Subsurface Sewage Treatment Systems

Prescriptive Designs and Design Guidance for Advanced Designers

MINNESOTA POLLUTION CONTROL AGENCY

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This is a guidance document produced by the Minnesota Pollution Control Agency for the benefit of the general public and wastewater treatment professionals alike. This document is not intended as a substitute for professional engineering consulting advice and/or a substitute for the assistance from wastewater treatment professionals who should address the unique, onsite conditions (soils, topography, etc.) and decide on the appropriate treatment products to be used in that particular situation. While the scenarios described in this document may appear to provide solutions for some situations, users of this guide are strongly recommended to seek the advice of their own consultants and wastewater treatment professionals who can assess the unique circumstances and address the specific concerns and needs of an individual project. The State of Minnesota Pollution Control Agency and/or its employees accept no responsibility or liability for the contents of this guidance document, the designs, or advice contained herein. This guidance document is not intended, and cannot be relied upon, to create any rights, substantive or procedural, that can be enforced in litigation or any administrative proceeding with the State of Minnesota or the Minnesota Pollution Control Agency.

Contents

I. Introduction

I. A. Purpose of this document

This document was developed to present a clear process for design of larger and more complex Subsurface Sewage Treatment Systems (SSTS). The concepts in this document can be applied to all systems which have its starting point from small rule complying systems and includes differences for the larger and more complex systems. The concepts should be applied by all advanced professionals and these concepts can be used as a basis for local government review and approval. Minn. Stat. § 115.56, subd. 2 states:

> *"(a) Except as provided in paragraph (b), a person may not design, install, maintain, pump, inspect, or provide service to a subsurface sewage treatment system without a license issued by the commissioner. Licenses issued under this section allow work on subsurface sewage treatment systems that do not require a state permit using prescriptive designs and design guidances provided by the agency. Licensees who design systems using these prescriptive designs and design guidances are not subject to the additional licensing requirements of section 326.03."*
>
> and
>
> *"(g) No other professional license under section 326.03 is required to design, install, maintain, inspect, or provide service for a subsurface sewage treatment system that does not require a state permit using prescriptive designs and design guidances provided by the agency if the system designer, installer, maintainer, inspector, or service provider is licensed under this subdivision and the local unit of government has not adopted additional requirements."*

This design guidance provides prescriptive designs and guidance for systems up to 10,000 gallons per day (gpd). It is the intent of the Minnesota Pollution Control Agency (MPCA or Agency) to periodically review, update, and expand this document, as needed, to meet the needs of advanced designers and the SSTS industry.

I. B. Design guidance for systems

The following documents listed in Table I.A constitute SSTS prescriptive designs and design guidance:

Table I.A List of standards for advanced designed systems

Sewage Flow Volume	Type of System	Design Guidance References
0 to 2,500 gpd	Types I, II and III	· Minn. R. ch. 7080 · MPCA List of SSTS Sewage Tanks · MPCA List of Registered Treatment Products for Residential Strength Sewage · MPCA List of Registered Treatment Products for High Strength Waste · MPCA List of Registered Distribution Media Products · MPCA Drainfield Rock Distribution Media Recommended Standards and Guidance · MPCA Remediation Technologies and Processes for Subsurface Sewage Treatment Systems · University of Minnesota (U of M) Onsite Sewage Treatment Manual University of Minnesota Design Forms (worksheets)
2,501 to 5,000 gpd	Types I, II and III	· Minn. R. ch. 7080 · MPCA List of SSTS Sewage Tanks · MPCA List of Registered Treatment Products for Residential Strength Sewage · MPCA List of Registered Treatment Products for High Strength Waste · MPCA List of Registered Distribution Media Products · MPCA Drainfield Rock Distribution Media Recommended Standards and Guidance · MPCA Remediation Technologies and Processes for Subsurface Sewage Treatment Systems · This Design Guidance Manual · University of Minnesota Design Forms (worksheets)
0 to 5,000 gpd	Type IV	· Minn. R. ch. 7080 · MPCA List of SSTS Sewage Tanks · MPCA List of Registered Treatment Products for Residential Strength Sewage · MPCA List of Registered Treatment Products for High Strength Waste · MPCA List of Registered Distribution Media Products · MPCA Drainfield Rock Distribution Media Recommended Standards and Guidance · MPCA Remediation Technologies and Processes for Subsurface Sewage Treatment Systems · This Design Guidance Manual · University of Minnesota Design Forms (worksheets)

