Design Guidance for Large Subsurface Wastewater Treatment Systems

Minnesota Pollution Control Agency

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Introduction

What is an LSTS? LSTS stands for **Large Subsurface/Sewage Treatment System**. In very simple terms, a LSTS is a large “septic system” that discharges treated sewage (wastewater) through the soil to the ground water.

Minn. R. 7080.0600, subp. 2(B) requires a State Disposal System (SDS) Permit for *a single Individual Sewage Treatment System (ISTS), or group of ISTS, under single ownership within one-half mile of each other, that is designed to treat an average design flow greater than 10,000 gallons per day.*

This document is intended to guide an LSTS designer through a step-by-step outline on how an LSTS evaluation and design should be performed. However, it should be understood that designing an LSTS is typically an iterative process. If, while actively working on a design, an unfavorable restriction becomes evident and a design change is made, this change could affect conclusions reached earlier in the design process. It is suggested that you contact the Minnesota Pollution Control Agency (MPCA) when changes are made anytime during the entire process.

Desired Goals/Outcomes for LSTSs:

- Treatment processes and devices should not allow contact (human and animal) with sewage or sewage effluent.
- Systems must discharge sewage effluent into soil below final grade, with the effluent remaining below final grade until the ground water naturally discharges into surface water. The below-grade discharge shall not result in creation of a surface seepage of sewage or sewage effluent.
- Systems must not discharge to drainage tiles, ground surfaces, or directly to surface waters.
- Systems must treat and dispose of sewage effluent in a safe manner that adequately protects the public, including protection from physical injury and harm.
- System effluent must not impact ground water and current or future sources of drinking water.
- Systems with subsurface discharges must not impact down-gradient surface waters.
- Systems should be designed so all structural components and sealants meet or exceed a 25-year design life.
- Systems shall be operated and maintained in accordance with permit requirements by a licensed operator.

How to Use This Guidance Document

MPCA staff recommends the LSTS designer carefully review this guidance, complete the attached worksheets and checklists (as necessary), and submit this packet with the necessary application forms and supporting information to the MPCA. This ensures that MPCA staff has the necessary information to review, approve, process, and issue the permit in a timely manner.

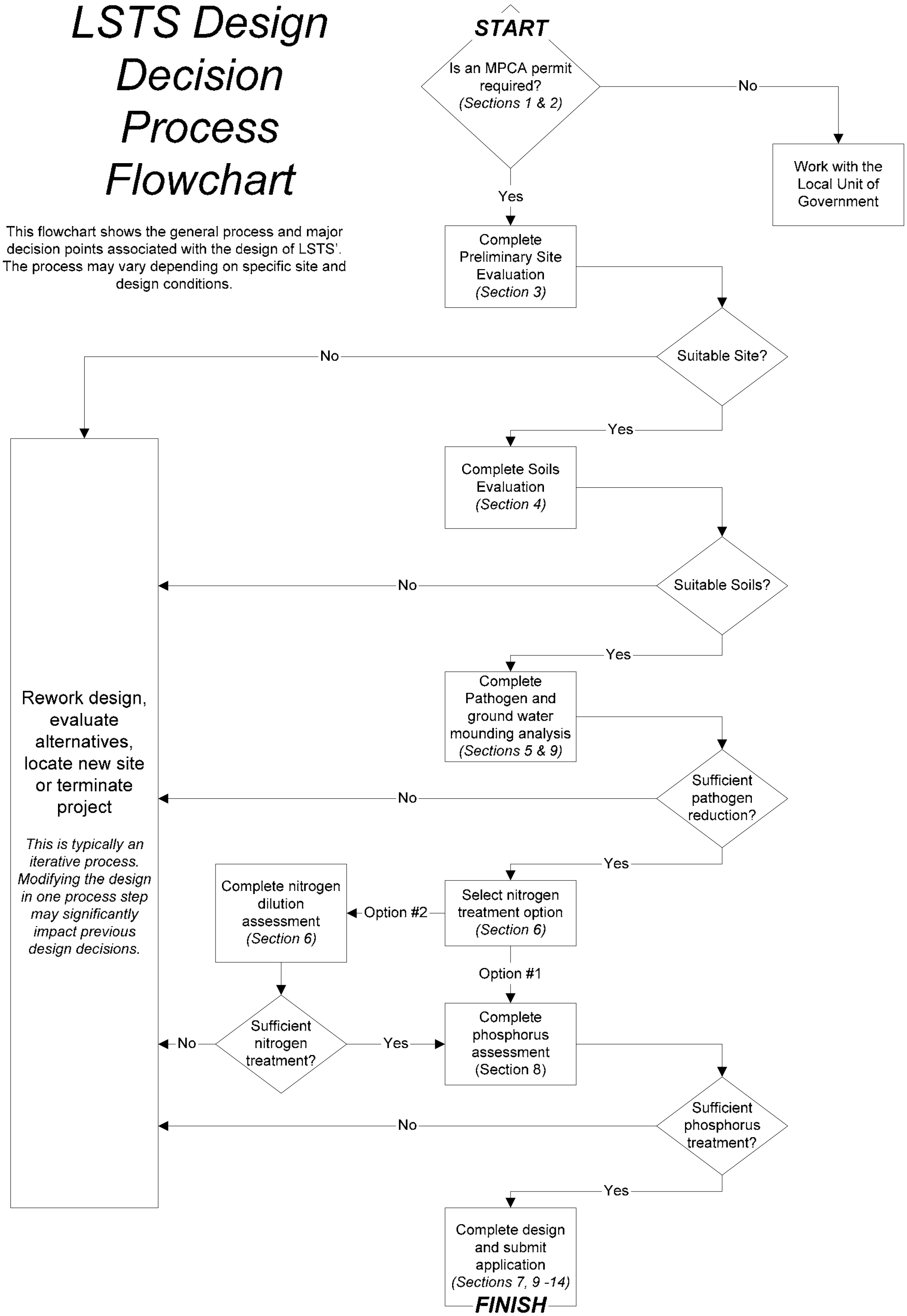
Where appropriate, this guidance recommends certain procedures, policies, formulas, etc. for the design and construction of an LSTS. By applying these recommendations to the LSTS design, best available technology and principles are generally followed. As such, the time it takes the MPCA to review and permit a facility should be less than if these recommendations are not followed. However, as the MPCA wants to encourage the advancement of the technology for the design of LSTSs, MPCA staff will make every effort to accommodate new concepts and design ideas through timely technical review and permit issuance.

The MPCA encourages implementation of pollution-prevention activities — eliminating or reducing pollutants at the source — in the operation of the LSTS and through education of the users. Pollution prevention can often save money by maximizing the life of the LSTS. Pollution-prevention ideas and resources can be found at the Minnesota Technical Assistance Program (MnTAP) Internet site at http://mntap.umn.edu/potw/index.htm.

If you have questions or need assistance, please contact the MPCA staff assigned to the project. If you are unsure of whom to contact, call the MPCA at 800-657-3864 or 651-296-6300.

LSTS Design Decision Process Flowchart

This flowchart shows the general process and major decision points associated with the design of LSTS'. The process may vary depending on specific site and design conditions.



1. Knowing an MPCA permit is needed (complete Attachment 1)

The first step in the design-and-permitting process is to determine whether an MPCA permit is required for the project. If not, the project falls under the jurisdiction of the local governmental unit (LGU) — usually the county, city, or townships. Contact the LGU for requirements and/or permits.

It is important to note that the permit design flow may be different than the **average wet weather (AWW) design flow**. The permit design flow is used to determine if a state permit is needed and the AWW flow is to determine the design of the treatment units. If the two flows are different, a more detailed review will be needed explaining how the AWW design flow was calculated.

This design process may be used even if an MPCA permit is not required. However, please be aware that the LGU may have different design requirements. To determine whether a system needs a MPCA permit, all of the following **must** be met:

1) Does the waste contain sewage? Sewage is defined as waste produced by toilets, bathing, laundry, or culinary operations, or the floor drains associated with these sources. Household cleaners and other constituents in sewage are restricted to amounts normally used for domestic purposes.

2) Is the AWW flow greater than 10,000 gallons per day, as determined in Attachment 1, or does a group of smaller subsurface sewage treatment systems under single ownership within one-half mile of each other have a design AWW flow greater than 10,000 gallons per day?

3) Is the discharge of sewage effluent below final grade and into the soil? This includes such systems as in-ground trenches, in-ground beds, mound systems, at-grade systems, and drip dispersal.

If the answers to **all three** questions are "yes," then an SDS Permit is required and this document should be used as guidance. If any answer is "no," contact the MPCA for further guidance. Additional information can be found at www.pca.state.mn.us/publications/wq-wwprm1-01.pdf.

It is important to remember:

- Surface discharges always require an MPCA permit.
- LGUs may also require local permits for LSTS in addition to MPCA permits. Contact the LGU for specific permit requirements.
- This guidance is for sewage wastes. If the waste is non-sewage and/or mixed with sewage, regardless of flow, contact the MPCA to determine whether a permit is required.
- The MPCA has the authority to issue discretionary permits based on such factors as environmental impact/sensitivity, new wastewater technology, or flow concerns for an LSTS that has less than 10,000 gallons per day design average wet weather flow. Contact the MPCA to address any of these concerns.

All subsurface sewage treatment systems serving two-family dwellings or larger, or establishments that serve more than 20 people and have subsurface discharges must register for a Class V injection well with the U.S. Environmental Protection Agency (EPA)(MN 7081.0050). Information and requirements for registration are located at www.pca.state.mn.us/programs/ists/business.html#largeists.

2. Design flow determination (complete Attachment 2)

The determination of design flows and pollutant loadings is one of the more important items in planning a new or expanded LSTS. A detailed analysis of existing flow conditions and the use of adequate flow estimates will determine the hydraulic and pollutant-removal capacity needed to properly treat the wastewater and comply with permit conditions. It is necessary to include all contributing flow streams and pollutant-loading sources in this analysis, including all residential, seasonal, institutional, commercial, inflow, infiltration, return-and-recycle streams and any other unique aspect of flow and pollutant contributions.

These guidelines are the recommended procedures for estimating the design flow and pollutant-loading conditions and are considered to be the minimum values necessary to assure adequate treatment facility capacity. It is expected that sound engineering judgment will be used to determine the appropriate design conditions for each treatment facility and that consideration will be given to impacts of decisions on upstream and downstream unit processes.

See the *MPCA Design Flow and Loading Determination Guidelines for Wastewater Treatment Plants* fact sheet at www.pca.state.mn.us/publications/wq-wwtp5-20.doc for additional discussion regarding design flow determination.

The flow conditions that are critical to the design and operation of an LSTS include both the average flow and the peak flow.

The average flow used for LSTS is the average daily flow for the wettest seven-consecutive-day period. This includes an amount for infiltration and inflow and is defined as **the average wet weather (AWW) design flow** for an LSTS. The AWW flow is the flow used to determine whether a permit is required and for the sizing treatment units and drainfield disposal areas.

The peak flows used for LSTSs are called the **peak hourly wet weather (PHWW) flow** and the **peak instantaneous wet weather (PIWW) flow**. The PHWW flow is the peak flow during the peak hour of the day at a time when the ground water is high and the number of connections to the LSTS is at full occupancy, and a five-year one-hour storm event is occurring. The five-year one-hour storm event for the specific project area may be determined from the map attachment in the MPCA Design Flow Determination Guidelines documents at www.pca.state.mn.us/publications/wq-wwtp5-20.doc.

The PIWW flow is the peak instantaneous flow during the day at a time when the ground water is high and the number of connections to the LSTS is at full occupancy and a 25-year one-hour storm event is occurring. To determine the appropriate 25-year, one-hour storm event, refer to Map No. 2 at www.pca.state.mn.us/publications/wq-wwtp5-20.doc.

The PHWW and PIWW flows are critical in the design of septic tanks, sewer systems, pumping facilities, and other components. Peak flows are important for septic tank capacity to ensure that solids are retained. Other treatment units also consider peak flow values to be certain that the units can accept the peak flow rate without backing up or overflowing.

A. Flow determination for existing dwellings

The AWW flow determination for systems serving existing dwellings where the bedroom numbers are known shall consist of the sum of the AWW flows for each individual dwelling unit as determined in either (1) or (2) below. It is recommended that flows be determined by both methods and the largest value used for design of the disposal system. When determining AWW flow with these methods, the change in dwelling usage and the potential for changes in the number of bedrooms shall be considered.

1) **Measured flow.** The flow monitoring period for any particular project must record flow data during critical wet weather flow events at peak occupancy which have occurred during a sustained wet weather flow period. For existing dwellings that have daily flow measurements over a peak water use period, the design AWW flow can be determined by averaging the highest consecutive seven-day measured values. **Note: This procedure cannot be used to determine if a permit is needed, but it could be used for design purposes**.

2) **Estimated flow.** For existing dwellings with the number of bedrooms for each dwelling known, the design AWW flow can be estimated from applying the following equation to Table 1: Permit Flow = the total flow from the ten highest flow dwellings + (total flow from the remaining dwellings * 0.45) + I/I (see Attachment 2 Step 6). **Note: This procedure is used to determine if a permit is needed and can also be used for design purposes**.

Table 1 Average Daily Flow for Four or more Dwellings (gallons per day)

	Classification of Dwelling		
# of bedrooms	**I**	**II**	**III**
2 or less	300	225	180
3	450	300	218
4	600	375	256
5	750	450	294
6	900	525	332

Classification I: Classification I dwellings are those with more than 800 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, or where more than two of the following water-use appliances are installed or anticipated: clothes washing machine, dishwasher, water conditioning unit, bathtub greater than 40 gallons, garbage disposal, or self-cleaning humidifier in furnace. The average daily flow for Classification I dwellings is determined by multiplying 150 gallons by the number of bedrooms.

Classification II: Classification II dwellings are those with 500 to 800 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, and where no more than two of the water-use appliances listed in Classification I are installed or anticipated. The average daily flow for Classification II dwellings is determined by adding one to the number of bedrooms and multiplying this result by 75 gallons.

Classification III: Classification III dwellings are those with less than 500 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, and where no more than two of the water-use appliances listed in Classification I are installed or anticipated. The average daily flow for Classification III dwellings is determined by adding one to the number of bedrooms, multiplying this result by 38 gallons, then adding 66 gallons.

