapping unit delineation. The inclusion of varying soils within a single delineation may at times be as much as 30% or more of the mapping unit. These soils may possess similar or different soil characteristics that influence their suitability for an ISTS. The inclusions presented are well-defined, quantified, and characterized.
Since soil treatment areas cover only 1,000 to 5,000 square feet of the parcel, a soil survey would not provide enough accuracy to determine the suitability of the soils and site. Unfortunately, a soil survey created to this detail is extremely rare and costly to produce. Only high intensity uses warrant such soil surveys. In absence of such a site-specific soil survey, the designer must investigate the site and soil characteristics and interpret their findings into a recommendation for an ISTS.

**Edition age**

Hard copy soil surveys are no longer the official record for any soil interpretations. They are considered outdated by modern standards. The determination of soil mapping units from the detailed soil mapping pages is still valid for some soil surveys (check county map unit legend on Soil Data Mart vs published soil survey map unit legend). Beyond this use, all other interpretations and soil properties must utilize the internet resources referenced in the preceding sections.

**Online availability**

In 2006, tabular soil survey information became available online for all counties in Minnesota, via the Soil Data Mart website. In 2008, 83 soil survey areas have digital soil maps available via the Web Soil Survey. See [http://www.mn.nrcs.usda.gov/technical/soils/images/maps/mnssurgo.pdf](http://www.mn.nrcs.usda.gov/technical/soils/images/maps/mnssurgo.pdf) for current list of digitized soil surveys. The web soil survey, official soil series descriptions, and soil data explorer should be used for all site evaluation work.

**Saturated Hydraulic Conductivity**

Permeability of the soil is now listed as the saturated hydraulic conductivity. For a complete discussion of saturated hydraulic conductivity, including conversions, see “Saturated Hydraulic Conductivity” in Section 3: Soils.

**Linear Extensibility**

Linear extensibility is the current term for what was called shrink-swell potential. The data are expressed as a percent change of an unconfined soil ped (length) as soil dries from a moist to dry state. Typically soils that possess a high linear extensibility potential have over 30% clay-sized soils and a specific type of clay that actually expands (swells) in size when moisture is present in the soil and contracts (shrinks) upon soil drying. These areas are identified and characterized by large cracks in the soil when dry. The largest area in Minnesota with this potential is in the Red River Valley of the North.

This information is available in the Soil Data Explorer > Soil Properties and Qualities > Soil Physical Properties > Linear Extensibility tab of the web soil survey [http://websoilsurvey.nrcs.usda.gov](http://websoilsurvey.nrcs.usda.gov).

**Water Features**

The Soil Moisture, Ponding, Flooding (MN) report has improved upon data previously presented in the hard copy soil surveys. The USDA-NRCS along with various other organizations, has begun collecting and summarizing field-based water monitoring data to provide more accurate monthly high and low water status readings throughout the entire calendar year.
The Soil Moisture, Ponding, Flooding (MN) report should be utilized to address the potential for:
- flooding hazards
- ponding hazards
- depths to water table

Access this report using the web soil survey - Soil Data Explorer > Soil Reports > Water Features > Soil Moisture, Ponding, Flooding (MN).

**Soil Treatment Areas - Trench, At-Grade, Mound**

The septic tank absorption fields ratings found in the web soil survey can be a useful predictor of site limitations that may occur during a site evaluation. There are three ratings developed specific to Minnesota Rule Chapter 7080 for trench, at-grade, and mound ISTS. These ratings vary from “Not limited” to “Extremely limited.” A “Not limited” rating means few limitations have been detected in the soil survey information, while a rating of “Extremely limited” indicates severe limitation(s) for that type of ISTS. The tables produced below the web soil survey map will list the soil characteristic(s) that limit suitability. Three maps for each parcel can be created for each type of ISTS. These interpretations only exist in Minnesota and were produced through a collaboration of the USDA-NRCS, MPCA, and University of Minnesota. These ratings should be used as a guide when conducting a preliminary site evaluation.

These data can be accessed via the web soil survey by selecting Soil Data Explorer > Sanitary Facilities > Septic Tank Absorption Fields.

**Drainage Classification**

Soil drainage classification describes the natural frequency and duration of wet periods. It is an interpretation available in the soil survey that has limited application to ISTS suitability.

Within the web soil survey, select Soil Properties and Qualities > Soil Qualities and Features > Drainage Class.

**Slope Phases**

Slope phases represent the common land slopes found within these areas on the soil survey. They are labeled after the map unit symbol.

**Reading the Soil Survey**

For example: The soil map unit symbol HcC2 (104C2) appears on many soils maps in Minnesota. (See Figure 4.1.) As indicated in the soil map legend, Hc or 104 refers to the soil series Hayden clay loam. The soil map unit will also include areas of other soils that were too small in area to map out. As mentioned previously, every square foot of the mapping unit area is not necessarily a Hayden clay loam.
The second part of the soil map unit symbol indicates the different slope phases used in Minnesota. They are indicated by capital letters and defined in percent of slope (Table 4.2).

<table>
<thead>
<tr>
<th>TABLE 4.3 Erosion Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion Class</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

The third portion of the map symbol is the erosion class. This part of the soil mapping unit has been dropped in the newer soil surveys because of inaccuracies in predicting erosion. Table 4.3 explains the erosion classes 1-3.

So the map symbol **HcC** or **104C** indicates a Hayden clay loam with six to 12 percent slopes.

**Map unit inclusions**

The delineated areas on the aerial photographs are called soil map units, which consist primarily of the soil for which the unit is named and soils with similar characteristics. In addition, there are areas within the unit consisting of soils with different characteristics. While the soil survey alone cannot be used to determine the suitability of a specific site, it does provide useful background information and may indicate potential problems that may be encountered on the parcel.

Besides providing information on the spatial extent and kind of soil, the soil map shows other physical features. Since the map has an aerial photo background, it is possible to determine different land features and uses directly from the map, such as woodland, farmland, roads, cities, buildings, lakes, streams, and airports. Drainageways are shown with special map symbols, as are small wet spots, marshy areas, and sandy, clayey, gravelly, or stony spots. The standard symbols for these features are presented in the legend of the soil survey.

To demonstrate how survey data and accompanying soil maps can be used to help determine suitability and system design, consider another typical mapping unit found in many central and southern Minnesota counties. The mapping unit could be represented on the soils map by **104B** or **HdB**.

In either case, by looking at the soil map unit legend, the name of the mapping unit is Hayden fine sandy loam, two to six percent slopes. Series and the Map Unit Description (MN) indicate that the Hayden fine sandy loam has no zones of soil saturation to a six-foot depth and that the fine sandy loam texture at the surface changes to a sandy clay loam in the subsoil.

There is a distinct possibility that minor soil components, also called inclusions within this mapping unit may be present in the 3,000 square foot area selected. On the Web Soil Survey the Soil Reports has a check box feature to include the minor soils as part of the soil report. The survey lists three minor components. These are Nessel, Dundas, and Braham soils.

From the Map Unit Description (MN) report, it is apparent that Nessel soils have a periodically saturated zone occurring within two to five feet, with a saturated hydraulic conductivity in the subsoil about the same as that of the Hayden soils. For the Dundas soils, which occur in small, narrow drainageways, periodic zones of saturation occur within one to three feet of the surface, with a saturated conductivity in the subsoil slower than the Hayden soil. The Braham soil is a well-drained soil like Hayden, with a faster hydraulic conductivity in the surface layer and similar conductivities in the subsoils.
If Dundas or Nessel soils occur within the proposed treatment system site, there will be a problem due to the need for unsaturated soil beneath the trenches. At certain times, maintaining vertical separation to saturated soil conditions will not be possible if the trenches are installed at a depth of two to three feet in the original soil.

Any site with the Dundas or Nessel soils on the property should be avoided when the field site evaluation is conducted. On the other hand, if the Braham soil is present (even though it is different from the Hayden soil, with a coarser-texture and deeper surface layer), the installation of a shallow standard trench system can be used to take advantage of the more permeable surface layer.

**Soil Series Limitations**

There are numerous soil series represented on most parcels and several hundred per soil survey area. Some differences among the soil series can be quite minor, and other differences can be very significant. Soil limitations to an ISTS can vary widely.

**Coarse Sand Treatment Concerns**

Coarse sands do not have many surface areas for treatment and water holding capacity. These soils will allow septic tank effluent to permeate through these layers too rapidly and must be addressed, either by not including these coarse layers as part of the required three feet of vertical separation, or by following the requirements in 7080.2260 for rapidly permeable soils (see “Problem soil areas” later in this Section). If the design for these soils follows 7080.2260, the system is classified as a Type II system.

Soil textures included in coarse sand concerns include coarse, medium, and fine sand; and loamy sand, loamy fine sand and loamy very fine sand. (7080.2260 Subp. 1).

**High clay content soils: acceptance and smearing concerns**

Soil textures classified as sandy clay loam or finer textures have a large amount of surface area. A high surface area will result in many potential sites for treatment of septic tank effluent and a high water holding capacity. These soils will not permit large volumes of effluent to permeate through these soils. The sizing of these systems is largely based on achieving hydraulic acceptance of effluent. There are some soils that will have too much clay to allow any significant amount of effluent to permeate through the soil and will require additional design consideration.

**Plastic limit**

The higher the clay content, the higher the likelihood that the soil will hold water. Soils that are saturated or nearly saturated have lower soil strength and compact, smear, and move more than the same soil under dry conditions. In order to assess the potential of a soil to smear, the plastic limit must be tested.


A five-step process for determining whether a soil is suitable for construction, or above the plastic limit, is discussed in Section 3, page 35.
**4-10  SECTION 4: Site Evaluation**

*Above ground system required*

ISTS may require distribution above natural grade may be due to periodically saturated soils, bedrock, slow permeabilities, or high permeabilities.

**Slopes**

7080.1100 Subp. 77. Slope means the vertical rise or fall divided by the horizontal distance, expressed as a percentage.

Vegetative and topographic information is available on U.S. Geological Survey (USGS) 7.5 minute quadrangle maps, also referred to as topographic maps. These maps indicate areas of excessively steep slopes, depressions, and surface drainage characteristics. The slope information can also be assessed by investigating the soil survey report online (http://websoilsurvey.nrcs.usda.gov).

Siting an ISTS on a slope will require special construction considerations. A proper design should ensure that equipment can access and operate as expected at the proposed soil treatment area.

**Water table depths**

A periodically saturated soil or water table depth is a restrictive condition that limits treatment of effluent by the soil. Ordinary high water levels of surface water bodies must also be investigated to allow for proper ISTS functioning. The soil survey provides a preliminary estimate of this limiting depth, but site conditions may vary. Accurate interpretation of this soil characteristic is discussed in Section 3: Soils, Soil Colors - Redoximorphic Features.

**Permeability**

Soils with high permeabilities (sands) allow too much effluent to pass without proper treatment, while low permeability soils (clay loams and clays) do not hydraulically accept large volumes of effluent. See saturated hydraulic conductivity section for more information.

**Property Limitations**

**Determining Homeowner Preferences**

Before beginning the field-based evaluation or physical investigation of the lot, determine the needs and wants of the property owner. Also, it is important at this stage to evaluate the amenities of the dwelling (bedrooms, water using devices, etc.). This will help estimate flow amounts. The major items for a designer to consider in developing a lot are the following:

- Location of the house/ building improvements including the following MN code requirements:

  7080.1710 A. design flow for the dwelling, dwellings, or other establishments.
7080.1710 B(4). existing and proposed buildings or improvements on the lot.