Sewage Flow Volume	Type of System	Design Guidance References
5,001 to 10,000 gpd	Types I - IV	· Minn. R. ch. 7081 · MPCA List of SSTS Sewage Tanks · MPCA List of Registered Treatment Products for Residential Strength Sewage · MPCA List of Registered Treatment Products for High Strength Waste · MPCA List of Registered Distribution Media Products · MPCA Drainfield Rock Distribution Media Recommended Standards and Guidance · MPCA Remediation Technologies and Processes for Subsurface Sewage Treatment Systems · This Design Guidance Manual · University of Minnesota Design Forms (worksheets)

If a conflict exists between these referenced documents and this standards and guidance, these standards and guidance shall apply. Please report these discrepancies to the Agency.

Each of the documents related to the registration of SSTS products are found on the MPCA website at: https://www.pca.state.mn.us/water/product-registration. The SSTS products found on this website include: 1) sewage tanks, 2) treatment products for residential strength sewage, 3) treatment products for high strength sewage, and 4) distribution media products. Other information is contained on this website, including letters to manufactures and operating permit templates. The University of Minnesota (U of M) Onsite Sewage Treatment manual can be found at: https://septic.umn.edu/publications/manual. The U of M design forms are located at: https://septic.umn.edu/ssts-professionals/forms-worksheets, or use the copy you received during the U of M training.

I. C. Limitations of advanced design

This document is the statutorily referenced Prescriptive Standards and Design Guidance, per Minn. Stat. § 115.56 subd. 2. Advanced designers are certified to complete assessments and provide wastewater treatment and dispersal system designs as defined in this document. This includes completing designs using Recommended Standards and Guidance (RS&G) documents for public domain products (e.g., single pass sand filters) found on the MPCA webpage at: https://www.pca.state.mn.us/water/product-registration.

Advanced designers are:

- not allowed to design components not found in this document
- not allowed to vary from the standards and guidance prescribed in this document

It is not possible to develop prescriptive methods for every detail of system design. Advanced designers are allowed to fill in minor gaps within the prescriptive method.

A Minnesota-licensed Professional Engineer or Geoscientist (as applicable) is required for assessment or design of components in their recognized area of expertise for situations where the guidance is not provided or is insufficient for a specific situation.

I. D. Desired goals and outcomes

Systems that require advanced designs need to adequately protect the environmental and public health and safety. Table I.B provides the environmental protection indicators and performance standards that need to be achieved by SSTS which need an advanced design.

Table I.B

Row	Contaminant/Issue	Compliance Concentration	Compliance Boundary
1	Treatment vessels and exposed sewage	No exposed sewage or effluent	Treatment devices
2	Soil dispersal and exposed sewage	No exposed sewage or effluent	No surface discharge before native groundwater discharge
3	Free from physical injury and harm	Drowning, electrocution, falling, etc.	Entire system
4	Hazardous waste	No hazardous waste in system - Hazardous waste regulations	Influent
5	Non-sewage waste	Waste must be suitable for groundwater discharge, must size system for additional flow	Influent
6	Must meet all state, local and federal requirements	Shoreland rules, wetland, rules, well code, plumbing code, etc.…	Entire system
7	Maximum concentrations of BOD_5, TSS and O&G before additional design considerations are needed	BOD – 300 mg/l TSS – 200 mg/l O&G – 50 mg/l	Influent (raw sewage)
8	Maximum concentrations of BOD_5, TSS and O&G before additional design considerations are needed	BOD – 170 mg/l (cBOD – 125 mg/l) TSS – 60 mg/l O&G – 25 mg/l	Influent to the soil dispersal system (treatment tank effluent)
9	Fecal organisms	< 1 colony/100 ml	Bottom of the unsaturated soil layer
10	Total nitrogen	Varies based on system size and aquifer sensitivity – refer to section II F.	
11	Unsaturated soil zone for treatment	Minimum of 12 inches for ISTS and 24 inches for MSTS (i.e. must account for groundwater mounding for MSTS). See Section IV. F. 3. D.	Below soil treatment and dispersal system
12	Setbacks	See Appendix J	-
13	Site requirements	See Section IV F. 3, 5, 8 – 11..	-
14	Any additional local standards	Refer to Local Ordinance Requirements	-
15	Soil treatment and dispersal system loading rates and system geometry	Conventional loading rates for septic tank effluent, higher loading rates for BOD_5/$cBOD_5$ reduced effluent, must consider affects on groundwater mounding and fecal coliform removal. See Section IV. F. 8 – 11.	-
16	Longevity of structural components	25-year design life under normal use and maintenance	-
17	Operation and maintenance	Operated per management plan or operating permit conditions	-