B. Flow determination for new dwellings

1) According to Minn. R. 7081.0110, subp. 2 the developer should determine and restrict the total number of bedrooms for the development.

2) Use 110 gpd per bedroom plus an amount for inflow and infiltration (see Attachment 2 Step 6).

C. Flow determination for other establishments (7081.0130)

1) **Measured flow.** The flow monitoring period for any particular project must record flow data during critical peak wet weather flow events at peak occupancy which have occurred during a sustained wet-weather-flow period. For other establishments with daily flow measurements over a peak-water-use period, the design AWW flow can be determined by averaging the highest consecutive seven-day measured values.

2) **Estimated flow.** For existing or proposed other establishments, the estimated design AWW flow can be determined from the reliable data acceptable to the agency such as though found below.

Additional information on flow estimates can be found at the following Internet sites:

Link to chapter 7081 flow information: www.pca.state.mn.us/programs/ists/mr7081final.pdf

University of Minnesota Extension Service Web site for Non-dwelling Flows: http://septic.umn.edu/commercial/PDFs/flowratesfornondwellings.pdf

Wisconsin Department of Commerce Web Site (see Table 4): http://commerce.wi.gov/sb/docs/sb-PowtsManualAtGrade.pdf

EPA Onsite Wastewater Treatment System Manual: www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008totaldocument.pdf

3. Preliminary site evaluation (complete Attachment 3)

The next step involves completing a general evaluation of the proposed LSTS site(s). It is recommended that this preliminary site evaluation be performed not only to determine the suitability of the potential LSTS site(s), but also to justify the expense of more detailed and time-consuming soils and hydrogeologic evaluations.

The purpose of the preliminary site evaluation is threefold:

1) to screen the area, or subdivision property, for potentially suitable LSTS sites, dependent on readily available soils and ground water information
2) to use this information to determine whether a LSTS is a feasible method of wastewater treatment/disposal for the subdivision development
3) to determine the concerns that may be associated with the proposed LSTS site(s)

The four primary concerns that may be associated with a proposed LSTS site(s) include:

1) Soil suitability (or the soil's long-term hydraulic acceptance rate).
2) Long-term maintenance of an unsaturated treatment zone.
3) Compliance with the MPCA Nitrogen Policy.
4) Impact of phosphorus to nearby surface waters.

In general, the preliminary site evaluation will consist primarily of a desktop review of readily available information. It is suggested that the designer seek out and obtain published soils and hydrogeologic information for the area. If some relevant information is not available, it is recommended that the designer make conservative assumptions for the data not found based on his/her best professional judgment.

The end result of the preliminary site evaluation should lead to a conclusion as to whether the more site-specific soil and hydrogeologic evaluations should be pursued for a proposed LSTS site. If one or more of the four concerns listed above appears to be insurmountable, perhaps a different LSTS site or a different wastewater treatment method should be pursued as opposed to conducting an expensive, detailed investigation of the current site. If the decision is made to investigate the proposed site further, it is recommended that the detailed evaluation initially focus on the area of concern that represents the most environmental consequence.

The preliminary site evaluation may become an iterative process. Based on available information, the desktop assessment may suggest that evaluation of the proposed LSTS site be discontinued and another site be pursued. This cycle may repeat itself several times until the most acceptable LSTS location is found on a given parcel. For this reason, it is recommended that platting of residential subdivisions be deferred until the ideal LSTS location is found.

The designer should obtain as much of the following general information as possible during the preliminary site evaluation. It is recommended that this information be evaluated to assess the significance of the four areas of concern listed above.

County soil survey information (http://websoilsurvey.nrcs.usda.gov/app/)

- soil texture and structure
- soil permeability
- depth to redoximorphic features

- depth to seasonally saturated soil
- depth to bedrock
- flooding potential
- presence of hydraulically restrictive soil layers
- slope

USGS topographic maps (www.dnr.state.mn.us/maps/tomo.html)

- landforms
- surface elevation contours
- distance to wetlands/surface waters

USFWS wetland inventory maps (www.fws.gov/wetlands/data/index.html)

- location of classified wetlands
- description of wetland type

County well index (CWI) (www.health.state.mn.us/divs/eh/cwi/)

- distance to nearby wells
- depth to ground water
- aquifers used as water source
- presence of confining layers
- stratigraphy of geologic materials

USGS hydrologic atlas (www.geo.umn.edu/mgs/currentpubs.pdf)

- regional ground water flow direction
- regional ground water contours
- location and characteristics of surficial aquifers
- aquifer water quality
- annual water budget (aquifer recharge)
- aquifer thickness

MGS geologic atlas (www.dnr.state.mn.us/waters/ground water_section/mapping/status.html)

- depth to bedrock
- surficial and subsurface geology

Special studies (http://talc.geo.umn.edu/mgs/gwig/index.html)

Many federal, state, county and municipal agencies have conducted special studies and investigations that may contain valuable information for the preliminary site evaluation. These documents include county ground water plans, municipal wellhead protection plans, ambient or baseline ground water quality reports (MPCA), local hydrogeologic assessments (Minnesota Department of Natural Resources, or MDNR), ground water elevation monitoring (MDNR), etc.

This discussion is meant to provide a general approach to preliminary site evaluation. With the information and data collected from the resources suggested above, the designer can predict whether there might be special concerns associated with the selected LSTS site. For instance, the designer can use the data obtained from these and other resources, as preliminary inputs to estimate or model the following concerns:

- suitable LSTS type (seepage bed, trenches, at-grade, mound, etc)

- ground-water mounding
- vadose zone mounding (over soil restrictive layers)
- nitrogen dilution
- phosphorus attenuation

If during the preliminary site evaluation one or more of these concerns appears to be significant, it is recommended that either an alternative LSTS site be selected or that the detailed soils/hydrogeologic evaluation focus initially on the concern representing the greatest risk.

4. Soils evaluation / treatment (complete Attachments 4A and 4B)

Generally, the soils evaluation is conducted to a depth of no greater than seven feet. The soils evaluation depth is usually equal to the distance to the bottom of the proposed soil dispersal system (maximum of four feet) plus the necessary soil treatment zone thickness (generally considered to be three feet). The purpose of the soil evaluation is to:

- Determine the presence of any soil characteristics that may impact the suitability and/or thickness of the soil treatment zone (seasonally saturated soil, bedrock, extremely coarse soil textures, etc.). The thickness of the necessary unsaturated treatment zone below the soil dispersal system will be measured from these features or from any ground-water mound which may form above these features.
- Determine the infiltration rate from the soil dispersal media into the surrounding soil (infiltration/loading rate).
- Determine the presence and possible influence of any other soil characteristics that may influence the soil sizing factor, hydraulics and/or constructability (hard pans, abrupt textural changes, disturbed soil, smearing, compaction, etc.).
- Determine the treatment abilities of the unsaturated soil based on soil texture, depth of unsaturated zone, and loading rate.
- Determine any construction-related concerns (slope, topography, smearing, compaction, etc.).

State law requires evaluation of the soil be performed by a licensed subsurface treatment system (SSTS) designer who works with or is a professional soil scientist (PSS) licensed in Minnesota.

The first step in a soils evaluation involves reviewing the applicable county soil survey information, if available. This can be accomplished online at http://websoilsurvey.nrcs.usda.gov/app/.

The second step is to determine site restrictions and unusable areas, such as easements, setbacks, unsuitable topography and disturbed areas.

The third step involves choosing the location and examination of the soil in soil pits. Soil observations and descriptions must be in accordance with the U.S. Department of Agriculture's *Field Book for Describing and Sampling Soils* found at (http://extension.agron.iastate.edu/soils/SSDS_maps.html). Soil descriptions must be recorded on soil log reports in Attachment 4A of this document or similar format. Test pits should be evaluated to a depth equal or greater than the proposed soil dispersal depth (maximum of four feet) plus the thickness of the treatment zone (generally three feet unless a pathogen pretreatment method is proposed). Enter soil pits in accordance with Occupational Safety and Health Administration (OSHA) confined space requirements. Enough test pits should be excavated and analyzed to adequately characterize the site. One test pit per 10,000 square feet of dispersal area is recommended. Test pits must be located within or near the system boundaries. It is important to locate test pits such that the disturbed soil will not interfere with the future absorption area.

The soil morphology information gathered in the test pits is to be used to size the needed absorption area. Conventional sizing values are recommended as a starting point, but may need to be changed based on other loading considerations, such as ground-water mounding, waste strength loading or nitrogen loading. Conventional loading rates are found in Attachment 4B.

From this evaluation, a few tentative design decisions can be made:

- proposed depth/height of system and system geometry to achieve the needed unsaturated soil treatment zone thickness from the bottom of the soil dispersal system to the seasonally saturated soil, bedrock or any associated ground water mound
- loading rate (gal/ft^2/day) or soil sizing factor (ft^2/gal/day)
- whether pretreatment is desired to reduce drainfield area or unsaturated soil treatment zone thickness above seasonally saturated soil, bedrock or any associated ground water mound

However, later in the design process, these initial decisions may need to be modified.

Removal of BOD and TSS by using secondary processes (other than primary septic tanks) is recommended but not required. The discharge of cleaner effluent into the soil dispersal system should prolong the life of the system. The land requirement for a backup soil dispersal system may be reduced if cleaner effluent is discharged into the soil dispersal system.

However, reducing the size of the system may have adverse implications to the other sizing considerations, such as ground-water mounding or nitrogen loading.

Additional manufacturer's information and additional references may be used as appropriate. Documentation of the sizing of the pretreatment unit must be submitted with the permit application.

5. Pathogen treatment (complete Attachment 5)

For systems without pathogen-removal treatment devices, the primary point for the removal of pathogens occurs in the soil treatment zone beneath the dispersal/treatment unit (drainfield) of the LSTS. Effective pathogen treatment depends on these factors:

- soil texture in the treatment zone
- effluent loading rate to the soil
- effluent dosing frequency
- depth and width of system as it affects oxygen transfer into the soil
- capillary fringe in the unsaturated zone
- ground-water mounding
- concentrations of contaminants in the effluent
- hydraulic head over bottom absorption area

These design parameters must be accounted for, and some can be manipulated to achieve pathogen reduction goals (see Attachment 5). As a comparison, a system serving an individual dwelling requires the following treatment conditions:

- A minimum three-foot vertical soil treatment and dispersal zone shall be designed below the distribution media that meets the criteria below:
    a. The zone must be above the seasonally saturated soil and bedrock.
    b. The zone must be continuous and not be interrupted by seasonal zones of saturation.
    c. Any soil layers in which 50 percent or more of the particles are greater than two millimeters in size, coarse sand or coarser, must not be credited as part of the necessary three-foot zone.
    d. The entire treatment zone depth must be within seven feet from final grade.
- The hydraulic head placed over the soil treatment zone must be no greater than 30 inches.

It should be understood that a system serving an individual dwelling is **designed** with a three-foot unsaturated zone, but during loading and operation of the system, the treatment zone is **reduced** due to ground-water mounding. This mounding is accounted for in state rules for individual systems. However it is difficult to "cookbook" a design separation distance for an LSTS due to the variation in ground-water mounding. In other words, sufficient removal of biological contamination will be achieved if an LSTS is **designed** with a three-foot treatment zone if the loading rate and ground-water mounding is the same as a system serving an individual dwelling.

Therefore, LSTS designers must be aware that systems designed to provide three feet of separation prior to actual operation will experience artificial ground-water mounding under the soil treatment and dispersal system, thereby reducing the separation distance to less than three feet. Please refer to the mounding discussion in Section 9.

A method to calculate the needed separation distance is found in Attachment 5. **Since this method is based on limited research, ground-water monitoring for fecal contamination must take place directly under the dispersal field.** Concentration limits of fecal organisms will be placed on the ground water directly below the system. As stated for the other sizing considerations, the designed vertical separation and loading rate for pathogen removal must also provide acceptable hydraulic performance.

6. Nitrate-nitrogen treatment (complete Attachment 6)

Nitrogen compounds in ground water can be a human health concern. Typically, conventional septic systems (or pretreatment systems not designed to reduce nitrogen) do not adequately remove nitrogen. To ensure the best, reasonable protection of the state's valuable ground water resource and to provide a consistent technical basis for permitting decisions, the MPCA adopted a nitrogen permitting policy. This policy can be found at: www.pca.state.mn.us/publications/wq-wwprm1-10.pdf. This policy is based on safe drinking water standards set by federal and state laws (40 CFR part 141.62 and Minn. Rules 4717.7500 supb. 68).

MPCA's Nitrogen Permitting Policy
New LSTS facilities and *existing* LSTS facilities that are expanding (increasing design flow) that submitted permit

Complying with this policy will significantly affect the design, siting and construction of LSTSs. Therefore, it is important to carefully consider and understand the implications of these decisions now and throughout the design process. Careful upfront planning of the LSTS will very often reduce work later in the process.

New and expanding LSTS systems that are subject to the requirements of the policy must address nitrogen impacts by selecting from **one of the two** permitting options described below. These options generally provide trade-offs between the frequency, detail and timing of hydrogeologic and long-term system monitoring requirements, as well as up-front capital costs, operational and maintenance costs, and permit times. Changing permitting options later in the process may be allowed; however this will likely affect the type and quantity of technical documents that are required to be submitted and may slow the overall design approval and permitting of the project.

Ambient and siting conditions

LSTSs are only responsible for treating the wastewater discharged from the facility. In other words, an LSTS system will not be prohibited from being constructed on a site with high ambient nitrogen concentrations or other pollutants of concern. However, ambient conditions may affect monitoring or discharge permit requirements depending on the site-specific conditions and design factors.

Permitting Option #1 may be mandatory under situations where nitrogen dilution cannot be effectively modeled (such as areas containing Karst geography), where protection of the ground water cannot be adequately assured, or in areas containing particularly sensitive or vulnerable receiving waters.

Nitrogen limits in permits

LSTS permits will contain a maximum discharge limit for Total Nitrogen (as nitrogen) to account for all potential sources of nitrate nitrogen. This limit will be applied at the end-of-pipe (EOP) prior to discharge to the soil dispersion portion of the LSTS. Total Nitrogen is defined as the sum of nitrate (NO_3), nitrite (NO_2), organic nitrogen and ammonia (all expressed as N). Note that for laboratory analysis purposes, Total Kjeldahl Nitrogen (TKN) is an analytical method that measures both organic and ammonia nitrogen.