Lot line locations must be confirmed in the field using appropriate documentation including land surveying, legal descriptions, etc. including the following MN code requirements:

7080.1720 Subp 2. Lot lines shall be confirmed in the field using the most recent document source.

Proposed location of the onsite sewage treatment system and:

7080.1710 G. all required setbacks from the system.

To the owner of an undeveloped lot, however, major concerns usually include the location, aspect, view, and type of house proposed. In addition, such projected improvements as a driveway, garage, patio, or swimming pool may conflict with the area best suited for onsite sewage treatment. Therefore, it is important to discuss the site evaluation for the ISTS at an early stage in developing plans for the lot. It is a rare instance when all the desired improvements can be located exactly where the lot owner desires. Priorities must be established (a properly designed, sited, and installed ISTS is a high priority) and trade-offs are inevitable.

Location of the proposed or existing water supply wells (see 7080.1710 B(1-3, 5) and 7080.1710 K. for detailed information).

All lot setbacks and easements including the following MN code requirements:

7080.1710 C. easements on the lot.
7080.1710 D. the ordinary high water level of public waters, if adjacent to the lot.
7080.1710 E. floodplain designation and flooding elevation from the published data or data that is acceptable to and approved by the local unit of government or the Department of Natural Resources, if applicable.

This information is found in the preliminary evaluation form and will be required to properly design an ISTS, especially in the preliminary evaluation process. (A copy is included in Section 13: Forms).

Setbacks

There are numerous reasons that a setback can exist on a site. It is the job of the designer to determine what setbacks exist, determine the extent of their impact on the parcel, and identify suitable areas for an ISTS given these limitations. It is important to note that setbacks can differ between the sewage tank and the soil treatment area.

7080.1100 Subp. 72. Setback means a separation distance measured horizontally.

Properly siting an ISTS requires an understanding of the many setback requirements. These requirements are summarized in Tables 4.4 and 4.5 below and are illustrated in Figures 4.2 and 4.3. For more information on setbacks and requirements review Section 2 of this manual, MN Rules Chapter 7080.2150 Table VII, and MN Rules Chapters 4725 (Wells), 4715 (Plumbing), 6105 (Rivers), and 6120 (Shoreland). Many of these setbacks are determined by these chapters of rule. The Preliminary Evaluation Form (Section 13) lists all of the setbacks that must be assessed.
## Section 4: Site Evaluation

### Table 4.4 Setbacks from a Soil Treatment System

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any water supply well with less than 50 feet of casing and not encountering 10 feet of impervious material (See MN Rules Chapters 4725.4450 and 7080.1710 B. for a complete description of setbacks from all types of water supplies.)</td>
<td>100 feet</td>
</tr>
<tr>
<td>Any other water supply well (MN Rule Chapter 4725) (7080.2150 Table VII)</td>
<td>50 feet</td>
</tr>
<tr>
<td>Building (7080.2150 Table VII)</td>
<td>20 feet</td>
</tr>
<tr>
<td>Streams, lakes, or other bodies of water (Shoreland Management Act (MN Rule Chapters 6105 and 6120))</td>
<td>50, 75, 100, 150 feet (depending on classification)</td>
</tr>
<tr>
<td>Property line or any buried pipe distributing water under pressure (7080.2150 Table VII and MN Rule Chapter 4715)</td>
<td>10 feet</td>
</tr>
</tbody>
</table>

### Table 4.5 Setbacks from a Septic Tank

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property lines (7080.2150 Table VII)</td>
<td>10 feet</td>
</tr>
<tr>
<td>Buried pipe distributing water under pressure (MN Rule Chapter 4715)</td>
<td>10 feet</td>
</tr>
<tr>
<td>Building (7080.2150 Table VII)</td>
<td>10 feet</td>
</tr>
<tr>
<td>Any water supply well (MN Rule Chapter 4725)</td>
<td>50 feet</td>
</tr>
<tr>
<td>Streams, lakes, or other bodies of water (Shoreland Management Act (MN Rule Chapters 6105 and 6120))</td>
<td>50, 75, 100, 150 feet (depending on classification)</td>
</tr>
</tbody>
</table>

### Figure 4.2 Pressure Testing Requirements

- "Sewer lines must be pressure tested if they are within 50' of a water supply well and cannot be placed closer than 20' (See MN Rules Chapter 4725 for complete details)."
Unknown buried items (fuel oil tanks, old drainfields)

These areas, where identified, may present issues for the proper functioning of various components of an ISTS, so it is best to avoid these areas when possible.

Property lines

Property lines must be established before the field-based site evaluation is completed to the satisfaction of the property owner. If the property owner or their legal representative disputes lot line locations, a licensed land surveyor should be hired to verify property lines.

Lot line verification (survey)

Lot lines can require verification in many areas. If there are not clear boundaries or identifiable survey-grade markers, then a licensed land surveyor may be required to establish the legal lot lines. Surveying lot lines assures that the home, ISTS, and etc. will all be sited in the proper locations without infringing on adjacent parcels or setbacks.

Easements

An easement is the right to use another person’s land for a specific, stated purpose. Knowing where the easements are located and the type of easements that exist will prevent improper siting of a SSTS.

Road right-of-ways

A road right-of-way is a type of easement that gives road workers the right to travel across property owned by another person.

Utility easement

The utility easement will allow access by the utility company to use another person’s land for the said utility.

Dwellings

Location or locations of existing and/or proposed dwellings and other buildings can severely limit the potential for an ISTS on many parcels. Careful consideration of the location of all structures is required to adequately evaluate a site.

7080.1100 Subp. 25. Dwelling means any building with provision for living, sanitary, and sleeping facilities.

Lakes, rivers, streams

According to the Shoreland Management Act (MN Rule Chapter 6120), all land within 1000 feet of lakes greater than 25 acres (10 acres in municipalities) or all land within 300 feet of rivers and designated floodplain with a drainage area of two square miles or greater must follow shoreland management standards. Included within these standards are differing distances of setbacks from lakes, depending on the lake class. Similar setbacks exist for differing river classes. The local permitting authority can make these setbacks more restrictive. It is important to verify setbacks with the local zoning office before the design phase.
Designers must also be aware of MN Rule Chapter 6105, which includes setbacks and use limitations for areas designated as Wild, Scenic and Recreational Rivers. Rules can vary for different water bodies. Currently, portions of the St. Croix River, Kettle River, Mississippi River, North Fork of the Crow River, Minnesota River, Rum River and Cannon River all fall into these classifications and may have different setback distances or restrictions. Inquire about any of these specific limitations at the local governmental unit that issues SSTS permits.

**Wells**

Drinking water supply and other water wells (public or private) require proper protection from contamination as a result of many human activities. To ensure that an ISTS is not negatively impacting a well, minimum setbacks have been established. The type and depth of well will have an impact on the setback distances. Also, verify with local governmental unit that you are not in an inner wellhead management zone or the wellhead protection area of a public water supply. These requirements are part of MN Rule Chapter 7080.1710 and require knowledge of the MN Well Code, MN Rule 4725.

**Ownership**

**Legal Land Survey Description**

Legal land surveys in Minnesota are based on a township/range description, with a typical township containing 36 sections of land, each of which is one square mile, or 640 acres, in size.

Townships contain 36 sections of land numbered in a particular sequence starting at the northeast corner of the township. Thus section 7 is immediately below section 6, section 12 is immediately south of section 1, section 13 is south of section 12, section 18 is south of section 7, and so on (Figure 4.4).

Within sections, divisions are made on a quarter basis with respect to the four cardinal directions. Figure 4.5 shows a typical section with its divisions. When subdivisions are platted, individual properties are assigned block lot numbers. A complete legal description includes township and range, section number, section division, block number, and lot number.
Townships also have numbers that are counted as north of baselines. The township is also given a range number measured east or west from a principal meridian. Within the section, the division is in quarters with respect to the cardinal four directions.

The southwest quarter of section 23 contains 160 acres, and the southwest quarter of the southwest quarter (SW 1/4, SW 1/4) contains 40 acres and is found in the extreme southwestern portion of section 23. This designation may be used for the legal description of larger tracts of land. When subdivisions are platted, the individual properties normally have block and lot numbers.
Zoning
The local zoning office can verify that the property can be used as intended/proposed. At the same time, required setbacks from buildings, property lines, road right of ways, utility easements, surface waters, wells, and any other covenants on the property should be investigated. A good way to keep track of these requirements is to locate them on a scale map. Graph or cross-hatched paper can be used to make a map of the lot. In the lot illustrated in Figure 4.6, soil borings and percolation tests have been taken in the area proposed for the ISTS. The proposed house location is shown, along with the proposed well location.

The preliminary site evaluation required information is absolutely necessary on a permit application in order to determine the possibility of a location for sewage treatment. The information presented by the application should always be checked against the soil survey information together with a brief site walk through before the permit is granted.

If the site is near surface waters, particularly rivers and streams, there may be a floodplain map that gives the dimensions and elevations of areas that may be flooded. This information may be available from the local zoning office. Other potential sources are the Department of Natural Resources Regional offices and local Watershed District offices. Information on required setback distances from lakes and streams are also available in these offices.

Wetlands are also a protected resource in Minnesota (Wetland Conservation Act, 1991). The local government unit or the DNR has preliminary locations of potential wetland areas. These areas must be identified and delineated by a wetland delineator before the field evaluation for an ISTS occurs. For additional information about wetlands in Minnesota, contact the MN Board of Water and Soil Resources.

Field Evaluation
A field-based site evaluation is the only way to accurately determine the actual conditions present on the site. A field evaluation should be done regardless of the results of the preliminary evaluation.

All interested parties should be present at the time of the field evaluation so that all can see the same conditions and issues can be discussed immediately.
At least 48 hours before beginning any digging for soil investigation or system construction, you must (MN State Statute 216D) contact Gopher State One Call for the location of underground utilities. In the metro area, call (651) 454-0002. Elsewhere, call (800) 252-1166. Be prepared to answer where and when you will be digging (legal address, date, etc.).

The preliminary evaluation, discussed above, is a comprehensive investigation and characterization of geological, hydrological, topographic, soil, and setback factors to determine the potential for site suitability. The preliminary evaluation is not meant to replace a field evaluation. It simply provides the background data for an effective and efficient field evaluation.

Nearby road cuts, railroad embankments, or other exposed slopes may provide a broad view of the landscape, soils, and geology of the area including the site, so don’t limit your investigation to the lot itself. A field evaluation must include the following items per 7080.1720 (for a complete list of detailed requirements, see MN Rule Ch 7080.1720. See also forms section - Field Evaluation, Soil Boring Log and Percolation Test forms):

Subp. 2. Lot lines. Lot lines shall be established to the satisfaction of the property owner or the property owner’s agent. Lot improvements, required setbacks, and easements must be identified.

Subp. 3. Surface features. The following surface features must be described:
   a. the percent and direction of the slope at the proposed system location;
   b. vegetation types;
   c. any evidence of cut or filled areas or disturbed or compacted soil;
   d. the flooding or run-on potential; and
   e. a geomorphic description.

After lot boundaries have been established, the process of selecting locations for the various improvements can begin. The first observations on the site should rule out areas that are obviously unsuitable. A check of the vegetation and topography will help rule out some areas of wet soil, bedrock outcropping, steep slopes, and drainage ways.

Carefully evaluate topography, landforms, vegetation (including large trees the owner may want to preserve or wetland vegetation indicating a high water table), drainage ways, recent construction activities that may have disturbed or removed the topsoil, and any other physical features impacting the site. The soil treatment area should be located in original, naturally occurring mineral soil.

7080.1100 Subp. 59. Original soil means naturally occurring soil that has not been cut, filled, moved, smeared, compacted, altered, or manipulated to the degree that a different soil loading rate is needed from natural soil conditions.

7080.1720 Subp. 4. Soil observations. A minimum of three soil observations are required for the initial and replacement soil treatment area and at least one soil observation must be performed in the portion of the soil treatment area anticipated to have the most limiting conditions. The total number of soil observations required is based on the judgment of the certified individual or the local unit of government. If the replacement soil area is not contiguous with the initial soil treatment area, then the designer would need to have a minimum of six soil observations.

The soil observations must utilize tools that preserve soil integrity so that undisturbed soil colors, textures, etc. can be described per 7080.1720 Subp. 5. The purpose of this observa-
tion is to determine depth to periodically saturated soils, bedrock, standing water and any other soil characteristics import to the proper functioning of a SSTS.

If the soil texture and structure observation is conducted in order to determine the soil loading rate utilizing Table IX, 7080.2150 Subp. 3. E., a method must be used to accurately determine soil structure and soil consistence. This is typically done by soil pits or other method approved by the local government unit (LGU) as long as undisturbed structure can be observed. Several soil observations are commonly conducted across the proposed area to adequately assess soil variations, but a minimum of one soil observation is required for system sizing. The recommended depth of excavation is to the depth of the periodically saturated layer, bedrock or other limiting condition or three feet below the proposed depth of the system, whichever is less.

Subp. 5. Soil descriptions. Each soil profile observed at the proposed soil treatment area must be evaluated under adequate light conditions with the soil in a moist unfrozen state for the characteristics discussed in Section 3: Sewage Treatment Utilizing Soil, including:

- The depth of each soil horizon,
- The soil matrix and mottle colors,
- A description of the soil texture and consistence,
- Depth to the bedrock,
- Depth to the periodically saturated soil,
- Depth of standing water in the hole, and
- Any other soil characteristic, which may affect system design.

Subp. 6. Determination of loading rate and absorption area size. The effluent loading and absorption area size must be determined by either a soil description, following 7080.1720 Subp. 5. (see above discussion), or percolation tests, following 7080.1720 Subp. 6., as required by the local unit of government (see “Determination of percolation rates of most restrictive horizon” on page 44 for more detailed information.).

Subp. 7. Site protection. The proposed soil treatment and dispersal area site shall be protected from disturbance, compaction, or other damage by staking, fencing, posting, or other effective method.

Both the owner and the designer should have a written plan on uses and future plans for the property. Since it is much easier to remove lines on paper than to move structures such as water wells or other improvements, this is the time to determine the suitability of proposed locations. The crests of knolls and hills, as well as slightly sloping portions of hills, are likely areas for placement of an ISTS. Avoid depressions, drainage swales that collect runoff from the surrounding area, and excessively steep slopes. The landscape and slope forms should be observed and recorded.

Consider future landscaping plans to assure site access not only during the construction phase but also afterward, so that the septic tank can be pumped as required. Identifying two or three potential ISTS locations on the lot provides additional flexibility if the initial site is found to be unsuitable. It is required for newly platted lots (platted after March 31, 1996) that two areas suitable for a soil treatment area are located on each lot, so check with the local permitting authority before moving to phase II of the design.
Landscape Position

Landscape/Topography
Landscape is the collection of specific landforms that can be observed in a single view. Identification is facilitated by consulting with the geologic atlas and soil survey reports for the area, as well as local soils and geology professionals.

Landform
A landform is a specific feature in the landscape (e.g. hill, pothole, mountain, etc.) that has a characteristic form. We have many landforms in Minnesota that present unique soil and site issues for locating ISTS. The geologic atlas and the soil survey reports will be the best sources of this information locally, as well as local soils and geology professionals.

Hillslope Position and Slope Shape

Landscape is an important factor that can determine surface and subsurface flow of water and should be a major consideration when locating an ISTS. The hillslope position and slope shape for the area should be identified as shown in Figure 4.7. This information is useful in determining surface and subsurface drainage patterns. For example, sloping convex areas typically have good surface and subsurface drainage away from the area, while concave sloping areas such as potholes, drainage ways, and foot slopes are more likely to possess wetter soil conditions.

More information and descriptions can be found in the Field Book for Describing and Sampling Soils (USDA-NRCS, 2006).

Slope
The slope of the soil surface has several distinct properties: gradient, complexity, configuration, length, and aspect. Slope influences the retention and movement of water, rate and amount of runoff, potential for soil slippage, accelerated erosion, ease with which machinery can be used, and soil-water state.

Slope steepness is critical in system design and must be accurately determined and recorded. One method is to use a clinometer.

7080.1100 Subp. 77. Slope means the vertical rise or fall divided by the horizontal distance, expressed as a percentage.

Slope direction, also referred to as aspect, must also be assessed. This can be recorded as the direction of the slope or as the angle (0-360°) e.g. north-facing. This is important as many design criteria require slope direction.
Section 4: Site Evaluation

Slope plays a significant role in onsite sewage treatment as it affects the following:

- Type of system to be used (no beds on slopes of six percent or greater)
- Type of gravity distribution system to be used (drop box or distribution box)
- Pressure distribution system design (if all laterals are not on the same elevation)
- Layout (trenches parallel to slope)
- Mound or at-grade design (if more than one percent slope)

Slope determination

The slope percentage of a landscape is determined by dividing the rise by the run and multiplying the answer by 100 as shown in Figure 4.8. For example: a six percent slope is a rise or fall of six feet in a run of 100 feet, or a three foot rise or fall in 50 feet, or a rise or fall of one foot in every 17 feet of horizontal run. Evaluation of the significance of the slope of a soil must be made in relation to the other properties of the soil and to the environment.

Upslope conditions—run-on/diversions

Proper location of an ISTS requires examination of upslope areas that may contribute water to the site. Additional water over the ISTS can potentially cause failures or severe erosion. Locating a system to minimize run-on is ideal. If this is not possible, diversions of surface waters and/or subsurface water should be designed to ensure proper functioning of the ISTS.

Slopes, elevations, and benchmarks

Another method of determining slope is by using surveying equipment and setting benchmarks. Using survey equipment will also allow the designer to determine contours and slopes using elevation.

System orientation to slope

For sites where slopes are greater than 1%, design of any ISTS must follow the contours of the natural landscape.

Benchmark

A vertical reference point (also called a benchmark) is required in addition to a horizontal reference point for locating the distance to test sites—unless they are both the same point. A vertical reference point is an object of permanent elevation, the height or surface of which cannot be easily changed. The vertical reference point may be a lot line corner stake, cornerstone of an existing building, top of a well casing, a centerline of a road, or a stake...
placed by the soil tester in a location where it will remain undisturbed for future reference. The elevation of the vertical reference point may be arbitrarily labeled 100 feet (or any other number), as long as the elevation of the test holes are determined in relationship to the elevation of the vertical reference point.

**Contours**

Contours are lines of equal elevation. They should be determined on sites where slopes are greater than 1%. Flagging and mapping these lines will also help determine whether the location is suitable, due to curvatures (swales).

**Flooding**

The field evaluation should determine whether the site is subject to flooding. Flooding, as defined by the Minnesota Department of Natural Resources (DNR) is the temporary covering of the soil surface by flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, or any combination of sources. Shallow water standing or flowing during or shortly after rain and snowmelt are excluded from the definition of flooding, but both must be considered when designing an ISTS. Standing water (ponding) or water that forms a permanent covering is excluded from the definition of flooding.

7080.1710 E. floodplain designation and flooding elevation from published data or data that is acceptable to and approved by the local unit of government or the Department of Natural Resources, if applicable.

MN Rule Chapter 7080.2270 has specific requirements for designing systems within floodplain areas. Whenever possible, this practice must be avoided. If the ISTS must be placed on a floodplain, the field evaluation should accurately determine what portion of the parcel is affected by the floodplain and demonstrate that other options are not viable.

**Distance from floodplain**

Maps are the best way to determine the distance of the proposed ISTS to the floodplain. Distances can also be measured from field-based identification of the floodplain elevation.

**Floodway, flood fringe, and floodplain identification**

The floodplain is comprised of the floodway and the flood fringe. The floodway is adjacent to the channel and conducts flood waters. The flood fringe is the remainder of the floodplain where flood waters are shallow and slow moving.

Information received from the DNR or county should reveal if the site is located in an identifiable floodplain. ISTS should not be installed in the floodway areas of the floodplain. Floodway ISTS are allowed if the requirements of 7080.2270 are met.

Floodplain means the area covered by a 100-year flood event along lakes, rivers, and streams as published in technical studies by local, state, and federal agencies, or, in the absence of these studies, estimates of the 100-year flood boundaries and elevations as developed pursuant to a local unit of government’s floodplain or related land-use regulations (see MN Rules 6105 and 6120).

Soil survey information should also have identified whether the soil is subject to localized flooding in such landscape positions as drainage ways or intermittent streams.
If flooding is suspected, the following can be used to determine the potential flooding hazard:

- **Landscape features**: Certain landscape features have developed as the result of past and present flooding, such as former river channels, oxbows, point bars, meander scrolls, sloughs, natural levees, back-swamps, sand splays, and terraces. Most of these features are easily recognizable.

- **Vegetation**: The vegetation that grows in flood areas may provide clues to past flooding. The survival of trees in flood-prone areas depends on the frequency, duration, and time of flooding (dormant season or growing season), and also on the age of the tree and the depth of flooding. Some species are intolerant of flooding and are not found in areas that are flooded. Other species are very tolerant of flooding and even withstand partial or total submersion during the growing season. Pure stands of these species indicate frequent or long duration flooding. A biologist or forester can help relate the vegetation to flooding frequency, duration, and flood period. See Eggers and Reed, 1997, for a list of wet plants.

- **Soil Profile Characteristics**: these provide clues to past flooding:
  1. A thin strata of material of contrasting color or texture or both;
  2. A soil layer that is darker than the layer above is an indication that the darker layer has been covered by more recent deposition; and
  3. Soil layers that have abrupt boundaries to contrasting kinds of material, indicating that the materials were laid down suddenly at different times from different sources or deposited from stream flows of different velocities.

**Vegetation**

Observations of the growth of both native vegetation and cultivated crops aid in recognizing soil boundaries and provide information about soil limitations.

**Native Vegetation** Generally, close relationships exist between native vegetation and certain soil properties, yet there are important exceptions. A reliable field evaluation cannot be made by studying vegetation alone, but with careful observations of both soils and vegetation, excellent correlations can be established. Cattails, alders, dogwood, willows, tamaracks, and sedge grasses (along with numerous other plants) all indicate wet soil areas. These areas should be noted on the site evaluation map.

Common names of the plants may be used if such names are clear and specific, but many common names are used for different species in the same region. See Appendix B-4: Wetland Plant List for a list of common wet soil indicators for use in Minnesota.

**Cultivated Vegetation** Over an extended period of cultivation, farmers learn which crops do well and which do poorly on different soils and adjust their cropping patterns accordingly. If the differences are large—as between crop failure and reasonable performance—the absence of a given crop may reflect the suitability of that soil for the crop. If the differences are small, many non-soil factors can determine the farmer’s choice of fields for a given crop. Relationships observed must be interpreted with caution because of economic factors, management systems, and farmer preference. But within fields of a single crop, differences of vigor, stand, or color of the crop or weeds commonly mark soil differences and are valuable clues to the location of soil boundaries.
Soil Observations

Information must be reported on the thickness in inches of the different soil horizons and their suitability for treatment and hydraulic acceptance of septic tank effluent. It is required that a replacement soil treatment area be investigated and identified.