Permitting options (select one)

Permitting option #1: This option requires the design of a nitrogen pretreatment system to achieve 10 mg/L total nitrogen as N prior to discharge to the soil-dispersion portion of the facility. An end-of-pipe (EOP) limit of 10 mg/L total nitrogen as N will be applied and measured as a rolling 12-month average.

Advantages*:

- less detailed up-front hydrogeologic assessment
- faster permitting times
- a ground-water monitoring well network will likely not be required for long-term assessment of the system unless there are other ground water related concerns, such as pathogens or phosphorus
- fewer monitoring requirements

Disadvantages*:

- higher up-front capital costs
- higher operation and maintenance costs
- no accounting for nitrogen reduction by soils and ground water and no accounting for dilution by down-gradient green space (precipitation recharge) a 10mg/L Total Nitrogen limit will be assigned at end of pipe (EOP)

Permitting option #2: This option allows any combination of nitrogen pretreatment devices, soil and ground-water nitrogen reductions and dilution by down-gradient green space (precipitation recharge) to comply with the 10 mg/L ground water nitrate-nitrogen standard. An up-front, detailed hydrogeologic assessment and dilution/dispersion modeling are required as part of the design process. Based on the results of the assessment, the MPCA will assign an EOP limit (above 10 mg/L total nitrogen as N) as a rolling 12-month average.

Advantages*:

- lower up-front capital costs
- allowed to consider nitrogen reduction by soils and ground water and dilution by down-gradient green space (precipitation recharge) a limit >10 mg/L total nitrogen as N limit will be assigned at EOP

Disadvantages*:

- more detailed up-front hydrogeologic assessment is required
- long-term ground-water monitoring well network will likely be required to measure effectiveness of system
- more monitoring requirements
- longer permitting times

** The relative advantages and disadvantages of each permitting option are only anticipated. The actual requirements are dependent on the facility-specific design factors.*

Nitrogen treatment design considerations

The design of wastewater treatment systems that denitrify wastewater can be a complicated process. The following design factors must be considered when designing a nitrate-nitrogen removal system:

- stoichiometry of the reactions, including the carbon source requirements of the reactions and the alkalinity requirements
- denitrification reaction kinetics, including temperature requirements, mixing requirements, and reaction residence time requirements
- operation and maintenance of the system (i.e., how to operate the system)
- nitrogen mitigation plans (how to optimize the system to achieve end-of-pipe nitrogen limits)

Additional resources for the design of denitrifying LSTSs:

U.S. Environmental Protection Agency, 1993. *Process Design Manual: Nitrogen Control.* EPA Office of Research and Development. EPA/625/R-93/010. Cincinnati, Ohio.

Water Environment Research Federation's final report, *Investigation of Hybrid Systems for Enhanced Nutrient Control (2000).*

Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants, WEF Manual of Practice No. 29.

7. Infiltrative surface sizing (complete Attachment 7)

Proper drainfield sizing is critical to the operation of any subsurface system. See Attachment 7 for the necessary calculations for sizing the drainfield based on hydraulics. Drainfield sizing may later be changed based on the necessary sizing to accommodate fecal-treatment (mounding concerns) and nitrogen-dilution requirements. Using the infiltrative loading rate value from the calculations done in Attachment 7, calculate the minimum drainfield size (in square feet) using the following calculation:

Bottom area of soil absorption system (ft^2) =

Design Average Wet Weather Flow (gpd) x Loading Rate for most restrictive soil horizon* (gpd/ft^2)

***(see Attachment 4B)**

Use the design AWW flow value from Attachment 2 and the loading rate from Attachment 4B. Other flows include all nonresidential contributors, including restaurants, hotels, schools, commercial, etc. Other flows should be determined using the University of Minnesota Extension Service estimates for non-dwellings at https://www.revisor.mn.gov/rules/?id=7081.0130.

The design AWW flow is used to design the drainfield, septic tanks (along with a peaking factor), and the pretreatment unit (if applicable). Now that the average daily flow value and the hydraulic loading rate value have been determined, perform the calculation and determine the minimum square footage of drainfield needed. The reduction in the size of the drainfield is related to the hydraulic loading rate value. The hydraulic loading rate value for pretreatment is smaller, thus the drainfield area will be smaller.

Initial system size and back-up site requirements

1) Divide the design AWW flow by the loading rate (found in Attachment 4B).
2) Multiply the land area in Step 1 by a factor of 2. This is the total amount of land area needed for two full-size systems.
3) Construct 1.5 times the amount in Step 1, ensuring a usable area with suitable contours. All systems shall provide a natural area equal to 25 percent of the treatment area set aside as a replacement area.
4) Divide the system into a minimum of three zones for dosing and resting.

Additional drainfield design considerations:

- Even distribution is necessary to maximize surface contact and the reduction of pollutants. Therefore, pressure distribution of the drainfield is required. The pressure distribution system should be designed so there is less than 10 percent flow variation over the drainfield and the minimum distal head pressure at the orifices should be two feet.
- Time-dosing of the zones on a rotating basis is recommended.
- Inspection pipes are required in the design of LSTS drainfields. The following are two types:
    1) trench inspection pipes (for monitoring the water level within rock-filled trenches or chambered trenches)
    2) lateral flushing valve inspection pipes (for providing access to valves on the ends of laterals)
- Piezometer inspection pipes are optional in the design (for monitoring the mound height beneath a drainfield).

Once the square footage of the drainfield area needed to get the water in the ground is determined, a determination of how the water will disperse laterally is needed to determine the most appropriate length-to-width ratio or geometry of the drainfield. Knowing how well the water disperses (moves horizontally away from the site) involves the use of information obtained from the hydrogeologic investigation. This involves analyzing the subsurface environment at a depth much deeper than the soils evaluation looked at. This is done via soil borings, which is referenced in Section 3 – Preliminary Site Evaluation and Section 4 - Soils Evaluation/Treatment of this guidance.

Water dispersal is determined by calculating the linear loading rate for the site and/or by ground-water mounding calculations. The ability for water to disperse along a contour at any given site is looked at closely in an LSTS design.

Getting water into the ground via the appropriate infiltrative loading rate (as determined by the soil morphology analysis) is only one component of good LSTS drainfield design. Once the water gets in the ground, it still has to move away from the site. This is where linear loading rate and mounding come into play. At any given site location, either the infiltrative loading rate or the linear loading rate will be the more limiting. At some sites, it will be easier to get the water into the ground than to have it move away horizontally. At other sites, the opposite will be true or the two loading rates may be nearly equal. Appropriate LSTS designs must account for both loading rates. If water gets in the ground quickly but moves away horizontally rather slowly, the drainfield design will need to be spread out over the contour and thus the drainfield will be shaped more like an elongated rectangle than a square.

8. Phosphorus treatment (complete Attachment 8)

Typically phosphorus is not a concern as a contaminant source unless the proposed system is near a surface water body such as a lake. In such a case, the phosphorus loading from a LSTS might exceed the soil’s ability to attenuate the phosphorus and break-through can occur into the ground water. The phosphorus-laden ground water can then travel and be discharged into nearby surface water. This phosphorus input into the surface water can contribute to unwanted algal growth.

If the LSTS is located within 500 feet of a surface water that would normally have a phosphorus limit or a surface water with a TMDL for phosphorus, a determination shall be made as to whether surface water may be impacted with phosphorus via a ground water plume created by the LSTS. This determination consists of a phosphorus impact study which includes the phosphorus absorption capacity of the soil and the expected phosphorus breakthrough to the receiving water.

Designers should work with MPCA staff to determine the suitable evaluation process to predict phosphorus attenuation prior to application submittal. It is suggested that a phosphorus treatment work plan be developed and submitted for approval before starting the phosphorus evaluation. The basic approach is to determine whether the soil phosphorus absorption capacity meets or exceeds the design life of the soil treatment and dispersal system.

Refer to Attachment 8 for specific information on methods to determine phosphorus attenuation. Also, submit a work plan that outlines the phosphorus attenuation discussed in the above paragraph to the MPCA.

9. Hydrogeologic evaluation

The Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience and Interior Design (AELSLAGID) requires the use of professional geologists (PG) that are hydrogeologists for this portion of the review.

Complete a thorough hydrogeologic evaluation of the site and submit the findings of that evaluation to the MPCA as a report. The MPCA staff should be contacted to discuss the project before beginning the hydrogeologic evaluation.

The purpose of a hydrogeologic evaluation is to:

1) Estimate the height of the ground water mound above the saturated zone and/or the height that effluent may perch over an unsaturated restrictive layer. It may be necessary that this assessment also include a determination of the potential for sideslope break-out (seepage) due to mounding or perching of effluent. The evaluation of mounding/perching is necessary for all proposed LSTS systems.
2) Estimate the concentration of nitrate-nitrogen at the LSTS property boundary. This evaluation is only necessary for LSTS systems that choose Permitting Option 2 (see Section 6 for the definition of Option 2.)

Information that will be collected and evaluated from the hydrogeologic evaluation includes:

- the direction of ground water flow
- the depth to the static ground water level
- the rate of ground water movement (hydraulic conductivity)
- the hydraulic gradient
- the specific yield
- geologic cross-sectional analysis of the site, including the presence of deeper limiting layers, water table surface, perched water tables, bedrock, karst, etc.
- characterization of aquifers that may be impacted by the wastewater and whether the impacted aquifer is connected to a current or future drinking water aquifer
- thickness of the saturated zone
- background ground water quality data

The items above involve hydrogeologic field work operations. This field work involves the drilling of deep borings at the proposed site followed by an evaluation of the bore holes and excavated material. The borings, and subsequently installed wells or piezometers, are used to test for the direction of ground water flow, the static water level, the hydraulic conductivity, the hydraulic gradient, saturated thickness, and the specific yield.

The sixth bulleted item, geologic cross-sections, involves field work to create boring logs using the Unified Soil Classification System (USCS) method, and then office work creating two- or three-dimensional profiles. To use the borings to determine ground water quality (including total nitrogen levels), the LSTS designer will be required to convert some or all of the borings to ground water wells to collect ambient ground water chemistry samples. This step will only have to be done if Permitting Option 2 from Section 5 – Nitrate-Nitrogen Treatment is chosen.

If Permitting Option 2 is selected, use this ground water information in the nitrogen model provided in this section or other contaminant dispersion model. Based on the results of the modeling, some of the borings/wells may be allowed to be properly abandoned; although a minimum of three wells will likely be used for long-term ground-water sampling.

Ground-water mounding

Regardless of the Permitting Option chosen, all proposals will have to estimate whether ground-water mounding will become an issue with the performance and operation of the LSTS. Percolating effluent from an LSTS can create hydraulic performance problems in two ways: (1) by artificially raising the water table immediately below the LSTS by the creation of a ground water mound, or (2) by perching of the effluent on low permeability layers in the vadose zone immediately below the LSTS.

To estimate the height of a ground water mound below an LSTS, a hydrogeologic evaluation must be conducted. The goal of the evaluation is to collect the hydrogeologic information necessary to enter into the selected ground-water mounding model or formula. The following information is generally needed to estimate the potential height of a ground water mound:

Input Parameter	Suggested Methods
Time	Use 20 years (7,300 days)
Effluent infiltration rate per unit area	Design flow ÷ entire area of the soil absorption field
Soil absorption field dimensions (length and width)	From project plan sheets
Hydraulic Permeability	Slug tests, pumping tests, laboratory tests, estimates from grain-size distribution
Aquifer (saturated) thickness	Deep borings, hydrogeologic atlas, nearby well-boring records
Effective porosity (specific yield)	Literature data, laboratory tests
Distance to and elevation of lateral control (constant-head boundary)	Measured distance to nearest lake, river, wetland, etc.

Suggested references that provide methodologies for estimating ground water mound heights include:

Minnesota Pollution Control Agency. 1984. High Rate Soil Absorption (HRSA) Task Force Final Report. 6.0 Appendix.

Finnemore, E.J., and N. N. Hantzsche. 1983. Ground-water mounding due to on-site sewage disposal. Journal of Irrigation and Drainage Engineering 109(2):199-210.

Hantush, M. S. 1967. Growth and decay of ground water mounds in response to uniform percolation. Water Resources Research 3(1):227-234.

Finnemore, E. J. 1993. Estimation of ground-water mounding beneath septic drain fields. *Ground Water* 31(6):884-889.

Poeter, E., J. McCray, G. Thyne, and R. Siegrist. 2005. Guidance for evaluation of potential ground-water mounding associated with cluster and high-density wastewater soil absorption systems. Project No. WU-HT-02-45. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, Mo., by the International Ground-water Modeling Center, Colorado School of Mines, Golden, Colo.

Poeter, E., J. McCray, G. Thyne, and R. Siegrist. 2005. Designing cluster and high-density wastewater soil absorption systems to control ground-water mounding. Small Flows Quarterly 6(1):36-47.

The information in this section is used to ensure that water from the LSTS will stay below ground and is primarily a concern for more limited sites where surfacing of effluent may occur. Specific site conditions will determine which methods to use in order to estimate if the necessary separation distances (i.e., treatment zone thickness) will be met. Requirements should be determined in consultation with MPCA staff.

Various practices/actions can minimize or reduce the nitrogen that exits LSTSs. Common best management practices (BMPs) include:

- separating black water and grey water discharge
- presence of natural soil conditions which promote denitrification
- nitrogen removal pretreatment devices
- systems designed as long as practical along the ground water contour
- creation of a downgradient riparian zone which captures the contaminant
- increased stormwater dilution downgradient of the LSTS
- presence of ground water conditions which naturally denitrify
- installation of downgradient recovery wells for nonpotable use
- dosing and resting cycles which promote denitrification

10. Final soil dispersal system sizing

There are two types of sizing considerations when determining the needed area for a soil treatment and dispersal system: (1) infiltrative (soil absorption) sizing and (2) lawn area sizing.