To locate the ISTS properly, thoroughly evaluate soil texture, structure and consistence, the presence of soil redoximorphic features, direct water table measurement, and presence of bedrock. Soil survey information may aid in determining parent material (see “Soil Reports and Geologic Atlases” in this Section). In some cases, an examination of road cuts, stream embankments or building excavations will also provide useful information. Wells and well driller’s logs can also be used to obtain information about groundwater and subsurface conditions.

There are three methods typically used to conduct soil investigations: probing, augering, and pits. Each method has its own advantages and disadvantages. A soil probe (diameters and lengths vary in size) is a hollow tube pushed into the soil. When extracted, it displays an undisturbed column of soil for viewing. Probing is probably the quickest method of examining the soil. It also has the advantage of revealing undisturbed soil in which faint soil mottling or cemented layers may be seen. One disadvantage is that a probe can be difficult to push into rocky or dry soil. The hand probe also has a limited sampling depth, while hydraulic probes and foot driven probes have greater sampling depths.

A soil auger typically allows the designer more soil to examine. It is a hollow bucket with cutting tips that cut soil to fill the hollow bucket as the handle is turned. This method disturbs the soil a bit, but toward the middle of the sample should be an adequate sample for description. A disadvantage of auguring is that soil structure can be hard to identify. The soil series description (Official Series Description) can assist with proper identification of soil structure where significant site alteration has not occurred.

The soil pit is the optimal choice for identification and description of soil properties. A pit can be dug hand or by an excavator. It provides the designer with a large window into the soil to describe colors, textures, structure, consistence, and any other pertinent soil conditions. There are drawbacks to the soil pit: it can be destructive to the site, hinder access to the site, be costly, and add to safety concerns. To mitigate this last drawback, proper pit excavation safety precautions must be followed at all times.

Preserving the soil sample in its most natural form is the key to a proper soil observation. For this reason, a screw type or flight auger is strictly forbidden for ISTS purposes. Whatever soil investigation method(s) is used, the designer/inspector must understand its strengths and weaknesses and develop strategies to ensure complete and accurate soil observations on each parcel. Each LGU shall list acceptable tools to conduct soil observations in their area.

Before a soil description can be written, the excavated soil from a boring or augering must be laid out on the ground surface, with the depths of the excavated soil corresponding with the depth of the hole. A tape measure should be laid alongside the excavated soil. Rain gutters cut to six-foot lengths provide for good soil preservation for the soil examination. It is not recommended to excavate an auger full of soil, briefly examine the bottom, and dump the soil into a spoil pile next to the hole.

When describing the soil, it is best to work in adequate natural light with moist soil. If naturally moist soil does not exist at the time of observation, options exist. If the soil is too dry, you can slightly wet (mist) the soil from a water bottle. Saturation of the soil sample also does not equate to moist soil conditions. If saturation exists, the soil must be left to dry or can be blown on until field moist conditions are reached.
The exposed soil is usually examined starting at the soil surface and working downward to identify significant differences in any property that would distinguish between adjacent horizons. Boundaries between horizons are then marked and described. Horizon depths are measured from the soil surface and recorded.

**Soil Observations Procedure**

The soil investigation can begin after a visual elimination of unsuitable areas (including all setbacks, etc.) is complete. Soil observations and descriptions can be challenging, but they are always interesting as no two soils are ever identical. The thoroughness of the soil investigation will depend upon the amount of site variability and is at the discretion of the designer.

The following is the minimum required soil observations and locations of these observations according to MN Chapter 7080.1720 Subp. 4.

A minimum of three soil observations are required for the initial and replacement soil treatment area and at least one soil observation must be performed in the portion of the soil treatment area anticipated to have the most limiting conditions. The total number of soil observations required is based on the judgment of the certified individual or the local unit of government. A minimum of three observations are required for both areas if the initial and replacement soil treatment areas are adjacent.

A typical soil excavation is first done to the depth of three feet below the bottom of the proposed system or until a soil limitation is encountered. The soil information gathered from the boring should include texture, soil horizon depth, changes in soil color, soil structure, consistence and presence of bedrock.

The following procedure is given for conducting soil investigations:

1. Locate the center of the proposed soil treatment area. The first soil excavation should be dug to a depth of six feet unless a limiting soil layer is encountered at shallower depths.
2. Make one soil observation (B1 in Figure 4.9).
3. Estimate maximum depth of system and the texture, structure and consistence at this depth. Find soil loading rate using Table IX or XII in Section 13: Forms.
4. Determine the total area needed:
   \[
   \text{(Average daily flow / soil loading rate)} / \text{trench width} \times \text{trench spacing}
   \]
5. Determine the system geometry from the calculated size.
6. Make four additional observations at the soil treatment area corners (B2 to B5 in Figure 4.9). These remaining observations at the system corners should be dug to three feet below the proposed depth of the system.

**For example:** The first observation (in the middle) is dug to six feet with no indication of bedrock, periodically saturated soil, or other limiting conditions. The designer proposes the system depth at two feet, and the remaining excavations will then be dug to a five-foot depth.

After the initial soil observations have been observed, described, and interpreted, the proposed system locations and layout can begin.
Soil Boring Log
Section 13 provides a soil boring log form for recording data during soil observations. This form should be used for any type of soil observation whether a soil pit, soil probe, soil auger or other approved soil sampling method. When conducting a soil observation, enter the soil texture whenever a change in texture occurs. For example, the top 12 inches may be a fine sandy loam; from 12 to 18 inches the texture may be loam; from 18 to 36 inches the texture may be a clay loam; and from 36 to 72 inches the texture may be clay.

At the bottom of the soil boring log form, the total depth of the boring hole should be entered, as well as any evidence of redoximorphic features or standing water along with all other information on the form.

The depth of water in the bore hole must be measured and recorded. However, this depth should not be used as the estimated high water table for designing a system. Most water tables fluctuate by many feet in a normal year. A single observation of water in a hole probably does not indicate its highest level. The observation of redoximorphic features or other indications of wetness is scientifically valid and is the MN State Rule Chapter 7080 required method to determine this maximum height.

Data on the depth to zones of soil saturation is presented in the Soil Moisture, Ponding, Flooding (MN) report on the web soil survey. This reports can help the designer determine what limitations exist and at what depths in a general area. While useful, the soil survey information alone should never be used to make this or any other site-specific determination.

Limiting layer identification
There are numerous possibilities for limiting conditions on any site. Common conditions include:

- Redoximorphic features/saturated soils
- Bedrock (including soils with >50% coarse fragments)
- Flood elevation
- Restricted percolation rates/high clay contents

Redoximorphic features
Changes in soil colors indicate a change in soil conditions. A site evaluation should carefully observe, describe, and interpret all soil color changes, whether matrix color, mottle color, or both.

A specific type of mottling that indicates saturated soil conditions is called redoximorphic features. The presence of these features in the soils is used as an indicator of soil saturation at these depths.

Formation
Refer to Section 3: Soils for a detailed description of redoximorphic feature formation in soils.

Identification
The ability to correctly identify redox features in the soils relies on an understanding of soil coloring influences and chemical reactions in saturated soils and proper site condi-
Section 4: Site Evaluation

Limitations
Problem soils and exceptions to the above standard redox processes exist in many areas of Minnesota. These soils and landscapes require special consideration, including careful documentation of all site evaluation parameters (soils, slopes, percolation rates, contours, etc.). Also, supporting evidence from the soil survey of the area will aid in proper identification of depth to soil saturation. Many problem soils are a direct result of human impacts (e.g., erosion, drainage, filling, raising water levels, etc.). These soil identifications are specific to one site and determinations cannot be standardized on a state or regional level. Such site evaluations should involve the ISTS professional and the Local Government Unit in the decision making process. In some problem areas, soil investigations may benefit from the expertise of a Licensed Professional Soil Scientist who is a certified SSTS designer or inspector. County inspectors, Soil and Water Conservation District staff, Natural Resources Conservation Staff, or other registered SSTS professionals are all sources of additional information.

Recognition of problem soils
Many times redox features do not exist in the soil, but the soil may still be limiting due to saturated soil conditions. Below are examples of areas in Minnesota where this can occur.

Red parent material
Areas of soil with Munsell color of hues 7.5YR or redder are called red parent material soils in Minnesota. They exist northwest from St. Cloud to Canada and south from Duluth to the southern Twin Cities metropolitan area, where glacial advances out of the Lake Superior Basin brought highly weathered iron minerals. These redder iron minerals do not change form as readily as iron in the rest of Minnesota soils, and result in difficult observation of redox features. If features exist, they are often very subtle. Carefully considering the landscape, landform, and vegetation will greatly assist site evaluations in these areas.

Because these soils are known to present difficulties in limiting condition identification, MN Rule Chapter 7080.1720 Subp. 5 E 1(c) addresses them specifically:

Faint redoximorphic concentrations or faint redoximorphic depletions in subsoil or parent material with a hue of 7.5YR or redder. These conditions indicate a periodically saturated soil.

Faint is defined in Section 3: Soils, “Soil Color,” - Soil Color and Chapter 7080.1100 Subp. 33.

Thick topsoil
Thick topsoil exists over much of western and southern Minnesota as a result of prairie vegetation. Prairie grasses provide a rich annual source of organic matter (i.e., decomposing material that was once living) to the soil. Over many years, this organic matter accumulation becomes very dark and thick (greater than 12 inches). This annual accumulation of organic matter also masks (covers) any other soil colors that may be present in the soil, including redoximorphic features.
When a soil has been identified as having greater than 12 inches of topsoil (with a soil matrix color of chroma and value of three or less), MN Rule Chapter 7080.1720 Subp 5. E. provides the following requirements for identifying redoximorphic features:

(2) in lower topsoil layers that are deeper than 12 inches from the surface and are immediately followed in depth by a periodically saturated horizon, redoximorphic features include:

(a) soil colors with a redoximorphic chroma of two or less; or
(b) redoximorphic accumulations or depletions;

(3) in the upper 12 inches of the topsoil layer immediately followed by a periodically saturated horizon, the depth of seasonal saturation is determined by indicators in units (a) to (e):

(a) soil colors with a chroma of zero;
(b) organic soil textures or mineral soil textures with an organic modifier;
(c) dominance of hydrophytic vegetation;
(d) the soil treatment area at or near the elevation of the ordinary high water level of a surface water or in a concave hill slope position; or

Elluvial horizons

Elluvial horizons (E horizons) are horizons that form immediately below the topsoil and are characterized by their loss of certain soil materials, including clay, iron, and organic matter. The conditions that most often lead to E horizon formation include forested sites. As leaves (deciduous or coniferous) are deposited on the soil surface, their decomposition releases acids that help remove soil materials below the topsoil.

The interpretation of soil saturation can be complicated by these horizons' high value and low (i.e., light and dull) chroma colors. To properly understand the reason(s) for this coloration, soil observation must continue for the next three feet to investigate soil properties that may cause saturation within this layer. Only when there is an absence in soil restrictions for the next three feet can the light and dull colors of an E horizon be considered part of the suitable soil required for an ISTS.

Lamellae

Throughout the sandy-textured soils of Minnesota, especially in the Anoka Sand Plain, it is common to observe fine-textured subsurface bands. These bands are typically identified as part of the soil forming process and are called lamellae. Properly identifying and interpreting their effect on soil water movement is of particular concern for evaluating sites for ISTSs. The University of Minnesota and the Minnesota Pollution Control Agency have prepared more information on the soils of the Anoka Sand Plain. Please contact Dan Wheeler (dwheeler@umn.edu) for more information.
What do lamellae indicate?