A. Infiltrative (soil absorption) sizing

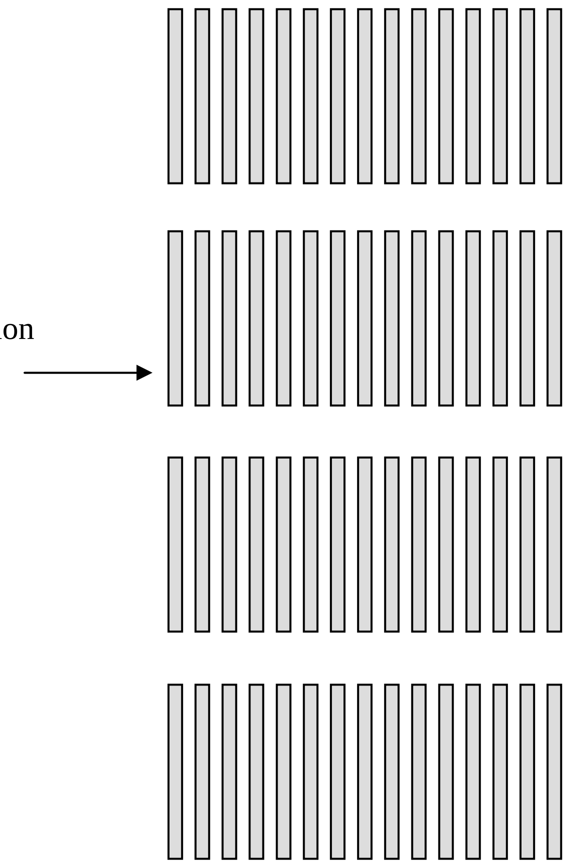
The infiltrative (soil absorption) sizing is the area needed to infiltrate/absorb the effluent from the drainfield media (drainfield rock, chambers, etc) at a rate that will result in the removal of fecal organisms. This area is dependent on the hydraulic properties of the soil (soil texture, structure and porosity); along with the impedance due to effluent strength (the formation and extent of the clogging mat). Acceptable fecal removal occurs when effluent is in contact with unsaturated soil for a sufficient residence time.

For purposes of LSTS design only the bottom area of the soil absorption units (trenches, beds, mounds, etc.) is to be considered as the absorption area. This infiltrative area, when divided by system flow, results in a loading rate that is used in the calculations for pathogen removal (Attachment 5) and organic loading (already factored in Attachment 4B). Infiltrative sizing is described in Section 7.

B. Lawn area sizing

The second sizing consideration is termed “lawn area” sizing. Lawn area sizing is the bottom absorption area size described in “A” above, plus all the area between the soil absorption units (e.g., trenches). This lawn area sizing/dimensions is used in calculations for phosphorus (Attachment 8), nitrogen (Attachment 9) and ground-water mounding (Section 9).

Infiltration Trenches
Plan View
Shaded area = infiltration (soil absorption) area



C. Examples

A soil treatment and dispersal system has 60 trenches that are three feet wide, eight feet on-center and 100 feet long. The system has four zones of 15 trenches each placed side by side on the slope spaced 10 feet apart. The AAW flow is 10,800 gpd. The system is 175 feet from the downgradient property line.

1) Infiltration (soil absorption) area

The infiltration (soil absorption) area is 18,000 ft^2 (60 x 3 ft x 100 ft) and the loading rate for pathogen removal or organic loading would be: 0.6 gpd/ft^2 (10,800 gpd / 18,000 ft^2).

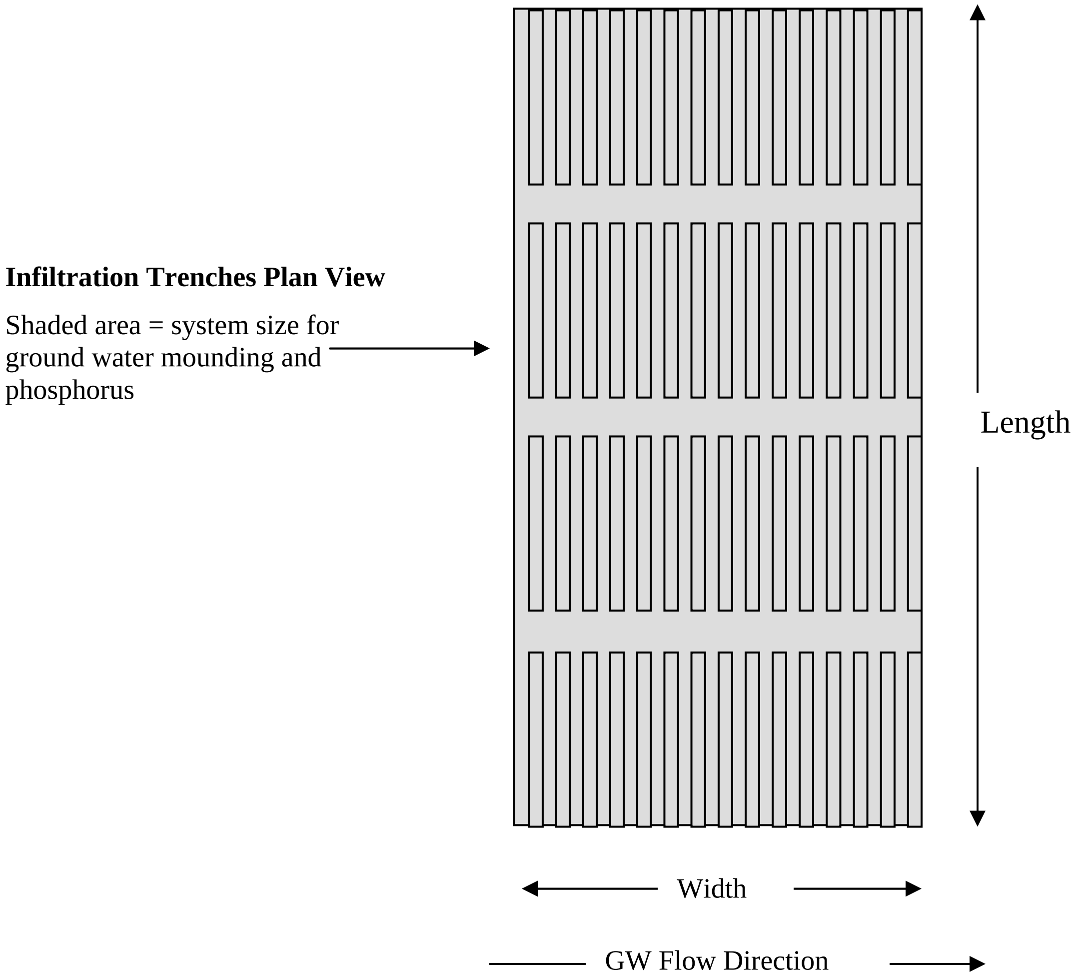
As presented in Attachment 7, Step 4, the minimum infiltration area should be multiplied by 1.5 and divided into at least three zones. Consequently, for this example, the recommended infiltration area would become 27,000 ft^2 (18,000 ft^2 x 1.5 = 27,000 ft^2).

2) Ground-Water Mounding and Phosphorus – System Area

The "lawn area" size is used for ground-water mounding and phosphorus calculations. The lawn area in the example would be to multiple the overall system length by its width. The calculation for the above example is:

((19 x 8′) + 3′) x ((3 x 10′) + (4 x 100′)) = 66,650 ft^2

[width] [length]



3) Nitrogen Dilution – System Area

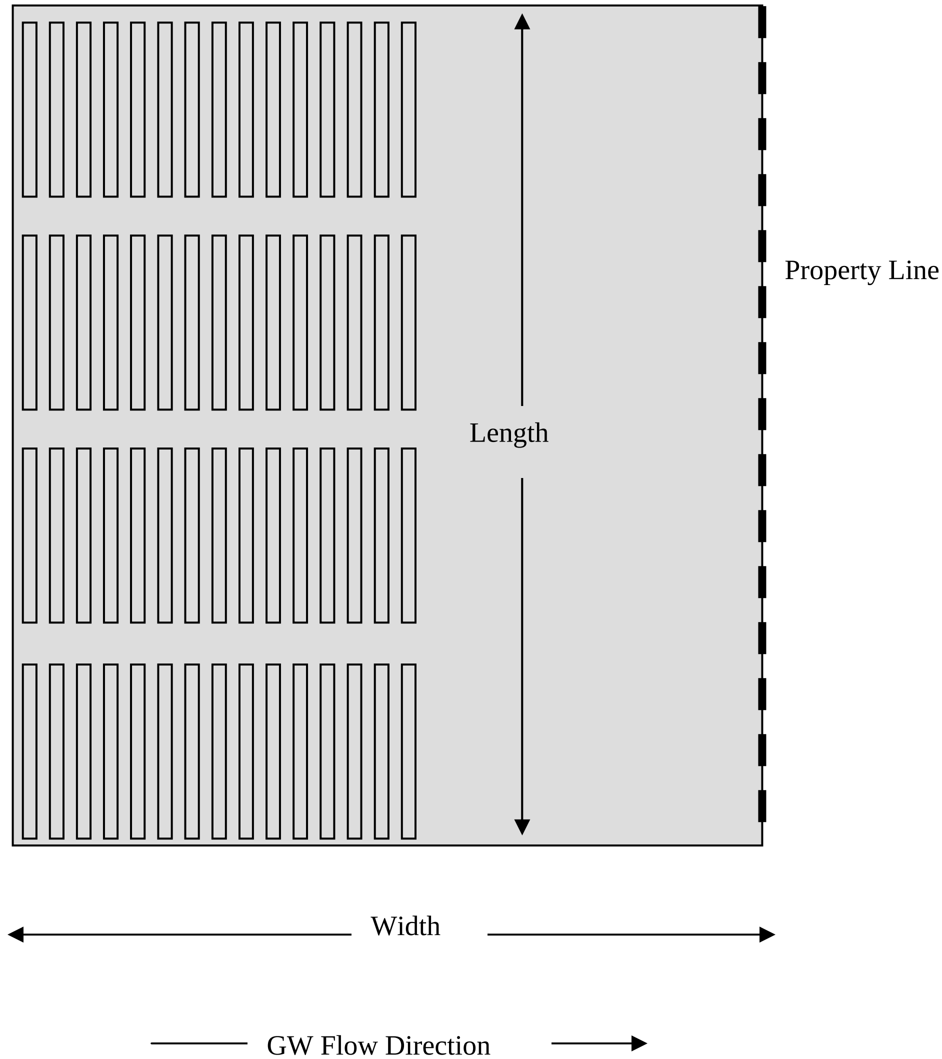
The area to calculate nitrogen dilution from precipitation recharge would be the same as for ground-water mounding and phosphorus, plus the downgradient area inside the property boundary that infiltrates precipitation (“green space”). The calculation for the above example is:

$$((19 \text{ x } 8') + 3') \text{ x } ((3 \text{ x } 10') + (4 \text{ x } 100')) + (175' \text{ x } ((3 \text{ x } 10') + (4 \text{ x } 100')) = 141{,}900 \text{ ft}^2$$

[width] [length] [downgradient area]

Infiltration Trenches Plan View

Shaded area = system size for nitrogen dilution



D. Final Sizing

The most restrictive total land area from items C 1), C 2), or C 3) above will be multiplied by 1.25 with the additional 25 percent area set aside for future use if needed. This can be accomplished in a variety of ways. The first way is to design enough area in between the trenches for additional trenches (this will not be the solution if phosphorus or nitrogen breakthrough is the failure) or additional area set aside elsewhere. If area is set aside elsewhere, then adequate downgradient green space must also be added.

The different sizing considerations are interrelated. For example, lowering the waste strength would allow a greater hydraulic loading rate (Attachment 4B), which would impact the soil's ability to remove fecal organisms (Attachment 5). Therefore, arriving at a final sizing/loading rate can be very complicated.

To arrive at the most successful system design, the designer must consider the following factors:

- waste strength treatment devices
- nutrient treatment devices
- fecal reduction devices
- soil dispersal system
    - sizing
    - geometry
    - dosing frequency
- natural soil treatment capabilities
- dilution
- operation and maintenance requirements

11. Septic tank sizing and design considerations (complete Attachment 11)

Now that the drainfield size and shape have been determined and the location and treatment effectiveness have been proven, the designer is ready to design the rest of the subsurface wastewater system.

The first step in this process involves appropriate sizing of septic tanks. LSTS designers have the option of designing either individual septic tanks or community septic tank systems. Thus, there will either a small (e.g. 1,500-gallon) septic tank at each house or a series of large septic tanks at one central location. Having a tank at each house and then pumping the septic tank effluent to a common treatment system is referred to as a STEP system (septic tank effluent pump) system. To size individual septic tanks for a STEP system, refer to Minnesota Rule 7080.0130. For the sizing of community septic tank systems, follow the sizing protocol below.

If a STEP system is utilized, agreements have to be made as to whose responsibility it is to maintain and pump the tanks (either the individual home owner or the wastewater operator for the treatment system).

There is a third option that could be considered: instead of installing septic tanks in which solids settle out and accumulate, the designer may consider installing a wastewater clarifier with a continuous solids-removal system. Because capacity for solids accumulation is no longer needed with a clarifier, one can often build smaller primary treatment units than if septic tanks were to be installed. Note, however, that clarifiers have mechanical moving parts. This may offset any savings. Also, one has to decide whether the wastewater system should look more like a mechanical wastewater plant or a large-scale septic system. Either system works, but it is the designer’s decision as to what will work best for the situation at hand.

Septic tank sizing determination

Septic tanks are designed for the removal of suspended solids, carbonaceous biochemical oxygen demand (CBOD), heavy metals, nutrients, and some pathogenic organisms. For normal, domestic-strength wastewater, properly designed septic tanks can provide discharge concentrations of 220 mg/L or less CBOD, 65 mg/L or less total suspended solids, and 30 mg/L or less fats, oil and grease. Note that the main design concern for septic tank sizing should be to assure the effluent exiting the last septic tank and entering the secondary-treatment device (if applicable) is within the design CBOD and TSS loading rates for that secondary treatment unit. If no secondary treatment unit is employed and the soil treatment unit is instead the secondary treatment unit, the soil treatment unit needs to be sized to accommodate the CBOD/TSS loading exiting the last septic tank.

Septic tank sizing is based on the peak design flows which ensures an adequate retention time during high-flow conditions. Additional volume above the minimum required volume will provide additional solids-settling capacity and will minimize downstream impacts from variable flows.

The worksheet in Attachment 11 shall be used to determine the minimum septic tank volume when there will be no septic tanks at individual dwellings. This method should be followed unless a particular treatment unit product vendor or registered engineer is willing to warranty or guarantee an alternative design sizing. Supporting data must be provided that justifies the alternative design sizing method. The key factor is to be sure that the effluent leaving the septic tanks remains within the design loading rates for the secondary treatment unit. Note that if this route is taken, permit requirements will likely be placed in the SDS Permit that requires ongoing septic tank effluent testing to verify the design basis is accurate. Note also that primary treatment (septic tanks or a clarifier) is not necessarily needed for various secondary treatment plant designs such as sequencing batch reactors.

Attachment 11 has additional considerations for more discussion on this topic.

12. Sewer system design

A sewage collection system is defined under Minn. Rules 7080 as a system having two or more sewage sources with a common soil treatment unit. A professional engineer is required to design a sewage-collection system for an LSTS. System designs can be gravity sewer systems, pressure sewer systems, or combinations of the two. Low-pressure sewer systems with a grinder pump at each house are a common LSTS design in Minnesota, yet some experts disagree with the use of grinder pumps discharging to community septic tanks systems. This type of system, mentioned previously in Section 9, is often referred to as a STEP (septic tank effluent pump) system. STEG (septic tank effluent gravity) systems are also an option that can be used for discharge to a community septic tank system.

Good engineering practices shall be followed in the design of LSTS sewers. The standard guidance documents for designing sewer systems in Minnesota are:

- Recommended Standards for Wastewater Facilities document
- *Great Lakes – Upper Mississippi River Board* (often referred to as Ten States Standards)
- Standard Utilities Specification, *City Engineers Association of Minnesota*.
- Design Certification for Sanitary Sewer Extension Plans and Specifications can also be used to aid in the design of LSTS sewers. This MPCA fact sheet can be found at www.pca.state.mn.us/water/permits/index.html#sanitarysewer. It is recommended that this be completed and submitted with the permit application.

Some engineering design factors to consider include:

- assuring minimum scouring velocities of not less than two feet per second
- locating enough manholes and/or cleanouts to provide adequate ability to clean the sewer system when necessary
- providing individual home shut-off valving as well as backflow prevention measure (check valves)
- slope of the proposed system layout
- diameter of pipe needed to handle peak flows
- type of pipe
- proper pipe installation
- hydraulics of flow and friction loss, etc.

It is important to remember that the sewer system is part of the disposal system, and construction of the sewer system shall not occur until a permit has been issued and permit requirements, specifically plan and specification approval, have been fulfilled.

13. Operation and maintenance

Although this guidance document focuses on the design and permitting of Large Soil Treatment Systems (LSTSs), the long-term success of the system is dependent on it being adequately operated and maintained. Therefore, developing an operations and maintenance (O&M) manual is critical in the planning and design of the project. An O&M Manual acts as the owner's manual for the treatment system and is a bridge between the designer and the operator/owner of the system. It is essential that the operators of the system know what the intention of the designer is for the system.

The complete wastewater treatment system includes the treatment units and disposal areas, the collection system, and connections from individual users. This includes STEP tanks, grinder pump stations, individual septic tanks, or other remote components of the system, regardless of who ultimately owns the unit.

A. Operation and Maintenance Manual

Permits for LSTS contain several specific requirements for the operation and maintenance of the treatment system. One of those permit requirements is for submittal of an operation and maintenance manual sixty days before initiation of operation of the new system. An O&M Manual Certificate of Completion (www.pca.state.mn.us/publications/wq-wwtp7-02.doc) is required to be submitted by the Permittee. Even though the certificate of completion is not required until after design approval, it is important for the Permittee to address proper operation and maintenance as part of the system planning and design. A draft of the O&M manual shall be submitted with the permit application and design documents.

At a minimum, the O&M manual must include a detailed discussion of the operation, controls, site and equipment maintenance, sampling and analysis, problem mitigation, volatile organic chemicals (VOC) management, personnel records, reporting, safety and emergency response procedures. In accordance with the permit, the manual must be maintained and updated regularly and be available on site.

The fact sheet, *Wastewater Treatment Facility Operation and Maintenance Manual Guidelines*, is on the MPCA Web site at www.pca.state.mn.us/publications/wq-wwtp7-00.pdf, should be utilized as a guide for the overall format of the manual. The guidelines specifically discuss *stabilization ponds* and *mechanical plants*, but the exact same principles apply to the development of an operation and maintenance manual for a LSTS.

The following items should be addressed in the development of an operation and maintenance manual. Each item should be tailored to your specific treatment system and location:

1) The manual should not be just a collection of user manuals for individual pieces of equipment. While those must be included, the manual must also address how the individual components are operated, how that affects other components, and how the complete system, at your specific site and location should be operated to achieve the necessary treatment performance. The following are some examples:

   a. Design loadings into and out of each unit process and how results from one unit (i.e. septic tank effluent) impact operation of other units (i.e. constructed wetland).

   b. Operational monitoring at each unit process, as required by permit and what should be done by the operator during each site visit.

   c. Frequency of septic tank pumping.

   d. Equipment and control adjustments. For example, the recirculation rates for recirculating filters and how and when changes should be made based on operating data.

e. Seasonal operational changes — temperature changes affect the performance of many systems and seasonal operation changes may be necessary to maintain temperature and allow for access to equipment.

f. Start-up operation. Some new systems my require “seeding” with microorganisms from a similar facility with established biology to ensure proper initial operation. Also, many new LSTS systems begin operation with only a few connections and low flows relative to the design flow and can have difficulty with treatment. Operation at start-up must be considered in the sizing of the treatment units during design. A start-up plan for the initial operation of the system must be included. Pumping and hauling wastewater to another facility is an alternative that must be considered as a start-up plan. Agreements with haulers and other treatment plants willing to accept the wastewater should be procured prior to the start of operation.

2) The manual should cover all aspects of the collection system and LSTS. If STEP tanks, grinder pump stations, or individual septic tanks at each user’s location are utilized in the design, O&M for those tanks should be specified in the manual. Standards for the allowable treatments units that can be installed by users and the O&M of the units must be addressed regardless of whose responsibility it is to maintain them.

3) Permits for LSTS require that a vegetative cover must be maintained over all drainfield areas. Therefore, the O&M manual must include a schedule for mowing, planting, weeding, and other landscape care.

4) Permits for LSTS have a requirement that the operation and maintenance of the system shall be under the direct responsible charge of a state certified operator. The MPCA will determine the classification of the LSTS and operator required to operate the system based on the treatment units that are included in the LSTS. Planning should then occur as to who the operator for the system will be. If that is known when the permit application is submitted, it should be included in the draft O&M manual that is submitted as part of the permit application. If the operation of the system will be done through a contractual agreement, a copy of the contract must be submitted to the MPCA. The O&M manual should address proper operator certification and the steps necessary to maintain certification, such as continuing education.

5) Financial budgeting should be done as part of the planning and design of the system as to how many hours of operation will be required on a weekly or monthly basis to adequately operate the system and maintain compliance with the MPCA permit. Revenue collection from the rate payers should account for all of O&M costs, debt service, and equipment replacement costs for the system. The operating costs should include, but not be limited to, salaries, electricity, spare parts and lubricants for equipment, alarms and phone services, monitoring and lab fees, site maintenance like mowing and weeding, and any other potential operation and administration expenses. When a project is constructed in phases, the budget should include the timing for when the next phase is required and how the cost of each phase will be funded.

6) Many components of a treatment facility do not have an indefinite life cycle and need to be replaced. The age and condition of treatment units must be considered and a schedule for replacement should be developed. The cost for the future replacement of equipment should be factored into the operating costs of the system so that necessary funds are available.

7) To ensure proper functioning of the collection and treatment system it is important to also control the users of the system. Permits for LSTS prohibit the discharge of any waste into any part of the treatment system that could damage or inhibit treatment. In addition to damages that these materials may have on the treatment system, they could eventually be discharged into the soil and ground water.

a. The proper disposal of hazardous materials and what should and should not be disposed of in the treatment system are essential to its’ successful operation. The manual shall include a discussion of the proper use of the system and this portion of the manual should be provided to builders and homeowners.

b. The backwash water from home water softeners and other drinking water treatment systems should be address in the manual. Discharges from swimming pool or spas should also be discussed.

8) Not only should the manual include schedules and checklist for the performance of O&M activities for all equipment, but also for the sampling and monitoring to evaluate the performance of the system. The project construction contract should include all necessary equipment the operator will need to properly monitor the system. The following items should be provided for the operation of every LSTS system. Depending on the type of treatment system, additional equipment may be necessary:

   a. The permit requires that daily precipitation readings must be reported. A rain gage should be provided on site. A data logging model should be provided if an individual will not be visiting the site after each precipitation event. Precipitation can vary significantly in an area, so even if another rain gage is located nearby, one should be located on site.

   b. The permit requires the sampling of influent and effluent flow. Depending the actual location where a sample will be collected, long handled "dippers" may be necessary to collect samples from tanks and manholes. If composite samples are required, automatic samplers may be necessary. If the permit requires that monitoring wells be sampled, individual bailers should be provided for each monitoring well.

   c. Sludge and scum levels in septic tanks must be measured monthly in accordance with the permit. Therefore, a sludge core sampler, or tank sampler, is a necessary piece of equipment. NOTE: Larger diameter (1.5"+) core samplers seem to function better in septic tanks and do not clog as easily as those with small diameter (1").

   d. LSTS systems are biological processes that rely on microorganisms to consume the waste. The microorganisms need the proper conditions to survive and function. The most basic living conditions in a treatment system are dissolved oxygen (DO), pH, and temperature. Equipment to measure DO, pH, and temperature is necessary.

   e. Certain treatment processes may require additional equipment to aid the operator in maintaining the performance of the system. LSTS systems that use an activated sludge treatment process should provide a settleometer and centrifuge to evaluate and optimize the system performance.

9) The manual shall also include schedules and specifications for the care of the subsurface soil dispersal areas. While many of the mechanical pieces of a treatment system can be replaced with new equipment, the soil dispersal area cannot. This is the main reason that a secondary or "set-aside" soil dispersal area is required. Both the primary area handling the current effluent flow and the area set aside for replacement must be protected from damage. Compaction of the soils and other disturbances change the soil structure and impact the ability to move water through it.

   The primary dispersal area is the initial area used to handle the design flow for the system. The following are issues that should be specifically addressed in the O&M manual for the care of the primary dispersal site to help ensure its long-term function.

   a. Vegetation should not unduly hinder or prohibit locating or accessing system components for observation, cleaning, replacement or repairs.

   b. Vegetation should be close growing vigorous vegetation for the purposes of minimizing soil erosion and maximizing trapping of snow and frost protection.

   c. Vegetation should not contain noxious weeds and non-herbaceous plants (trees and shrubs).

   d. When mowed, the mowing should be conducted when the soil moisture state will minimize compaction.

   e. When mowed, the mowing may be conducted by a person trained by a certified operator and aware of soil compaction issues.

f. When mowed the drainfield inspection pipes should be clearly identified to prevent damage from mowing.

g. System shall be protected from activities which will compact the soils or damage the system. Access from unauthorized individuals should be limited as much as possible. Fences should be installed to prevent any vehicles from entering the site.

The secondary dispersal area is the area set aside to be used as a replacement area if the primary area is damaged. The following are issues that should be specifically addressed in the O&M manual for the care of the secondary dispersal area to ensure its ability to replace the primary dispersal area.

h. Vegetation should be close growing vigorous vegetation for the purposes of minimizing soil erosion.

i. Vegetation should not contain noxious weeds and non-herbaceous plants (trees and shrubs).

j. When mowed, the mowing should be conducted when the soil moisture state will minimize compaction.

k. When mowed, the mowing should be conducted with equipment that will not cause undo soil compaction.

l. When mowed, the mowing may be conducted by a person trained by a certified operator and aware of soil compaction issues.

m. System shall be protected from activities which will compact the soils or damage the system. Access from unauthorized individuals should be limited as much as possible. At a minimum, the area should be identified with signs on all four sides of the site.

B. Nitrogen Mitigation Plan

Permits for LSTS require a Nitrogen Mitigation Plan (Plan). This Plan should be included as part of the O&M manual. The Plan shall consist of the various activities the Permittee can perform to reduce nitrogen concentrations if monitoring shows the permit limits may be exceeded. Specific action steps as the result of end-of-pipe monitoring, ground-water monitoring or process-control monitoring shall be described in the Plan to improve the treatment performance and comply with limits.

A basic nitrogen mitigation plan is a step-by-step, "if…then" analysis of the treatment process to determine why nitrogen is not being treated. If a certain measured parameter result is known, then specific steps in response to that result should be taken. The following is only a brief outline of a plan and some of the specifics that should be addressed. The actual Plan must be tailored to the specific treatment system and site of your facility.

1) Compare design loadings and treatment efficiencies that were expected from the design to the actual operating conditions to and from each treatment unit. Flow, BOD, TSS, ammonia nitrogen, nitrate nitrogen, total nitrogen, pH, alkalinity, and temperature should be investigated. Periodic process control monitoring for these parameters should be done even when the treatment system is performing as expected so that normal operating conditions can be established and confirmed. It is recommended at the least, that process control parameters be monitored quarterly so that seasonal variations in operation can be defined.

2) The O&M manual should include a summary of all design influent pollutant parameters and expected removal amounts. If a permit parameter that is required to be monitored or process control monitor parameters are found to be outside of the design values, the Plan should list specific steps that are be taken to further evaluate causes of the difference should be specified in the plan. Below are only a few examples of typical problems that may be encountered and need to be addressed in the Plan. The Plan must provide the details necessary for the operator to evaluate the system and make specific changes to improve performance. These are not meant to be the minimum requirements for a Plan. They are just examples of nitrogen treatment issues

that have been observed at other facilities. The treatment system designer must base the Plan on the operation of each specific system.

a. It is necessary to know what form the nitrogen is in to evaluate the treatment system. An effluent high in ammonia nitrogen may indicate a need for additional DO to complete the nitrification process. It may also indicate hydraulic overloading or the need to increase detention time. However, increasing the detention time in the winter may further reduce water temperatures and the biological activity and make nitrification more difficult.

b. An effluent high in nitrate may indicate that the denitrification process is not complete. This may result from too much DO in the system. Systems using a supplemental carbon feeding technology may not be adding enough carbon.

c. The biological growth in the treatment system or on the treatment media should be examined to determine the amount and what type of microorganisms are present. A heavy growth may indicate overloading of the system.

d. The biology necessary for nitrogen removal is greatly reduced when wastewater temperatures fall below 50º F. Temperature monitoring may show that the wastewater is too cold for nitrogen removal. The plan should address methods of operation to maintain heat or for the installation of equipment to add heat into the system should be addressed.