Lamellae are finer textured layers in the soil that form due to a slowing of vertical water movement through the soil. As the water slows, anything carried in the water (sils, clays, etc.) is deposited. This creates a feedback mechanism causing more fine textures to accumulate in these areas. By themselves, lamellae indicate nothing about a saturated condition in the soil.

Is there a thickness criteria where lamellae become limiting?

The key to identifying a limiting condition where lamellae can be found is looking carefully for redoximorphic features within, above or below the bands. No matter how thick or thin the bands, the presence of redox features are the key to determination of limiting condition due to saturated soil conditions.

Calcareous

Soils commonly found throughout western and southern Minnesota have calcium carbonates inherited with their parent material. This calcium carbonate has its source as limestone bedrock that was crushed and transported by glacial activity. Soils with calcium carbonates have many white or light colored soft masses distributed throughout the soil profile. Where water moves through the soil, some calcium gets dissolved and carried deeper into the soil (recharge hydrology), brought to the soil surface (discharge hydrology), or transported off site (later flow hydrology).

The issue with calcium carbonates and ISTS is the misinterpretation of the light colors as redox features due to the prominent contrast from the surrounding matrix color. In many of these soils, there may be redox features present in the same horizon as the calcium carbonate masses, but they are overlooked because they lack the contrast of the calcium carbonates. To properly identify redox features in these very colorful soils, look for depletions and concentrations adjacent (i.e., touching) each other (see Figure 4.10).

Highly decomposed bedrock


Saturated soils

Water Tables

Saturated soil conditions are also known as groundwater and the water table. The relationship between soil and water is critical in evaluating the suitability for a soil. Soil wetness should be characterized by identifying the depth to the uppermost zone of saturation and the approximate duration of that saturation.

Saturated soil conditions are detrimental to soil treatment areas. Failures occur both in the movement of effluent into the soil and in its treatment. Premature system failure due to saturated soil conditions can result from:

- soil flowing at saturation and clogging the gravel beds or the distribution piping,
- accelerated clogging of the system area by bacteria that operate during saturated or wet soil conditions,
slow or no movement of effluent out of the system because the soil is already filled with water and is unable to accept additional liquid.

All of the preceding situations lead to effluent either surfacing on the ground or backing up into the home.

Treatment of effluent is not effectively achieved in saturated soil. Contamination of drinking water wells can occur when untreated effluent enters groundwater.

Knowledge of the times and depths at which a soil is wet is important to determine if the soil is suited for an ISTS. Free water exerts a strong influence on the physical, biological, and chemical processes that are necessary for sewage treatment and acceptance.

In some cases saturated soil conditions may be the upper level of an aquifer (see Figure 4.11). In other cases, these saturated soil conditions may be separated from a deeper aquifer by geologic materials, which may impede downward groundwater movement (Figure 4.12). In either case, there still needs to be a three-foot separation distance from the highest point of soil saturation to the bottom of the soil absorption system.

Groundwater flow rates and directions are controlled by the geologic character of an area. Recharge and discharge areas are an important concept in groundwater geology. A recharge area is usually a topographically high area from which a pressure gradient is established on the water table. From this point, the water table slopes until it intersects the surface in a stream, lake, or other groundwater discharge area.

**Soil color determination**

Determining the soil colors present in the soil profile will provide the designer with the proper information to determine the depth to any limiting condition, disturbance history, compaction, or other soil issues on a site. The soil colors must be identified, described, and interpreted using MN Rule Chapter 7080.1720. See also Section 3: Soils, “Soil Color.”

**Soil color implications**

Section 3: Soils, “Soil Color” and MN Rule Chapter 7080.1720 discuss the implications of using soil colors for interpretation.

**Bedrock**

Bedrock on a site will severely limit the treatment and hydraulic acceptance of septic tank effluent. Locating these areas during a field evaluation is key to an appropriate design.

From your preliminary evaluation you should have a good idea if bedrock is present on or near your site. If bedrock is suspected, methods to determine bedrock are as follows:

- Angular rocks on the ground surface or in the auger.
- Outcrops on or near the site.
- Bedrock in nearby road cuts or a backhoe pit.
The depth at which soil ends and bedrock begins is dependent upon the type of bedrock as described by 7080 below.

7080.1100 Subp. 8. Bedrock means geologic layers, of which greater than 50 percent by volume consist of unweathered in-place consolidated rock or rock fragments. Bedrock also means weathered in-place rock which cannot be hand augered or penetrated with a knife blade in a soil pit.

For more discussion on bedrock types and limitations, see Section 3: Soils, “Soil Formation.”

An example method for determining bedrock is presented in Figure 4.13.

**Other restricting soil conditions**

**Flood Elevation**

As discussed above under “Flooding”, saturated soil conditions caused by flooding constitute a limiting condition due to a lack of treatment and acceptance of septic tank effluent during certain times of the year. Flood elevations must be obtained and all design/construction considerations must be followed.
Disturbed Areas

Due to a loss of soil structure, areas that have been cut, filled, compacted, or disturbed in any way often have difficulty in accepting septic tank effluent. These areas can sometimes be identified by wheel tracks, hummocks, stunted vegetative growth, or incorporated debris. Normal agricultural and forestry uses do not constitute disturbed areas unless they are high traffic areas (e.g., skid trails, roads, fencelines, head lands, access points, etc.) or severely eroded areas.

Fill Soils

Fill soils are soils that have been moved from their geologic origin by mechanical means and deposited in a new location. This creates a man-made lithological discontinuity. When soils with textures other than clean sand are moved to a new location, the soil structure is destroyed, which liberates the silts and clays that migrate when water is added. This loss of pore space and restricted water movement between the different layers ultimately result in percolation problems in the soil, which can be severe. Percolation test results in a single area of loamy fill can range from seven mpi to over 200 mpi. This can complicate the decision of which sizing factor to use.

Problems in determining the depth to the periodically saturated soil are also encountered. Water tables can change when the topography is altered, and soil coloration of the fill cannot be used as an indication of the water table's height. Fill soil colors are characteristic of where it was excavated not that of its present location. Carefully consider the natural soils, landscapes, and vegetation is key to correctly identifying of limiting conditions on these sites.

Fill soils commonly have stratified layers or different colored and textured materials as indicated in Figure 4.14. These layers have abrupt boundaries. Typically, the thickness of subsoil material ranges from 1/8 inches to a few inches thick, but can vary widely. Probing or pits (not auguring) is necessary to see these layers.

Soils located in a valley or flood plain sometimes have a natural stratification of soil materials that were deposited from sediment carried by floodwaters. Each layer represents deposits from one flooding event. These layers are black to gray in color, have textures in the range of silt to fine sand, and lack rocks. These stratifications should not be confused with stratifications caused by fill activities.

Fill soils commonly have unnatural looking landscapes, such as:

- short steep linear slopes
- unusually flat area in a generally rolling topography
- higher areas adjacent to wetlands or shore land
- man-made structures (such as roads or buildings) nearby
- sparse vegetation (if new fill area) or vegetation lacking vigor as compared to adjacent areas
- many rocks on the soil surface

The soil survey report maps fill soils as urban land.
Cut Areas
Cut areas are areas where the land surface has been lowered by removal of earthen materials. Cut areas have usually been compacted by machinery during land leveling. This compaction may be localized and spotty or widespread, depending on wheel traffic patterns.

The topsoil and subsoil have often been removed from the cut area, exposing the native parent material, which usually has little or no soil structure to aid in water percolation. There may be a layer of topsoil added on top of the cut for lawn establishment. A restrictive condition likely occurs at this interface, slowing the movement of water. This problem is greater if the texture of the topsoil is unlike the texture of the underlying cut soil.

Altering the landscape typically alters the water table height. The depth to redoximorphic features will be shallower because the soil surface has been removed but may not reflect a change in the depth to periodically saturated soils due to altering the landscape.

Cut areas typically have an abrupt boundary between the imported topsoil and the top of the cut surface. The parent material exposed from the cut will lack soil structure and be lighter in color (i.e., soil color values of four or more).

Cut areas commonly have unnatural-looking landscapes, such as:
- short steep linear slopes
- an unusually flat area in a generally rolling topography
- a level area cut out of a steep hillside
- a flat crest of a hill.
- Man-made structures (e.g., roads or buildings) are likely to be nearby. There may be sparse vegetation as compared to adjacent areas. Soils may be dense, compacted, and difficult to probe. If cut areas are large, the soil survey report will map them as urban land or orthents.

Soils, Impacts on System Design
Soil properties such as texture, structure, and consistence will determine numerous design parameters.

Soil Texture
Soil textures will predominantly be used to help determine the size of the ISTS to be designed at the parcel.

Constructability
Soil erosion is an issue for design and installation when fine sands are present. Fine sands are very susceptible to wind erosion, and proper care must be taken to preserve soils on the site.

Water erosion can cause problems on sites where silty textured soils dominate the soil textures. Until vegetation can be established on the site, mulching or protecting the soil will ensure that the required soil cover is maintained. Because silty soils lack cohesive forces, channelization of water should be avoided in these areas.
Smearing
Any sandy loam or soil of finer texture can be susceptible to smearing if enough water is present. Plastic limit determination is key to minimizing smearing during construction activities.

Compaction
Compaction can occur on any soil texture. The best way to minimize compaction is not to allow equipment on site. However, this is seldom possible, so minimizing impacts is the next best option. The following is a list of some of the techniques used to minimize the potential for soil compaction:

- Distributing the weight of vehicles by tracks,
- Limiting construction activities when soil is wet,
- Protecting soil treatment area from trafficking,
- Minimizing unnecessary travel by equipment.

Soil structure - Preferential movement
In addition to soil texture, soil structure and consistence is evaluated to estimate the loading rate of an ISTS.

Soil structure is the common way that preferential flow occurs at a site. The process by which water and its constituents move by a preferred pathway through a porous medium is known as preferential flow (Glossary of Soil Science Terms, 2006). Preferential flow conditions can also occur in soils or bedrock.

Soil water movement
The flow of water in soil depends on the soil's ability to transmit the water and the presence of a force to drive the water. An understanding of how water moves into and through soil is necessary to predict the soil's potential for septic tank effluent acceptance and treatment. In this section, hydraulic conductivity, saturated hydraulic conductivity, and the percolation test are discussed.

The movement of water through the soil is controlled by landscape, internal soil properties, and environmental factors. Soil properties influencing water movement include cracks, coarse fragments, soil structure, total porosity, size, continuity of pores, and water content of the soil. Environmental factors include form and intensity of precipitation, evapotranspiration, and temperature.

Unsaturated water movement
Water flow is unsaturated when the soil water is under tension (negative pressure). Unsaturated hydraulic conductivity is a function of the same soil properties as saturated hydraulic conductivity and also of the soil water content. Unsaturated flow is slower than saturated flow.

The ability of the soil to draw or pull water into its pores is referred to as its matric potential. The affinity of water molecules to each other and to solid surfaces produces the matric potential. Molecules within the body of water are attracted to other molecules by cohesive forces, while water molecules in contact with solid surfaces are more strongly attracted to the solid surfaces by adhesive forces. As a result of these forces acting together, water is drawn into the pores of the soil. The water tries to wet the solid surfaces of the pores; because of cohesive forces, water pulls other molecules with it.
The driving force behind unsaturated flow is not gravity, but a soil tension force (sometimes called capillary action or wicking). Under unsaturated conditions, the largest pores drain first since they are able to exert the least tension. Water is pulled through the smaller pores. Since clays have smaller pores, they can actually transmit water faster under unsaturated conditions than sands.