All Plans must evaluate the need for the installation of additional treatment units. Systems that are overloaded may need additional capacity, while systems that are under loaded may need additional smaller treatment units to handle low flow conditions.

Expansion of the reserve disposal areas must also be addressed. Some facilities may be able to address nitrogen concerns by utilizing a greater land area for disposal.

If permit limits cannot be attained, other options for disposal must be considered even if the cost may be high. Pumping and hauling, or connection to another facility may be necessary to prevent further permit violations.

As mentioned above, a Nitrogen Mitigation Plan should be developed as a step-by-step process. Flow charts and checklists are helpful tools that should be provided to operators to evaluate the treatment process performance with respect to the original design assumptions.

C. Performance Evaluation Reports

LSTS permits require a system effectiveness evaluation be submitted one-year after initiation of operation of the treatment system and with the permit application for reissuance. Additional details are discussed in Section 15 regarding the one-year certification. The plans and specifications approval letter will also contain a listing of the requirements.

The evaluation report shall include, at a minimum:

1) A summary of all influent, effluent, and ground water monitoring data with a comparison to design parameters and permit limitations.

2) Any permit limit exceedances should be discussed in detail and include a discussion of the cause of the exceedance and all steps taken to change the problem. A corrective action report should be included with specific items that will be performed to prevent future exceedances. The report must also include a schedule of the dates the actions will be taken and when they are expected to be completed.

3) Any operating parameters that vary significantly from design assumptions should also be discussed.

4) A summary of operation and maintenance activities that were completed should be listed. This should include a discussion of the frequency of site visits and a description of the typical activities performed. Any problems that were encountered while operating the system or concerns that make operation difficult should be discussed.

5) A summary of any changes made to the system to enhance performance, improve the ease of operation, or address any other operations issue should be listed.

6) A summary of any proposed activities for the following year should also be discussed. Specifically, any changes to the system operation and maintenance to address problems or to make operation easier should be discussed.

7) A copy of a signed one-year performance standards certification form. www.pca.state.mn.us/publications/wq-wwtp2-15.doc

8) One copy of "as-built" plans on microfiche.

9) Documentation that sufficient funds are being collection for O&M, debt-service, and equipment replacement.

It has been found that some new LSTS are taking more time than anticipated for homes to be constructed and connected to the system. Therefore, the first year of operation may have little data available to evaluate the performance of the treatment system. In these cases, additional reports may be required each year until the entire treatment system has been in operation for one year and an adequate evaluation can be completed.

D. Additional information resources

MPCA Factsheet: LSTS Operator Certification requirements
www.pca.state.mn.us/publications/wq-wwists3-50.pdf

MPCA Wastewater Treatment Facility Operation and Maintenance (OM) Manual Guidelines
www.pca.state.mn.us/publications/wq-wwtp7-00.pdf

MPCA guidance on how to complete your Discharge Monitoring Reports (DMR)
www.pca.state.mn.us/water/dmr.html

Residential Onsite Wastewater Treatment Systems: An Operation and Maintenance Service Provider Program developed by the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT).
www.mwps.org/index.cfm?fuseaction=c_Products.viewProduct&catID=774&productID=6407&skunumber=CIDWT&crow=5.

The University of Minnesota Extension Service has useful information related to the operation, maintenance and management of septic systems and community septic systems, as well other information for homeowners and business owners, at http://septic.umn.edu/professionals/operation/index.htm.

14. Permit application submittal

Please note that the MPCA will only review complete permit applications of the proposed projects. This includes all of the necessary supporting documents. Failure to complete the application or submit the supporting documents will likely result in a delay in permit issuance and the application may be returned for completion.

The following information is required:

- Permit application forms:
  - Water Quality Transmittal Form found at www.pca.state.mn.us/publications/forms/wq-wwprm7-03.doc
  - The Attachment for the Land Application of Wastewater at www.pca.state.mn.us/publications/forms/wq-wwprm7-10.doc
  - If the permit is for a city, township, sanitary district, or other municipality, the Attachment for Municipal Facilities found at www.pca.state.mn.us/publications/forms/wq-wwprm7-09.doc

- If the permit is subject to biosolids regulation, the attachment for Biosolids Information Sheet found at www.pca.state.mn.us/publications/forms/wq-wwprm7-16.doc.

- This LSTS Guidance Document, including attachments (completed as appropriate)
- Ground-Water Mounding Calculations
- Hydrogeologic report (if applicable)
- Engineering report (complete system design including design of the septic tanks, pretreatment unit, if applicable, and the sewer system)
- Plans & Specifications
- A draft Operation & Maintenance Manual, including a Nitrate Mitigation Plan
- Additional information as appropriate

Send completed permit application forms, attachments and fee to:

Minnesota Pollution Control Agency
Attn: Beckie Olson, Permit Document Coordinator
520 Lafayette Road N.
Saint Paul, MN 55155-4194

15. Permit requirements / construction requirements

After receiving a permit from the MPCA there are many requirements that need to be followed. These requirements are found in the permit and in the plans and specification approval letter. **Be sure to read both documents to ensure compliance.** Remember no construction can begin until the permit is issued and plans and specifications are approved.

The following submittals are required:

- notice to proceed with construction 14 days after its execution
- change orders as described in the plan and specification approval letter
- for systems using synthetic liners

1) The Permittee must notify the MPCA in writing at least 14 days before the scheduled placement of the liner. Sub-grade soils tests and compaction test results will be needed for this pre-liner inspection.

2) The Permittee must notify the MPCA in writing at least 14 days before the scheduled pre-fill of the lined treatment unit. The MPCA may then complete a pre-fill inspection. "Pre-fill" means that the Permittee has accepted the work necessary to begin the water balance test in accordance with MPCA Pre-fill and Water Balance Criteria.

   Included with the above letter, if not previously submitted to the MPCA, must be the following:

   a. The contractor and liner manufacturer's certifications that the liner was installed per the plans and specifications.
   b. The contractor and liner manufacturer's certifications that the cover material was placed per the plans and specifications.
   c. The liner manufacturer's certification that the installation was in conformance with all warranty provisions and that no provisions of the warranty have been voided.
   d. A copy of all liner test results on seam strength, strength of liner material, mil thickness, etc.
   e. A copy of the liner warranty.

f. All soil test results (density, etc., on both sub-base and dikes).

g. The written results of a survey of the pond bottom indicating the level is within the proper tolerance.

3) After pre-filling and before discharging sewage to the treatment facility, the Permittee's engineer shall certify to the MPCA that the project was constructed in accordance with the final plans and specifications submitted to and approved by the MPCA

- At least 60 days before the scheduled contract date for initiation of operation, the permittee must submit to the MPCA:

  1) Evidence that the Permittee has hired a wastewater treatment operator with a valid state certificate for the classification of the treatment system;
  2) An operation and maintenance manual for MPCA's approval www.pca.state.mn.us/publications/wq-wwtp7-00.pdf or a completed O&M manual Certificate of Completion form www.pca.state.mn.us/publications/wq-wwtp7-02.doc

- The Permittee must notify the MPCA in writing at least 14 days before initiation of operation

- The Permittee must notify the MPCA in writing at least 14 days before the planned completion of construction date. The MPCA may complete a final inspection

- One year after the initiation of operation of the project, the Permittee must submit to the MPCA the following items (also see Section 13)

  1) An MPCA approved certification form that is signed by a professional engineer registered in the state of Minnesota stating that the project meets the following performance standards:

     a. The project has been completed according to approved construction plans and specifications and change orders.

     b. The Permittee has a sufficient number of trained and capable personnel, including a wastewater treatment facility operator having a valid state certificate, to provide adequate operation and maintenance of the project, and the project requires only the operation and maintenance as is outlined as normal and routine in the approved operation and maintenance manual.

     c. The project accepts hydraulic and organic loading to the extent described in the approved design specifications and SDS permit conditions.

     d. The project facility meets the effluent limitations as assigned in the SDS permit.

     e. Nonresidential wastewater discharges to the treatment system do not interfere with the operation of the project, disposal, or use of septage or municipal biosolids, and do not degrade the ground water or surface water.

     f. Septage treatment and disposal is accomplished in accordance with applicable state, federal, and local standards.

     g. The project meets the requirements in the approved plans and specifications for the prevention of contamination of underground drinking water sources beyond the property boundary.

  2) One copy of "as-built" plans and specifications on microfiche.

  3) A revised operation and maintenance manual or a completed O&M manual Certificate of Completion form (located on the MPCA website at www.pca.state.mn.us/water/wastewater.html#operation).

4) Documentation that the Permittee is collecting sufficient funds to provide for operation and maintenance and equipment replacement costs in conformance with the approved operation and maintenance manual on a form prescribed by the MPCA.

- A system effectiveness evaluation report 180 days before permit expiration.

A properly designed facility can only be expected to perform as designed if constructed according to plans and specifications. Therefore it is necessary that the permittee perform full-time resident inspections during construction. The permittee must certify that full-time resident inspections shall be provided during construction and that written inspection reports, describing the construction inspected, construction problems, and the amount of inspection time required, shall be submitted to the MPCA on a monthly basis.

The following items should be verified during construction:

- Soils described in the design phase match what is found during construction
- Sub base preparation and liner installation according to plans and specification
- Elevation of tanks and major components
- Pipe elevation and slope
- Reserve drainfield area is protected from compaction during construction
- Squirt height on distribution laterals meet specifications and is recorded in O&M manual
- Pump sequencing and pump floats operate as designed
- Material delivered to site meet specifications (sand, gravel, rock). Filter media should also be tested to ensure that there are not excessive fines.
- The liner is installed with care to prevent damage. Media is placed on the liner to prevent damage.
- Tanks, pipe joints and connections are water tight
- All setbacks from wells, buildings and property lines met
- Soils are compacted and trenches properly backfilled to prevent sagging and damaged pipes
- All components properly covered or insulted to prevent freezing
- All valving in place to isolate treatment units
- All OSHA safety measures are being followed

This list is not intended to be all inclusive, but addresses major units of construction. No construction should be covered unless the inspector representing the Permittee has viewed it.

Attachment 1 — Knowing an MPCA permit is needed

Step A — Surface or subsurface discharge

Will the system have a discharge pipe which discharges into a lake, river, stream, ditch or other surface feature that conveys water?

Yes — the system requires a National Pollution Discharge Elimination System (NPDES) permit. Please contact the MPCA.

No — Go to Step B.

Step B — Types of soil-based treatment

Will the system discharge to a spray irrigation system or rapid infiltration basin?

Yes – The system requires a State Disposal System (SDS) permit. Please contact the MPCA.

No – Go to Step C.

Step C — Types of subsurface sewage treatment systems

Systems that do not qualify under steps A or B are defined as a subsurface sewage treatment system (SSTS). Regulatory jurisdiction is dependent on the system size.

Step C1 — Does the waste contain sewage or other wastes mixed with sewage?

Yes — Go to Step C2.

No — Please contact the MPCA for the correct regulatory authority for non-sewage wastes.

Step C2 — Will a single SSTS or group of SSTSs under single ownership within one-half mile of each other be designed to treat a design AWW flow greater than 10,000 gallons per day as determined below?

Permit flow determination

1) Permit Flow for Existing Dwellings (See Table 1 Section 2)

   Permit Flow = the total flow from the ten highest flow dwellings + (total flow from the remaining dwellings * 0.45) + I/I (see Attachment 2 Step 6)

2) Permit Flow for New Dwellings

   Permit Flow = (Number of Bedrooms * 110 gpd) + I/I

3) Permit Flow for Other Establishments

4) See Chapter 7081.0130 Permit Flow for Other Establishments — Measured Flow

   a. How to determine the sewage flow if the LSTS will serve non-dwellings by the use of measured flow values.

      The design from measured flow values for LSTS serving other establishments is determined by averaging the measured daily flows for a consecutive seven-day period in which the establishment is at maximum capacity or use. If the establishment cannot be measured at maximum capacity or use, then measure data must be extrapolated for maximum use.

   b. Directions

      i. Record the consecutive peak seven-day measured daily flow readings on the chart below. (Be careful to account for meters that show consecutive amounts and meters which read cubic feet instead of gallons.)

      ii. List the percent that the establishment was utilized that day. Record this amount in decimal format (e.g., 50 percent is 0.5).

      iii. Divide the flow by the percent utilized.

      iv. Average the extrapolated values with the calculation below the chart.

Example 1: The following table explains how to use the above equation.
An existing subdivision with 19 single family homes. Determine the permit flow.

1	2	3	4	5	6
Dwelling #	**# of Bedrooms**	**Dwelling Classification** (see Table 1 in Section 2)	**Initial Flow** (see Table 1 in Section 2)	**Reduction Factor (0.45)**	**Design flow per Dwelling** (column 4 x 5)
1	3	I	450	1	450
2	4	I	600	1	600
3	3	I	450	1	450
4	3	I	450	1	450
5	3	I	450	0.45	202.5
6	2	III	180	0.45	81
7	4	I	600	1	600
8	3	I	450	0.45	202.5
9	3	I	450	0.45	202.5
10	3	I	450	0.45	202.5
11	2	III	180	0.45	81
12	4	I	600	1	600
13	4	I	600	1	600
14	4	II	375	0.45	168.75
15	5	I	750	1	750
16	3	I	450	0.45	202.5
17	4	I	600	1	600
18	4	I	600	1	600
19	4	II	375	0.45	168.75
Total Design Flow from Dwellings + I/I					7212 gpd +I/I

Example 2: Flow for Other Establishments

Establishment — Motel

Size — 14,000 square feet

Number of units — 40

Square foot method

$14{,}000\ ft^2 \times 0.33\ gal/ft^2/day = 4{,}620$ gallons/day

Guest method (max occupancy)

40 units * 4 guests/unit * 38 gal/guest/day = 6,080 gallons/day

Employees

1 employee * 15 gallons/8 hour shift * 3 shifts/day = 45 gallons/day

1 employee * 15 gallons/8 hour shift * 1 shift = 15 gallons/day

Known estimated sewage flow (both methods must be calculated)

Based on square foot

4,620 gal/day + 45 gal/day + 15 gal/day = 4,680 gal/day

Based on guests

6,080 gal/day + 45 gal/day + 15 gal/day = 6,140 gal/day

Flow Conclusion

6,140 gal/day is used to determine if a SDS permit is required, but 4,680 gal/day may be used for design purposes if it seems to be reasonable for the establishment and approved by the MPCA. (Plus I/I)

Example 3: Measured Flow Other Establishments

Establishment: Campground

Period Measured: Fourth of July Week.

Daily flow measurements (gals) and utilization rate (%):

Day	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**
Measured Flow (gpd)	3,000	3,500	5,000	4,000	4,200	4,000	3,200
Percent Utilized (in decimal form)	0.60	0.75	0.90	0.85	0.85	0.85	0.65
Extrapolated for max. capacity (flow / % capacity)	5,000	4,667	5,556	4,705	4,940	4,705	4,923

Calculation of measured average daily flow:

(5,000 + 4,667 + 5,556 + 4,705 + 4,940 + 4,705 + 4923) / 7 = 4,928 gallons + Inflow and Infiltration

Step C2 — (question repeated) Will a single SSTS or group of SSTSs under single ownership within one-half mile of each other be designed to treat a design AWW flow greater than 10,000 gallons per day as determined below?

Yes — the system requires SDS permit from the MPCA. Please see www.pca.state.mn.us/programs/ists/business.html#largeists.

No — Go to Step C3.

Step C3 — Will the SSTS or group of SSTSs cause adverse public health or environmental impacts if not regulated under a state permit (such as systems in environmentally sensitive areas, those with unsubstantiated or unexpected flow volumes, or systems requiring exceptional operation, monitoring and management)?

Yes — The system may need a SDS permit issued by the MPCA. Please see www.pca.state.mn.us/programs/ists/business.html#largeists.

No — The system is regulated under a LGU permit. Contact the local permitting authority (either county environmental health or planning and zoning office, or township office or city building inspector).

Step C4 — Does the system serve fewer than four dwellings or does it serve an Other Establishment with a design AWW flow of 2,500 gallons per day or less? (See Attachment 2 to calculate flow.)

Yes —The system is an individual sewage treatment system (ISTS).

No — The system qualifies as a midsized sewage treatment system (MSTS) with an average daily flow of sewage greater than 2,500 gallons and less than or equal to 10,000 gallons. The following attachments **may** be used to aid in the design and review of the proposed system.

Attachment 2 — Design flow considerations

This attachment is to be used to determine the design sizing of the wastewater facilities. It should also be used in Attachment 6 to design the drainfield.

How many dwellings are connected to the LSTS? ______

What is the design Average Wet Weather (AWW) Flow for the LSTS?

Step 1 Number of dwellings__________ dwellings

Step 2a Flow Determination for Existing Dwellings Section 2, Part A _________ gpd

Step 2b Flow Determination for New Dwellings, Section 2 Part B __________ gpd

Step 2c Flow per "other" establishments, Section 2 Part C ___________ gpd

(List all "other establishments" separately and show how the flow was calculated.)

Note: Refer back to Attachment 1 for flow determination examples.

Step 3 Step 2a + Step 2b + Step 2c flows = ______________ gpd

Step 4 Average diameter of sewer lines ____________ inches

Step 5 Total length of sewer lines _____________ miles

Step 6 Inflow/infiltration (I/I) flow ______________ gpd

(Use this equation: I/I = Step 4 x Step 5 x 200 gallons/inch/mile)

Step 7 AWW flow = Step 3 + I/I flow (Step 6) ______________ gpd

Attachment 3 — Preliminary site evaluation

The preliminary site evaluation is a desktop assessment of the selected LSTS site. The designer shall collect readily available published information from various documents and sources that describe the soils, geology, hydrology, etc. of the region in which the proposed LSTS is located. From this and other information, the designer can estimate, or make assumptions, regarding the following parameters:

A. Location information - Determine the locations of on-site and nearby property lines, easements, floodplains, wetlands, surface waters, buildings, buried pipelines, etc.
   Above determined? ___ Yes ___ No

B. Treated wastewater characteristics:

   - CBOD: _________ mg/L
   - TSS: _________ mg/L
   - Total nitrogen: _________ mg/L
   - Total phosphorus: _________ mg/L

C. Design AWW flow to LSTS: ____________ gpd (See Attachment 2)

D. Infiltrative loading rate: _____________ gpd/ft^2

E. Minimum soil absorption area = C / D: ____________ ft^2

F. Length of entire soil absorption site: ____________ ft

G. Width of entire soil absorption site: ____________ ft

H. Total area of soil absorption site = F x G: ____________ ft^2 (includes the area between trenches, beds, etc.)

I. Average site recharge rate = [C ÷ 7.48] / H: ____________ ft/day

J. Have the soils been disturbed at the soil absorption site: ___ Yes ___ No

K. Soil permeability at drainfield/soil interface: ____________ in/hr

L. Soil permeability of most restrictive layer: ____________ in/hr

M. Depth to seasonal saturation (redoximorphic features): ____________ ft

N. Depth to ground water: ____________ ft

O. Direction of ground water flow: ___________

P. Hydraulic conductivity of saturated zone: ____________ ft/day

Q. Ground water gradient: ___________ ft/ft

R. Thickness of saturated zone: ____________ ft

S. Specific yield of saturated zone: ____________ (dimensionless)

T. Distance from soil absorption site to downgradient property boundary: _________ ft

U. Width of soil absorption site perpendicular to the direction of ground water flow: _________ ft

V. Ambient nitrogen concentration of ground water upgradient of soil absorption site: ____________ mg/L

W. Average daily ground water recharge from precipitation: _________ ft/day

X. Distance to nearest surface water that receives ground water discharge: ________ ft

Y. For platted subdivisions, will the development be provided with a community water system or will each residential lot have its own private well?

____ Community water ____ Private wells

Z. Distance to nearest water-supply well: _____ ft. and/or sensitive water-supply well: _____ ft[1]

AA. Indicators of high phosphorus attenuation potential:

- Soil with high levels of iron and aluminum oxides: ____ Yes ____ No
- Soil with high levels of calcium and magnesium carbonates: ____ Yes ____ No
- Soil with high levels of clay minerals: ____ Yes ____ No
- Soil with medium to fine texture: ____ Yes ____ No
- Soil with high or low pH: ____ Yes ____ No
- Large volume of unsaturated soil below soil absorption site: ____ Yes ____ No
- Will portions of the soil absorption site be routinely rested for long periods of time (months): ____ Yes ____ No

Using the information obtained from the desktop review of available information, please address the following preliminary evaluations:

1. Soil suitability assessment

A. Estimate a soil sizing factor for the soil absorption site based on soil information and effluent characteristics.

B. Select an effluent distribution method (drainfield, bed, mound, drip, etc).

C. Provide your preliminary assessment regarding the soil's long-term hydraulic acceptance rate for the chosen treatment and distribution method.

____
____
____
____
____
____
____
____
____
____

[1] Minnesota R. 4725.4450, adopted on August 4, 2008, requires a minimum separation distance of 300 feet from the soil adsorption area of a LSTS to water-supply wells. This separation distance increases to 600 feet for sensitive water-supply wells. A sensitive water-supply well is a water supply well with less than 50 feet of watertight casing where the casing does not penetrate a confining layer or multiple layers of confining materials with an aggregate thickness of ten feet or more.

D. Will further detailed investigation be necessary to assess the suitability of on-site soils to accept wastewater at the proposed acceptance rate? Explain why or why not.

2. Unsaturated treatment zone assessment

A. Estimate the height of ground-water mounding above the saturated zone.

B. Evaluate the potential for vadose zone mounding above a restrictive soil layer.

C. Provide your preliminary assessment regarding the long-term maintenance of an unsaturated treatment zone of adequate thickness:

D. Will further detailed investigation be necessary to assess whether an unsaturated treatment zone of adequate thickness will be maintained after full operation of the LSTS? Explain why or why not.

3. Nitrogen impact assessment *(for those selecting Option #2 only)*

This option cannot be used where the nitrogen dilution cannot be modeled, such as karst geology.

A. Estimate the concentration of total nitrogen that will be delivered to the soil absorption site.

B. Model nitrogen dilution using the formula in Attachment 9 or other contaminate transport model.

C. Provide your preliminary assessment regarding long-term compliance with the 10 mg/L total nitrogen as N limit at the facility's property boundary.

D. Will further detailed investigation be necessary to assess potential nitrogen impacts and compliance with the nitrogen limit at the facility's property boundary? Explain why or why not.

4. Phosphorus impact assessment *(for systems within 500 feet of a surface water)*

A. Estimate whether ground water flow direction is toward a surface water body.

B. Evaluate if surficial ground water discharges to the surface water.

C. Determine whether soil characteristics and other information suggest a high potential for long-term phosphorus attenuation.

D. Provide your preliminary assessment regarding the impact of phosphorus to nearby surface water:

E. Will further detailed investigation be necessary to assess potential phosphorus impacts to surface waters? Explain why or why not.

Attachment 4A — Soils evaluation form

All information requested on this boring log must be submitted to properly design the soil treatment and dispersal system. The method to observe and describe the soil is found in the *USDA Field Book for Describing and Sampling Soils*.

Date:	Vegetation:
Project: Location:	Landscape:
Soil Survey Map Unit:	Slope Form:
Disturbed Soil: ____ Yes ____ No	Slope:
Type of Observation: pit boring auguring	Floodplain: ____ Yes ____ No

Depth (in)	Horizon Designation	Coarse Fragments	Texture	Matrix Color (Hue, Value, Chroma)	Redox Features (abundance, size, contrast)	Structure (Shape, Size, Grade)	Consist-ency	Roots (abundance and size)	Pores (Quantity and size)	Concretions Nodules	Boundary

Test pit ground surface elevation	Depth to Seasonally Saturated Soil	Depth of Standing Water in Hole/Pit (if any)	Depth to Bedrock (if any)	Proposed Bottom of System Elevation	Estimated Infiltrative Loading Rate

Attachment 4B – Loading rate table

This chart determines a soil dispersal system loading rate based on infiltration /absorption capabilities of the soil. The final loading rate may be less if another design constraint (e.g., ground-water mounding) is excessive at the loading rates provided in this table.

The soil condition at the proposed depth of the soil dispersal system is used for determining the loading rate. If more restrictive layers are present below the system, those values may also be used for sizing (but are not required). However the more restrictive layer may result in unacceptable ground-water mounding at the lower loading rate.

Soil classification	Soil texture (USDA)	Soil structure (USDA)	BOD 30 to 220 mg/L and TSS 30 to 150 mg/L (gpd/ft^2)	BOD < 30 mg/L and TSS < 30 mg/L (gpd/ft^2)
1	Coarse sand	Single grain	1.2	1.6
2	Medium sand, loamy sand	Single grain	1.2	1.6
3	Fine sand, loamy fine sand	Single grain	0.6	1.0
4	Sandy loam	Weak to strong	0.8	1.0
5	Sandy loam	Massive or platy	0.6	0.7
6	Loam	Moderate to strong	0.6	0.8
7	Loam	Weak or platy	0.5	0.6
8	Loam	Massive	0.4	0.5
9	Silt loam	Moderate to strong	0.5	0.8
10	Silt loam	Weak or platy	0.4	0.6
11	Silt loam	Massive	---	0.24
12	Sandy clay loam, clay loam, silty clay loam	Moderate to strong	0.45	0.6
13	Sandy clay loam, clay loam, silty clay loam	Weak or platy	0.3	0.3
14	Sandy clay loam, clay loam, silty clay loam	Massive	---	---
15	Sandy clay, clay, silty clay	Strong	0.24	0.24
16	Sandy clay, clay, silty clay	Weak to moderate, massive, or platy	---	---

* The soil structure must have a moist consistency of loose, very friable, friable, or firm as determined by the *Field Book for Describing and Sampling Soils* (NRCS, USDA).

Attachment 5 — Pathogen treatment

The pathogen-reduction methods that can be manipulated in system design are:

- Pathogen reduction treatment units
- Loading rates to the soil dispersal system
- Dosing frequency to the soil dispersal system
- Thickness of unsaturated soil treatment zone
- Disinfection units

Step 1 List the design loading rate based on the soils infiltration capacity in Attachment 2. ____________ gpd/ft^2 (1)

Step 2 Determine the fecal organisms concentration that can be achieved from the pathogen-reduction treatment device. __________ /100 ml (2)

Step 3 Convert concentration in Step 2 into a log value: __________ (3)

Step 4 Determine the soil texture of unsaturated zone:

Soil classification of unsaturated treatment zone from Attachment 4B	Soil textural terms used in log reduction table
Classification 1 – 3	Sandy Soil Treatment Area
Classification 4 – 11	Loamy Soil Treatment Area
Classification 12 – 16	Clayey Soil Treatment Area

Soil Textural Term: __________________________________ (4)

Step 5 Determine the estimated height of the capillary fringe from the table below:

Soil texture	Adverse effect of the capillary fringe (inches)
Sandy	1.5
Loamy	6
Clayey	12

Height of capillary fringe = ___________ (5)

Step 6 Choose dosing frequency: ____________ doses/day (6)

Step 7 Reduction of fecal organisms by a clogging mat

Mat Formation	Log Reduction
No clogging mat	0
With clogging mat	2.0

Reduction = _______________ (7)

Step 8 Determine the fecal organism reduction (in logs) from the charts on the following chart (use information from Steps 1, 4, and 6)

Log reduction/inch = _________________ (8)

Step 9 Calculate the minimum necessary unsaturated thickness needed for pathogen treatment:

___________	-	___________	/	___________	+	___________	=	___________ inches
(3)		(7)		(8)		(5)		

Some of the variables can be adjusted if the calculated unsaturated thickness is undesirable.

Since the calculated thickness is needed during system operation for pathogen treatment, the anticipated ground water mound as determined by the Hydrogeologic Evaluation (Section 9), must not infringe on this thickness. Therefore, the designed system depth/height of the bottom of the distribution medium can be calculated as shown below:

___________	-	___________	-	___________	=	___________
Depth to limiting layer (in.)		Needed unsaturated thickness (in.)		Ground-water mounding (in.)		Depth/height of system (A negative number is an elevated system.)