Water in unsaturated flow is moved because of tension, not gravity; the water does not have to travel downward, but can move sideways or even up, to wherever the soil is the driest. The presence of lush green grass over the soil treatment area is evidence of this capillary movement. Figure 4.15 shows how, as a biomat develops in a trench, flow under the trench becomes entirely unsaturated.

**Saturated hydraulic conductivity**

Saturated hydraulic conductivity is the rate of water movement within a water-logged soil. It is a measure of the ease with which water moves through the soil, and is measured in centimeters per hour or feet per day. Soils higher in clay contain more pore space than soils high in sand, but the individual pore spaces are smaller. As the clay content of soils increases, hydraulic conductivity decreases (Table 4.6).

Sands and gravelly soils in good landscape positions (e.g. convex and planar slope curvatures) can transmit water downward so readily that the soil or layer remains moist for no more than a few hours after a thorough wetting. These soils have large connected voids. After a thorough wetting, sandy loams, loams, and loamy sands commonly remain moist for no more than a few days if located in a dry landscape setting. These soils commonly have moderate to strong structure. These soils are also often considered favorable for rooting and for supplying water to plants. Silt loam and clayey soils commonly transmit water downward so slowly that they remain moist for a week or more after a thorough wetting. Other soils with low hydraulic conductivity may be structureless or have only fine and discontinuous pores (as in some clays, or cemented layers). Layers may be massive or platy. There may be few connecting pores that could conduct water when the soil is wet.
Saturated hydraulic conductivity does not necessarily describe the ability of soils, in their natural setting, to accept or transmit water internally. A soil may have very high saturated hydraulic conductivity, yet contain free water because there are restricting layers below the soil or because the soil is in a depression where water from surrounding areas accumulates faster than it passes through the soil. Therefore, the water may actually move very slowly despite the soil’s high saturated conductivity.

The actual rate of water movement is a product of the saturated hydraulic conductivity and the hydraulic gradient. The hydraulic gradient at any point is determined by the elevation of that point relative to some reference level. Thus, the higher the water above this reference, the greater its gravitational potential.

Saturated hydraulic conductivity is highly variable. Measured values for a particular soil series can vary by one hundred-fold or more. Saturated hydraulic conductivity can be given for the soil as a whole or for a particular layer or combination of layers. The layer with the lowest value determines the saturated hydraulic conductivity classification of the soil.

The above discussion relates to water movement in soils that are saturated with water. Distinction should be maintained between saturated hydraulic conductivity and unsaturated hydraulic conductivity.

<table>
<thead>
<tr>
<th>Texture Class</th>
<th>Mean Total Porosity %</th>
<th>Saturated Conductivity (Ks) ft/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>43.7</td>
<td>16.54</td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>43.7</td>
<td>4.81</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>45.3</td>
<td>2.04</td>
</tr>
<tr>
<td>Loam</td>
<td>46.3</td>
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</tr>
<tr>
<td>Silt Loam</td>
<td>50.1</td>
<td>0.54</td>
</tr>
<tr>
<td>Sandy Clay Loam</td>
<td>39.8</td>
<td>0.34</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>46.4</td>
<td>0.18</td>
</tr>
<tr>
<td>Silty Clay Loam</td>
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<tr>
<td>Silty Clay</td>
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<td>0.07</td>
</tr>
<tr>
<td>Clay</td>
<td>47.5</td>
<td>0.05</td>
</tr>
</tbody>
</table>

From Rawls et al., 1989. Estimating soil hydraulic properties from soil data

**TABLE 4.6 Porosity and Conductivity of Soils**

**Determination of percolation rates of most restrictive horizon**

The percolation test is an important part of a site evaluation as it is critical to the successful design of an onsite sewage treatment system. Suitable soil is the key to providing adequate septic tank effluent treatment. Soil observations are used to locate a suitable area before beginning the percolation test. (See “Soil Observations,” this Section, for a detailed discussion of soil boring.) Percolation testing is a required step of the field evaluation to determine loading rates when soil structure and consistence are not described in the soil observation. They are also useful in providing a better understanding of site impacts (e.g. compaction, fill, etc.).
Section 4: Site Evaluation

The Percometer and the Hook Gauge

Figure 4.16 shows a percometer, which is a device used to accurately measure the drop in the liquid level in soil. A rod that is fastened to the float is read by the scale or ruler at the top of the percometer. A four-inch plastic pipe can serve as the body of the percometer. Holes half an inch in diameter should be drilled near the bottom of the body to allow water to freely flow in and out of the percometer. A plastic bottle approximately one quart in size can be used as the float. A stiff wire fastened to the top of the bottle extends through the top brace of the percometer.

A different method of measuring the drop in liquid level may be used (see Figure 4.17). In this case, a hook gauge is used to determine the liquid surface level, and a batter board is used as a reference point. While this is an accurate method of determining the liquid level, it is not as convenient as using the percometer.

There are also electronic means of measuring water levels including pressure transducers to aid in the determination of liquid levels.
**Percolation Test Data Sheet**

A percolation test data sheet should be used to record the results of the test. Chapter 7080 states that the original percolation test data sheets should be submitted with the site evaluation report forms. A full-sized data sheet is provided in Section 13: Forms.

Field ratings of the time and water level should show no erasures. If you make a mistake, cross out the reading and enter the correct value. Erasures can be made on computed values, but erasures made on field readings casts doubt on the validity of the data.

Field readings should be taken until three consecutive percolation rates vary by no more than 10%. Use the average of these three readings to determine the percolation rate for the test hole. A percolation test should not be run where frost exists below the depth of the proposed soil treatment system.

**FIGURE 4.17 Percolation Rate Determined by a Hook Gage**
**Steps in a Percolation Test**

**Use soil observations to locate suitable area**

Soil observations should be at least three feet deeper than the proposed soil treatment system. A soil description may stop as soon as clear evidence of seasonal soil saturation or bedrock is encountered. Number the soil observation holes and locate them on a scale map of the site.

**Locate an adequate number of test holes**

If the soil texture is similar over the selected site, use at least two and preferably three percolation test holes. If the soil texture changes within the site, make at least two percolation test holes (P-1 and P-2 in Figure 4.18) in each soil texture. Space the test holes uniformly over the area proposed for the soil treatment unit.

**Dig the Test Holes**

The test holes should be round and at least six inches, but no larger than eight inches, in diameter. Dig each test hole as deep as you intend to excavate the soil treatment trench, bed or one foot for mounds and at-grades. The bottom of the percolation test hole must be at least three feet above the level of seasonally saturated soil or an impervious layer. A clamshell-type posthole digger can be used. If you use a six-inch auger, it is a good idea to drill a pilot hole with the three-inch auger. Observe and record the soil texture as the percolation test hole is being dug.

7080.1720 Subp. 6. B(1). Each test hole must be six to eight inches in diameter, have vertical sides, and be located in the soil. For mounds and at-grade systems, the bottom of each test hole must be in the upper 12 inches of the original soil. For trenches and seepage beds, the bottom of each test hole shall be at the depth of the absorption area.

**Prepare the Test Holes**

The auger or post hole digger is likely to smear the soil along the sidewalls of the test hole.

7080.1720 Subp. 6. B(3). The bottom and sides of the hole must be carefully scratched to remove any smearing and to provide a natural soil surface into which water. The scarification must not result in the hole having a diameter of greater than eight inches.

Figure 4.19 illustrates the effects of nails driven into a one-by-two-inch board, which will scarifice the hole to provide an open, natural soil into which water may percolate.
7080.1720 Subp. 6. B(4). All loose material must be removed from the bottom of the test hole and two inches of one-fourth to three-fourths inch gravel or clean sand must be added to protect the bottom from scouring.

The gravel can be contained in a nylon mesh bag so it can be removed after the test is performed and used for additional percolation tests.

**Distinguish Between Saturation and Soil Swelling**

- Saturation means that the voids between the soil particles are full of water. This can happen in a short time.
- Swelling is caused by intrusion of water into individual soil particles. This is a slow process, especially in clay soils, and is why a prolonged soaking period is necessary for some soils.

Carefully fill the percolation test hole with clear water to a depth of at least 12 inches above the soil bottom of the test hole. Use a hose to prevent the water from washing down the sides of the hole, or add the water directly in the percometer. A six-inch diameter hole requires about 1.5 gallons of water per foot of depth.

Sandy soils containing no clay do not swell. The percolation test may proceed immediately if the 12 inches of water seeps away in ten minutes or less.

For prolonged soil soaking, keep the 12-inch depth of water in the hole for at least four hours, and preferably overnight. Add water as necessary. You may use an automatic siphon or valve to maintain the 12-inch water depth (Figures 4.20 and 4.21).
Measure the Percolation Rate

If more than six inches of water remain in the hole after the overnight swelling period, bail out enough water so that only six inches of water remain above the gravel (eight inches if measured from the bottom of the hole). Measure the drop in the water to the nearest 1/8 inch (preferably the nearest 1/16 inch) approximately every 30 minutes. If possible, use a
percometer to determine the change in water level. A batter board can also be used as a reference point together with a hook gauge to accurately locate the water surface. The hook can be made from stiff wire or an 8d nail. After each measurement, refill the water in the hole so that the liquid depth is six inches above the gravel. Continue taking measurements and filling in the percolation test data sheet until three consecutive percolation rates vary by a range of no more than ten percent.

If no water remains in the hole after the overnight swelling period, add six inches of clear water above the gravel. Measure the drop in the liquid level to the nearest 1/8 inch (preferably 1/16 inch) approximately every 30 minutes. After each measurement, refill the water to a depth of six inches above the gravel. Continue taking and recording the water level drop measurements until three consecutive percolation rates vary by no more than ten percent.

In sandy soils, or other soils in which the first six inches of water seep away in less than 30 minutes after the overnight swelling period, allow about ten minutes between measurements. On very sandy soils, use a stop watch and measure the time in seconds for the water level to drop from six to five inches. Refill the percolation test hole after each measurement to bring water to six inches above the gravel. Continue taking readings and filling in the percolation test data sheet until three consecutive percolation rates vary by no more than ten percent.

### Calculate the Percolation Rate

Divide the time interval by the drop in water level to determine the percolation rate in minutes per inch (mpi).

- If the drop in water level is one inch in 30 minutes, the percolation rate is: 30 minutes/1 inch = 30 mpi
- If the drop in water level is 2 1/2 inches in ten minutes, the percolation rate is: 10 minutes/2.5 inch = 4 mpi

Calculate the percolation rate for each reading. When three consecutive percolation rates vary by no more than 10%, use the average value of these readings to determine the percolation rate for the test hole. Percolation rates determined for each test hole should be averaged in order to determine the design percolation rate. Compare the percolation rates determined for each test hole to the soil texture to verify the soil loading rate. The percolation test data sheet showing all measurements and calculations must be submitted.

Note: A percolation test should not be run where frost exists in the soil below the depth of the proposed sewage treatment system.

### Groundwater mounding

Groundwater mounding is a phenomenon that occurs in the soil when soil loading rates are greater than the soil’s hydraulic acceptance rate. As this occurs, the excess water builds up or mounds in the soil. If loading rates are high enough, this groundwater mound may influence the functioning of the onsite system by reducing vertical separation or surfacing of effluent. This soil condition can be a design consideration on small lots, high water-use households, fine-textured soils, wet soil conditions, high-strength waste and cluster SSTS.
Soil Loading Rate
The final soil loading rate is a function of the soil texture, soil structure shape, soil structure grade and soil consistence.