Attachment 5 (continued) — Removal of fecal organisms (logs/inch of soil)

Sandy Soil Treatment area — **Loading Rate (gal/ft.^{2}/day)**

Dosing Frequency Doses/day	0.24	0.48	0.72	0.96	1.2	1.4	1.9	2.4	2.9	3.4	3.8
1											
2	0.152	0.141	0.130								
4	0.163	0.150	0.137	0.117							
6	0.173	0.159	0.144	0.123	0.113	0.171					
8	0.184	0.168	0.152	0.130	0.118	0.107	0.084				
10	0.194	0.177	0.159	0.136	0.124	0.112	0.088	0.070			
12	0.205	0.186	0.166	0.142	0.130	0.117	0.092	0.074	0.056		
14	0.215	0.194	0.173	0.149	0.136	0.123	0.096	0.078	0.060	0.043	
16	0.226	0.203	0.181	0.155	0.142	0.128	0.100	0.082	0.065	0.047	0.031
18	0.236	0.212	0.188	0.161	0.148	0.133	0.104	0.086	0.069	0.052	0.036
20	0.247	0.221	0.195	0.168	0.153	0.138	0.108	0.090	0.073	0.056	0.040
22	0.257	0.230	0.203	0.174	0.159	0.143	0.112	0.095	0.078	0.061	0.044
24	0.278	0.248	0.217	0.187	0.171	0.154	0.119	0.103	0.086	0.070	0.053

Loamy soil treatment area — **Loading Rate (gal/ft^2/day)**

Dosing Frequency Doses/day	0.24	0.48	0.72	0.96	1.2	1.4	1.9	2.4	2.9
1									
2	0.183								
4	0.195	0.180							
6	0.208	0.191	0.173						
8	0.221	0.201	0.182	0.156					
10	0.233	0.212	0.191	0.163	0.149				
12	0.246	0.223	0.199	0.171	0.156	0.141			
14	0.258	0.233	0.208	0.178	0.163	0.147			
16	0.271	0.244	0.217	0.186	0.170	0.153	1.20		
18	0.284	0.255	0.226	0.194	0.177	0.160	0.124		
20	0.296	0.265	0.235	0.201	0.184	0.166	0.129	0.109	
22	0.309	0.276	0.243	0.209	0.191	0.172	0.134	0.114	
24	0.334	0.297	0.261	0.224	0.205	0.184	0.143	0.123	0.104

Clayey soil treatment area — **Loading Rate (gal/ft^2/day)**

Dosing Frequency Doses/day	0.24	0.48	0.72	0.96	1.2	1.4
1						
2						
4	0.212					
6	0.225					
8	0.239	0.218				
10	0.253	0.230				
12	0.266	0.241	0.216			
14	0.280	0.253	0.226			
16	0.294	0.264	0.235	0.202		
18	0.307	0.276	0.245	0.210		
20	0.321	0.288	0.254	0.218	0.199	
22	0.335	0.299	0.264	0.226	0.207	0.199
24	0.362	0.322	0.283	0.243	0.222	0.200

Attachment 5 (continued)

Unsaturated thickness needed for pathogen treatment

Design example

The following design calculation shows how to determine a suitable unsaturated thickness for pathogen reduction. This process is to conceptually determine how much vertical separation is necessary to achieve treatment and hydraulic performance. The assessment also attempts to account for the vertical separation distance lost due to capillary fringe above the saturated zone. Due to the limited research that was available to develop these charts, ground-water monitoring for fecal organisms will be required directly beneath the system.

System design:

Soil infiltration loading rate (from Attachment 4B) (Step 1)	0.7 gpd/ft^2
Fecal coliform concentration of pretreatment effluent in logs (Step 3)	3 Log (10^3 organisms/100 ml)
Chosen dosing frequency (Step 6)	8x/day
Soil texture (Step 4)	Sandy (i.e., Loamy sand)
Capillary fringe effect (Step 5)	1.5 inches
Clogging mat reduction (Step 7)	None (using pretreatment device)
Log reduction based on texture, loading rate and dosing frequency (Step 8)	0.152 log/inch

3	-	0	/	0.152	+	1.5	=	21	Minimum unsaturated thickness for pathogen treatment (inches)
(3)		(7)		(8)		(5)			

In this example, the depth to redoximorphic features in the soil is 45 inches and the ground-water mounding is anticipated to be 24 inches, therefore:

45	-	21	-	24	=	0
Depth to limiting layer (in.)		Needed unsaturated thickness (in.)		Ground-water mounding (in.)		Depth/height of system

Therefore, the system needs to be an at-grade system or design changes need to be made.

Attachment 6 — Nitrate-nitrogen treatment

Select **one** of the following permitting options:

☐ **Permitting option #1:**

This option requires the design of a nitrogen pretreatment system to achieve 10 mg/L total nitrogen as N *prior to* discharge to the soil dispersion portion of the facility. **An end-of-pipe (EOP) limit of 10 mg/L total nitrogen as N will be applied and measured as a rolling 12-month average.**

☐ **Permitting option #2:**

This option allows any combination of nitrogen pretreatment devices, soil and ground water nitrogen reductions and dilution by down-gradient green space (precipitation recharge) to comply with the 10mg/L total nitrogen (as N) limit. An up-front, detailed hydrogeologic assessment and dilution/dispersion modeling are required as part of the design process. Based on the results of the assessment, **the MPCA will assign an end-of-pipe (EOP) limit (above 10 mg/L total nitrogen as N as a rolling 12-month average.**

Attachment 7 — Infiltrative surface sizing

Calculating the Minimum Drainfield Size Based on Hydraulics (note that evaluations for fecal and/or nitrogen may alter this hydraulic sizing value):

Step 1 Design AWW Flow **(from Attachment 2, Step 7): _________** gpd

Step 2 Loading rate (allowable hydraulic loading rate based on organic strength of effluent) **(from Attachment 4B) __________** gpd/ft^2

Step 3 Minimum Drainfield Size = Step 1 / Step 2: __________ ft^2

Step 4 Multiply Step 3 by 1.5 to the drainfield size __________ ft^2

Step 5 Divide Step 4 by the number of zones the drainfield will be divided into (minimum of three required). ___________ ft^2/zone

Be prepared to alter the overall drainfield size, number of zones, length-to-width ratio of drainfield, and location of the drainfield on the property to accommodate the further evaluations required to assure pathogen treatment and nitrogen dilution.

Attachment 8 — Phosphorus treatment

Is the proposed LSTS located within 500 feet of a surface water with a phosphorus limit or a TMDL for phosphorus?

_____ No *(If no, there are no further requirements for phosphorus.)*

_____ Yes *(If yes, please submit a phosphorus workplan/assessment.)*

The assessment is based on the following factors:

1) The soil's ability to attenuate phosphorus, which is dependent on:
   a. The phosphorus retention capacity of the soil.
   b. The loading and resting cycles of the soil treatment and dispersal system.
2) The amount of phosphorus discharged to the soil over the life of the system, which is dependent on:
   a. The daily loading rate of phosphorus to the soil.
   b. The anticipated life of the soil treatment and dispersal system before hydraulic failure (i.e., clogging). The anticipated design life for a soil treatment and dispersal system receiving septic tank effluent is approximately 30 years. The anticipated design life for a soil treatment and dispersal system receiving secondary treated effluent is approximately 100 years.

A narrative report must be developed which includes a detailed discussion of the why or why not a phosphorus study was undertaken, and if undertaken, the following:

- Method used to determine phosphorus retention capacity
- Whether the method reflected long-term phosphorus retention (precipitation reactions)
- Method results and supporting documentation
- An estimation of expected phosphorus breakthrough to the receiving water
- Any phosphorus-treatment options or waste-reduction methods to be employed

Note: Designers should work with agency staff to determine whether a phosphorus study is needed and a suitable evaluation method.

Suggested references that provide methodologies for estimating phosphorus impacts include:

High Rate Soil Absorption (HRSA) Task Force Final Report. Minnesota Pollution Control Agency. (Found at www.pca.state.mn.us/publications/reports/ists-hsrareport.pdf)

Soil and Water Assessment Tool (SWAT). U.S. Department of Agriculture. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. (Information at www.brc.tamus.edu/swat)

MT3D. U.S. Environmental Protection Agency. MT3D is a 3D solute transport model for simulation of advection, dispersion and chemical reactions of dissolved constituents in ground water systems. (Information at www.epa.gov/ada/csmos/models/mt3d.html)

CHEMFLO-2000. U.S. Environmental Protection Agency. CHEMFLO-2000 enables users to simulate water movement and chemical fate and transport in vadose zones. (Information at www.epa.gov/ada/csmos/models/chemflo2000.html)

PHAST. U.S. Geological Service. PHAST--A Computer Program for Simulating Ground-Water Flow, Solute Transport, and Multi-component Geochemical Reactions. (See www.brr.cr.usgs.gov/projects/GWC_coupled/phast)

Soil Sampling Protocol to Evaluate Phosphorus Adsorption by Soils at Sites Receiving Wastewater (Appendix E). In "Guidesheet II: Guidance for the Development of a Discharge Management Plan." Michigan Department of Environmental Quality. (Information at www.michigan.gov/documents/deq/wb-gwdischarge-P22GuidesheetII_233512_7.pdf)

Attachment 9 — Nitrogen dilution mass balance equation

Nitrogen dilution modeling is used to predict operational compliance with the Nitrate-Nitrogen drinking water standard at the property boundary or nearest drinking water well. If compliance is met at the boundary, then the drainfield site chosen and the preliminary design sizing demonstrates an acceptable LSTS drainfield site. If compliance is not met, then re-evaluate the location of the drainfield and the need for pretreatment of the effluent for nitrogen. Compliance with the nitrogen standard for these LSTSs is an iterative process based on land-use planning and technology choices. If no combination of choices exists that satisfies the nitrogen modeling standards, then the site is not a viable LSTS drainfield/dispersal site.

The equation below, or another MPCA-accepted model, can be used to predict the nitrogen concentrations at the property boundary. The analysis shall be made to determine whether the ground water impacted from the system, as measured at the down-gradient property boundary or nearest receptor (whichever is closer), will theoretically meet a 10 mg/L Total Nitrogen (as N) concentration in monitoring wells for Permitting Option 2. This determination shall be made by a combination of nitrogen-reducing technologies, soil treatment of nitrogen (denitrification), and dilution by precipitation and up-gradient ground water.

Calculation –

$$C_O = (Q_B * C_B) + (Q_S * C_S) + (Q_I * C_I) / Q_B + Q_S + Q_I$$

Where C_O = output concentration of nitrate

Q_B = flow entering the system across the upgradient (background) area

C_B = upgradient nitrate concentration

Q_S = flow entering the system from the septic system drainfield

C_S = concentration of total nitrogen in the septic effluent

Q_I = flow entering the system from infiltration of precipitation

C_I = concentration of nitrates in the infiltrate

Please complete Attachment 11 with the values used in your determination of nitrogen dilution.

Note: The permittee is only required to address the fate and transport of nitrogen contributed to the ground water by its LSTS. In other words, one permittee will not be required to treat wastewater nitrogen to a lesser concentration than another permittee just because the ambient/upgradient ground water concentration may be greater in that location. Therefore, if the ambient/upgradient ground water has nitrate concentrations greater than the drinking water standard of 10 mg/L, the permittee is allowed to model a C_B value of 10 mg/L. In situations where upgradient nitrate concentrations are greater than 10 mg/L, the MPCA expects that the concentration of nitrate downgradient of the LSTS will not exceed the upgradient concentration.

It should also be noted that it is prudent to always use a C_B value of 10 mg/L even where upgradient (or ambient) ground water nitrate concentrations are currently low. Upgradient ground water nitrate concentrations can fluctuate over time. The model may yield an acceptable result for C_O by using a relatively low value for C_B. However, if upgradient ground water nitrate concentrations were to increase in the future, the permittee may find the facility not in compliance with the permit due to the fact that the nitrogen discharged by the LSTS is no longer receiving the expected dilution from upgradient ground water.

Inputs used in the mass balance nitrogen calculation

C_S ____ mg/L — concentration of total nitrogen discharged to soil dispersal system[1]

C_B ____ mg/L — concentration of nitrate-nitrogen in ambient/upgradient ground water[2]

C_I ____ mg/L — concentration of nitrate-nitrogen in precipitation percolating to ground water

L_1 _____ ft — dimension of soil dispersal system perpendicular to ground water flow direction

L_2 _____ ft — distance from upgradient edge of LSTS to downgradient property boundary or drinking water well, whichever is closest

K _____ ft/day — saturated hydraulic conductivity

i _____ ft/ft — hydraulic gradient

W_1 _____ ft — saturated thickness of saturated zone[3]

A _____ ft^2 — cross-sectional area of saturated zone upgradient of the LSTS $A = L_1 * W_1$

P _____ in/yr - net precipitation that ultimately percolates to the saturated zone

Q_S _____ gpd — quantity of effluent discharged to the soil dispersal system

Q_B _____ gpd — Q_B = KiA * 7.48 gallons/ft^3

Q_I _____ gpd — $Q_I = L_1 * L_2$ * (P/12 in/ft) * 7.48 gallons/ft^3 / 365 day/yr

[1]This value will become your permit limit (12-month rolling average).

[2]It is suggested that 10 mg/L be used for this value as upgradient nitrate concentrations could potentially increase in the future.

[3]It is suggested that no more than 10 feet be used for this dimension as this is generally the length of a typical monitoring well screen.

Attachment 11 —Septic tank sizing for community tanks

Minimum septic tank sizing:

Step 1 Determine the design AWW flow **(from Attachment 2)** ___________ gpd

Step 2 Determine peaking factor ___________
Use 3.0 unless system has low-pressure sewers and grinder pumps, then use 4.0.

Step 3 Calculate minimum required septic tank volume __________ gallons
Volume = Step 1 x Step 2

Additional considerations:

- Effluent screens/filters shall be provided at the outlet of the last septic tank.
- Baffles shall be installed at each inlet and outlet of the tank and each compartment.
- Where more than one tank is used to obtain the required liquid volume, tanks are typically connected in series. However parallel flow arrangements can be considered in the design, if justified. Accurate methods of splitting flows and maintaining accurate flow splitting in the future need to be accounted for. Please see Minn. R. 7080.0130, Subp 1, (A-P) for further information.
- The peaking factor of 3.0 is used to ensure that the same total septic tank volume will be provided in community septic tanks as would be provided if individual septic tanks, sized according to Minn. R. 7080.0130, Subpart 3, were used. The septic volume calculated at three times the AWW flow will be equivalent to the total volume if individual tanks are installed at each home (assuming a typical three-bedroom home uses a minimum tank volume of 1,000 gallons).