Soil texture
Coarser-textured soils are the appropriate size for treatment of septic tank effluent while finer-textured soils are sized for hydraulic acceptance.

Soil structure
Good soil structure shape and grade (e.g. strong blocky structure) will provide for more rapid acceptance of septic tank effluent and require less soil treatment area.

Soil consistence
The level of soil consistence of cementing of the soil has an influence on movement of liquids through soil. In coarse-textured soils, cementation is less desirable because liquids can move readily in these porous conditions. While a fine-textured soil, a moderate level of cementation results in optimal soil conditions for liquid movement.

Percolation rate
Permeability is the rate of water movement through a saturated soil in inches per hour. The percolation test measures only the rate of the drop of water in a test hole of a specific diameter and does not measure the rate of movement of water through the soil. However, the relative values obtained by the percolation test will give some index of the ability of soil to transmit water. A very slow permeability also indicates that a soil is relatively high in fine material such as silt and clay and thus, may need extreme care during the installation of the soil treatment system.

Slowly permeable layers occur in soils due to many geologic or soil-forming events. They may be layers cemented by translocation and deposition of iron, calcium, or clay. Dense layers (low porosity) are formed by the weight of glacial ice over soil parent material or by heavy construction equipment.

Basic predictive assessment methods
Proper observation, description, and interpretation of soil texture, soil structure shape, soil structure grade, and consistence will provide the designer with the information necessary to determine the correct soil loading rate. The following outlines levels of assessment in determining a soil loading rate.

Assumptions
The assumption is that the original soil conditions exist. If disturbed soils are suspected or identified, percolation tests must be run to determine the appropriate soil loading rates.

Parameters
Following the above percolation test procedures will ensure the most accurate and consistent results, when percolation tests are run multiple times at the appropriate depths. Proper soaking, hole diameter, and hole preparation will result in consistent results with published soil loading rates.
Application
The determination of the percolation rates in the soil from multiple tests for each location provides the designer with the appropriate data to determine the soil loading rate for the site and soil in question. Note: the percolation test should be used in concert with soil structure and texture identification in order to determine the most appropriate soil loading rate.

Percolation tests do not substitute for the soil description. The tests are another tool to utilize on sites where identification of soil structure is difficult or where soil disturbance(s) are suspected. Percolation tests do not indicate to the designer anything about the depth of suitable soil at the site. This must be determined by a complete evaluation of the soil profile (see Section 3: Soils).

Advanced assessment methods
There are numerous other tests available to determine saturated soil hydraulic conductivity, including the double ring infiltrometer and constant-head permeameter. They provide conductivity rates that still must be interpreted into correct soil loading rates. These methods also have limitations, as will any testing procedure.

Hydraulic Linear Loading Rate
The hydraulic linear loading rate is the potential horizontal and vertical flow patterns in the soil. Lower linear loading rates indicate fine textured soils or near surface soil limiting conditions exist.

Proper protection of tested area
Staking the Site
After initially evaluating the site, be sure to stake the location of the soil treatment area, the water supply well, the house, and other pertinent structures so that they are highly visible. The area of the proposed onsite sewage treatment system, as well as the replacement site, must be protected from any disturbance during the construction activities.

The next task is to stake off the required setbacks and home improvements. A measuring tape or wheel, stadia hairs on a level, or a range finder can measure these areas. Make sure the tank is accessible for pumping.

7080.1720 Subp. 7. The proposed soil treatment and dispersal area site shall be protected from disturbance, compaction, or other damage by staking, fencing, posting, or other effective method.

Because you called Gopher State One Call two days before beginning your soil investigation, the locations of all buried utilities have been marked.

Special equipment needed
Equipment limitations
Heavy equipment without tracks should be restricted from traveling over the soil treatment area at all times.
Traffic patterns to minimize compaction

Compaction from trafficking will damage the soil irreparably. Only allowing ISTS installation traffic with appropriate equipment on and around the soil treatment area will minimize compaction.

Maximum lift of typical pump trucks

Pump trucks must stay on compacted access points so as not to cause lawn compaction or compaction to various portions of the ISTS. Make sure that this location is accessible horizontally (hose required) and vertically (maximum lift of a pump truck is not exceeded).

Winter operation and protection from freezing

Know where winter traffic patterns will occur and require insulation of system components in these areas.

Site Evaluation Reporting Requirements

As site information is collected, it must be organized and recorded for review to determine site suitability. Providing the required information to the designer of the system eliminates the need for additional site visits.

Percolation test and soil observation data are of little value if related test sites cannot be located on a property. It is essential to relate the property location to field-identifiable reference points and to be very specific about test hole locations relative to both fixed reference points and each test site. One possible approach is to identify the distances between each test site and two reference points, such as a well and the corner of a building.

Preferably, all horizontal distances should be perpendicular to, and referenced to, a north-south line and an east-west line through the horizontal reference point, other fixed reference points, or identifiable baselines such as lot lines, roads, or fence lines.

It is the designer’s responsibility to clearly identify the location of test holes by both vertical and horizontal references. The elevation of the ground surface at a test site and the reported depth of test are used to compute the elevation of the bottom of the distribution media when the system is constructed or when surface soil is removed. Quick and easy ways to measure elevations are with a builder’s level, a surveying transit, or a quality hand level.

Information should be recorded on forms provided in this manual (preliminary evaluation, site map, field evaluation, percolation test and soil boring log forms). These forms should be duplicated and distributed to the permitting office and the client; a copy should be kept with the designer. The following are reporting requirements according to MN Rule Chapter 7080.1730.

a. preliminary and field evaluation results from parts 7080.1710 and 7080.1720;
b. dates of preliminary and field evaluations;
c. a map drawn to scale or dimension with a north arrow, and including (Sometimes a property is too large to illustrate conveniently all of the required in-
formation on the grid provided on the map. In these instances, use a separate sheet to draw a plot plan diagram):

1. horizontal and vertical reference points of the proposed soil treatment and dispersal areas, soil observations, percolation tests, and pertinent distance from the proposed ISTS to all required setbacks, lot improvements, easements, ordinary high water mark of public waters, property lines, and direction and percent slope;
2. the location of any unsuitable, disturbed, or compacted areas; and
3. the access route for system maintenance;

All soil observations should be reported including those that were not chosen.

e. the proposed elevation of the bottom of the soil treatment and dispersal system;
f. anticipated construction-related issues;
g. the name, address, telephone number, and certified statement of the individual conducting the site evaluation;
h. an assessment of how known or reasonably foreseeable land use changes are expected to affect system performance, including, but not limited to, changes in drainage patterns, increased impervious surfaces, and proximity of new water supply wells;
i. a narrative explaining any difficulties encountered during the site evaluation, including but not limited to identifying and interpreting soil and landform features and how the difficulties were resolved; and
j. a notation of any differences between observed soil characteristics and those identified in the soil survey report.

Soil and Site Additional Reporting

[Over 2,500 gpd]

As the flows of SSTSs increase, so does the inherent risks to public health and the environment. It only follows that additional soil investigations and site reporting are recommended for these systems. The following describes additional evaluation procedures.

Mounding evaluation

In previous sections, groundwater mounding was described. When larger flow SSTSs are proposed for an area, not only should groundwater mounding be considered, it should also be analyzed.

Method

There are numerous methods for analyzing groundwater mounding under various circumstances. All of the methods, even the most basic, require additional field testing and knowledge of the geometry of the proposed SSTS.

The appropriate method(s) will depend on your site/soil conditions, flow, local ordinance and potentially additional factors. Generally, hand calculations to complex computer
model simulations may need to be conducted in order to analyze the potential for groundwater mounding. This analysis also provides possible solutions in loading rates, system layout, etc.

Results
Most of the output from the various methods will estimate a mound height. From this output, the designer can determine if this mound height will interfere with long-term treatment and acceptance of septic tank effluent for the large SSTS. A change of location or change in geometry of the soil treatment area may lower the mounding height when the analysis is run again. This process is iterative until the geometry and the mounding height are acceptable.

Nutrient evaluation
Phosphorus and nitrogen can be issues for large SSTS and larger systems. A proper design for nutrient (i.e., phosphorus and nitrogen) reduction depends on careful consideration of pretreatment options and background levels of nutrients.

Nitrogen can exist in many forms in the SSTS. Organic N and ammonia forms of nitrogen can be stored in the soil and are not susceptible to leaching, while nitrate-nitrogen has been identified as a potential drinking water contaminant from many SSTS. As the size of the system increases, the risk of the impact of this nitrate to the groundwater is enhanced. Because nitrate-N can move through the soil with very little treatment, it is important that if nitrogen levels need to be reduced, that an appropriate pretreatment is selected and implemented.

Phosphorus is most often considered a concern near surface bodies of water. It is common to have more stringent requirements on P levels with coarser textured soils close to these surface waters. See Section 3 - Nutrient removal for nutrient dynamics in SSTSs.

Problem soils assessment
Designers can recognize many problem soils, as discussed previously (see Section 3: Soils, “Soil treatment,” as well as information throughout this Section and especially in “Problem sites and soils” below). Additional soil and site concerns exist when flows are increased. Additional and deeper soil observations, preferably soil pits, will result in the proper design considerations.

Topographic and site variability evaluation
When a site is being utilized to accept and treat over 2500 gallons of septic tank effluent daily, the SSTS covers a larger portion of a site. This larger area can mean more topographic and site variability. Minimizing this variability or splitting systems into parts will allow for better site utilization while ensuring the design is accurate.
Soil property variation and interpretation
Additional borings will be required to minimize or assess soil property variation. Designing for the most limiting conditions will be required for all SSTSs.

Water table monitoring basics
Some MSTS or ISTS will require water table monitoring to verify vertical separation is maintained throughout the operation of the system. A minimum of three feet of separation is required for adequate treatment of effluent. For a complete guide on installation and monitoring of water tables, consult “Installing monitoring wells/piezometers in wetlands,” US Army Corps of Engineers Wetlands Regulatory Assistance Program (2000).

For vertical separation monitoring, there is no extraction of a sample, and the equipment can be installed by any qualified person. If a sample is periodically extracted to test for nutrients, contaminants, etc., and a licensed well driller must install the monitoring well.

Equipment
To build a simple monitoring well, a commercial well screen is attached at solid piping at the ground surface or above. The hole should be excavated to a minimum of three feet below the depth of the distribution media. The depth should not be great enough to enter into a less restrictive soil horizon. If this is the case, the well should be installed within the same soil horizon as the distribution media.

Monitoring with chalk tape, bubbler tubes, automated recorders, or a simple rod are all acceptable methods for determining the depth at which to install the monitoring well.

Record the data in the field on data sheets and compile on a computer spreadsheet for comparison of years, precipitation, etc.

Duration
Monitoring should occur at least four times a year (April-May, June, July-Aug., Sept-Oct.) with biweekly sampling from spring to early May. Sampling is less likely in the winter months, depending on usage patterns. The monitoring should continue for no less than three to five years to account for seasonal fluctuations in temperature and precipitation.

Proper location
In order to determine if separation is being maintained, the wells must be installed within the area of influence of the SSYS. Depending on the configuration of the system, soils and site, the location of this area can vary. Locating the monitoring well so that effluent is not preferentially moving to the new opening is critical to accurately assessing separation. It is also recommended to install a monitoring well outside of the influence of the system (along a contour) to monitor natural soil conditions in case an increase in system area is needed in the future.
Problem Sites and Soils

Type II, III, IV and V Systems

Systems for Rapidly Permeable Soils
Soils in this category have low treatment capabilities and require special design considerations to overcome this limitation. The rapidly permeable soils must not occur within three vertical feet of the soil treatment area. When designed appropriately, they will be classed as Type II systems.

Coarse Sands and Gravels
Soil treatment systems in soils with percolation rates faster than 0.1 mpi or in coarse sand or systems classified as texture group of 1 must not allow direct contact between the distribution media and the highly permeable soil.

7080.2260 Subp. 2. The distribution media must not be in contact with soils with a texture group of 1 (coarse sand) as listed in Table IX in part 7080.2150, subpart 3, item E.

An option in these soils is a liner system consisting of trenches with at least 12 inches of clean sand placed between the drainfield rock and the coarse soil along the excavation bottom and sidewall. The soil loading rate to use in this liner situation is the sizing for the liner material, 1.20 gpd/sqft. Additional requirements must be addressed as found in MN Rule Chapter 7080.2260 including two additional vertical feet of suitable soils that are not coarse sands. Another option for such a site is to keep investigating the site. Perhaps there is natural variation in soil textures that would allow for proper septic tank effluent treatment.

Loamy, Medium, and Fine Sands
Soils in this percolation range contain uniform sand sizes in the fine and very fine classes. The concern in these soils is poor distribution and little or no treatment by overloading of the trench before the biomat is formed. Using the sandy soil loading rates has led to the construction of hydraulically undersized systems, so for soils that are classified as fine sands or loamy fine sand textured (i.e., more than 50 percent fine and very fine sand by weight, between sieve sizes 270-60), the required soil loading rate is 0.60 gpd/sqft, if loose consistence.

The treatment techniques required for an ISTS where the distribution media is in contact with loamy, medium, or fine sand textured soils by MN Rule Chapter 7080.2260 Subp. 3 are to utilize:

- pressure distribution as specified in part 7080.2050, subpart 4.

Small Lots

General Description
Generally these are existing lots in small communities, lakeshore areas, or existing developments with restricted land area. Many of these existing lots may still utilized soil-based
treatment techniques, but the design and assessment will require more analyses, as specified under Type III systems in 7080.2300.

**Solutions**
The best solutions on these difficult lots is to provide as much treatment of the septic tank effluent as necessary before the treated effluent is discharged to the soil treatment area, as size of the soil treatment area is most often compromised. Most of these options will result in these systems being classified as Type III systems. The complete technical requirements for such systems is found in 7080.2300.

**Reduce water consumption or reuse**
Using low flow fixtures, practicing water conservation, and investigating reuse options will reduce the amount of flow and can result in better treatment in the soil treatment area. Accurately monitoring water flows can also raise the residents’ water use awareness.

**Small field with holding tank**
A safety precaution: when the soil treatment area is no longer treating effluent (i.e., the effluent is surfacing or backing up) the ISTS can function as a holding tank and be pumped until the soil treatment area has recovered.

**Pretreatment to reduced size drainfield**
Pretreated effluent can be cleaned to similar levels as the surface and/or groundwater in the area. The soil treatment area in this case is often simply used for additional treatment and for hydraulic acceptance.

**Time dosing from large pump tank**
When small lots have ISTS, time dosing spreads the flow of water out evenly over the day. This allows the soil treatment area to treat water and hydraulically accept it before it is loaded with more effluent. This lowers the potential of the system surfacing.

**Box mound/vertical side wall mound**
The construction of a box or vertical side wall mound is another solution for small lots. It reduces the size of the absorption area.

**Lack of Unsaturated Soil**
This is a common situation in many parts of Minnesota. Careful consultation with local zoning officials is required to make sure that impacts of the ISTS do not interfere with protected wetland areas. These systems are classified as either Type IV or Type V.

**Pretreatment technologies**
Pretreatment is the most reliable form of treating effluent in this situation. Following the discussion in Section 10: Pretreatment is paramount to the success of these systems. All technical requirements are discussed in rule 7080.2350 and 7080.2400.

**Reduced hydraulic linear loading rate**
Lowering the linear loading rates will allow for more available soil to treat each gallon of effluent. Where practical, this can provide additional treatment.
**Texture break**

Sometimes there are textural discontinuities in the soil that cause soil to saturate, but underlying the restrictive soil layer there may be unsaturated soil conditions. SSTSs designed below these layers lack oxygen required for treatment, and often overload the underlying soil with effluent plus any additional soil-water from the perched horizon(s). In addition, as SSTS depths increase, microbial community populations decrease, which further limits treatment.

**Designed perimeter drain tile/curtain drain**

Note: the use of this technology is not standard. Please consult MPCA Policy on Utilizing Artificial Drainage Methods (document # wq-wwists4-04) and the permitting authority to determine if such a system is allowed and other associated requirements before design/installation. Some site conditions warrant a subsurface drainage system that conveys upslope surface and subsurface run-on away from the soil treatment area. These systems are called perimeter or curtain drains. They are implemented on sites with perched watertables.

These drainage systems do not lower the watertable, they simply remove excess water from the site as shown in figure 4.22. Frequent monitoring of these systems is required to verify that vertical separation is maintained throughout the SSTS operation.
Reduce water consumption or reuse
Using low flow fixtures, practicing water conservation, and investigating reuse options will reduce the amount of flow and can result in better treatment in the soil treatment area.

Disturbed Soil
See previous sections, discussion on types of disturbances to the soil that may warrant additional testing or design features. When soil disturbance is suspected, running percolation tests across the proposed areas will determine the extent and severity of the disturbance on soil water movement (soil loading rate). Interpreting the limiting conditions is complicated because the soils have been modified. Careful examination of surrounding areas, landscapes, aerial photographs, etc. may be required to reconstruct saturated soil elevations. Monitoring can be established to verify the vertical separation. Any design using disturbed soils will be considered a Type III, Type IV or Type V system. These systems must meet all associated requirements.

Soil modification methods
Options
There is no substitute for natural soil structure that has developed over thousands of years and is held in its characteristic shapes by organic matter, clays, and/or iron. This gluing effect is the key to consistent water movement through the soil.

There are many ways to rejuvenate the soil after disturbances have occurred; nevertheless, the one similarity of all methods is that they are temporary because they lack the gluing agents to keep the soil in aggregate forms. Rejuvenation will need to occur on a semi-regular basis throughout the life of a system. Monitoring of separation distances can help to determine when the soil has lost functionality and another rejuvenation treatment is needed. It is always recommended when you find disturbed soils that you consult with the LGU before proceeding with a design or site modification.

Excavate out the disturbed soil
One option, especially fill soil areas, is to excavate out the fill soil to the natural soil elevation. This eliminates the fill soils and lack of structure, but oftentimes there has been disturbance to the natural soils, too. They have been subjected to the additional weight of the fill soil, compacting the underlying soils. The natural soils may have also been compacted by whatever activity caused the fill to be placed in those locations. When areas such as these have been filled, they are typically low-lying or wet areas and water levels could be higher than historical levels due to the compaction.

Overexcavating the disturbed area is another option. Here caution must be used when determining the appropriate elevation of the system because simply removing the affected soil does not change the site soil-water conditions. Backfilling of the area must be completed with clean sand (mound sand). The system can then be designed and installed at the proposed elevations.

Use of the disturbed soil
Avoidance of the disturbed area(s) is the obvious and most cost-effective means of dealing with altered soils. If this cannot be accomplished, OSTP recommends a minimum of
three to five percolation tests is needed across the proposed areas to attempt to evaluate the hydraulic functioning of this soil. The soil texture and soil structure (if present) should also be evaluated. The most conservative soil loading rate (largest number) should be used from the combination of both techniques. Monitoring separation distances to ensure proper operation is oftentimes a requirement.

**Manipulate the disturbed soil**

Another option for mound sites where the native soil has been compacted is to place six inches of clean sand over the prepared native soil. Incorporate the clean sand with the native soil by dragging the backhoe bucket teeth or deeply cultivating (subsoiling) to create channels of clean sand, permitting water movement through the compacted soil. This does not alter the depth to the saturated soil condition, but is another remediation technique for compacted mound sites.

**Limitations**

There are numerous limitations to any of the above modification techniques. To ensure they are appropriate for a given set of soil and site conditions, consult with the local permitting authority. If questions about effectiveness persist, contact the MPCA or the University of Minnesota for further technical assistance.

**Effects**

Soil compaction is permanent. Any modification is temporary and is less than ideal. This does not mean that modifications cannot work, but that they simply may be more complicated, costly, and may increase maintenance/monitoring requirements.

**Design pressure distribution with varying elevation**

See Section 12 - Distribution for discussion.

**Valving with management**

See Section 12 - Distribution for discussion.

**Varying perforation sizes and spacing with valving and management**

See Section 12 - Distribution for discussion.

**Flooding**

This problem is usually associated with existing structures as construction would be prohibited in the flood plain. An existing structure in a floodplain with a failing system may need a replacement system.

The concerns about floodplain areas during flood events include surface water contamination and system damage by fine soil particles contained in the flood waters. Where ten-year flooding elevations are known, the following is a requirement for trenches.

7080.2270 Subp. 5. ...the bottom of the distribution media must be at least as high as the elevation of the ten-year flood.
For mounds, 
7080.2270 Subp. 7. A. the elevation of the bottom of the rock bed must be at least one-half foot above the ten-year flood elevation (Figure 4.24).

The complete design criteria for Type II systems in flood fringe areas are found in MN Rule Chapter 7080.2270.

**Slowly Permeable Soils**

Suitable soils for Type I systems range from percolation test values of five to 60 mpi in the soil in which the soil treatment area will be located. For soils with percolation rates higher than 60 mpi, consistent design considerations should be applied (see following section 60 to 120+ mpi). (Systems for soils with percolation rates less than five mpi are described in Systems for Rapidly Permeable Soils.)

Slowly permeable soils do provide adequate treatment, but problems are often encountered with the acceptance of effluent, construction of the ISTS, and vertical separation from saturated soils. Systems in these soils are considered Type III, Type IV or Type V systems.

**60 to 120+ mpi**

In these soils, never dig if the soil is at all moist. Construction of seepage beds is not technically feasible because of compaction of the bottom area during construction by vehicular traffic. There is also limited oxygen exchange underneath the center of the bed in case. A good rule of thumb in dealing with these soils is to keep the system dry, shallow, narrow, and natural. Consult with the local permitting authority for specific requirements or preferred techniques on these difficult sites.

Solutions:

- Mound or at-grade systems with reduced loading rates and differing levels of pretreatment (depends on soil texture, structure shape, structure grade and vertical separation distance).
- A liner system, in which a liner of sand is placed in the trench to reduce the compaction and settling when distribution media is placed into the trench

**Descriptions**

Soil descriptions are used to identify different horizons and determine if the soil has the ability to treat and dispose of the applied wastewater. Soil descriptions must be objective, complete, and clear.

**Texture**

See Section 3: Soils, “Soil texture” texture for a complete discussion on texture description and determination.

**Structure**

See Section 3: Soils, “Soil structure” structure for a complete discussion on the important aspects of soil structure.
4-54 ■ SECTION 4: Site Evaluation

Color
For a complete soil color discussion, see Section 3: Soils, “Soil Color.”.

Landscape
A complete landscape description should be included in any field evaluation and report. This includes landscape, landform, hillslope position, slope shape, slope direction, and slope gradient, as previously discussed in this Section under “Field evaluation.”

References