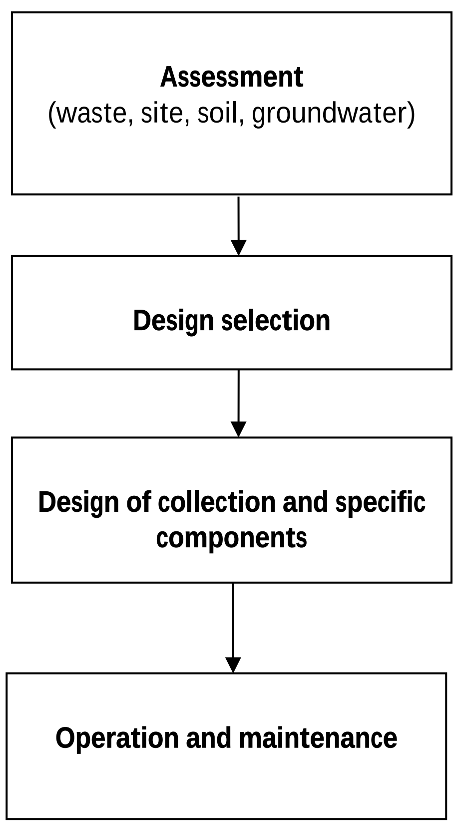
This guidance document is provided to meet state public health and environmental outcomes. This guidance should be used in conjunction with federal standards for Class V injection wells per 40 CFR parts 144 and 146.

The MPCA encourages implementation of pollution prevention activities, eliminating or reducing pollutants at the source, in the operation of the advanced design SSTS through education of the system's users. Pollution prevention can often save money by maximizing the life of an advanced design SSTS. Pollution prevention ideas and resources can be found at the Minnesota Technical Assistance Program (MnTAP) website at http://www.mntap.umn.edu/industries/facility/potw/.

I. E. How to use this document

This document is divided into five main sections; assessment, design selection, design of components, collection systems, and operation and maintenance. The assessment section determines the waste volume and constituents and the soil and groundwater conditions at the proposed site. The results of these assessments are viewed collectively in the design selection process to reasonably assure that the combination of the waste, system design and natural processes will protect public health and the environment. The design section provides detailed methods to design the selected system components. The collection system section provides design guidance for collection gravity and pressure collection systems. Lastly a section is included on operation and maintenance of the components as designers are required to develop management plans.

The assessment sections are divided into specific issues (suitable wastes, flow, waste strength, soil, etc.), and these specific topics are subdivided into sub-sections such as rules, definitions, technical overview, and assessment methodology.



It is required that the advanced designer carefully review Minn. R. chs. 7080 and 7081 in conjunction with this manual as many design issues are addressed in these rules. Specific assessment and design worksheets are included in this document. The applicable worksheets need to be correctly identified by the advanced designer. Completed worksheets and supporting information should be submitted to the local permitting authority for review and approval.

The recommendations contained in this document are based on Minn. R. chs. 7080 and 7081, along with the best available methods identified at the time of writing this document.

- This document provides introductory and background information on assessment and design selection processes and design of components. Calculations are also provided where applicable. This document is designed as a baseline of what designers of advanced systems need to know. As much as possible, this manual is organized in sequential order of work duties. In most cases is it assumed that a logical sequential order of assessment would be the following steps:
- Waste assessment (domestic, non-domestic, hazardous)
- High strength waste assessment
- Flow determination
- System classification/permit type
- Site evaluation
    - Site assessment
    - Soil assessment
    - Groundwater sensitivity assessment
    - Groundwater mounding assessment/contour loading rate assessment
    - Surface water phosphorus assessment
- Design selection
- Design of components
- Operation and maintenance requirements

Once the waste and site information is gathered, then an initial design can be generated. Once design components are selected, specific design worksheets can be used to design the individual system components. It is anticipated that the design will be an iterative process in which some of the initial steps will need to be repeated as the design process proceeds.

Definitions of terms used in this document can be found in chapter 7080.1100 and chapter 7081.0020 with some additional definitions provided in the instruction sheets in the appendixes. Appendix K contains a list of acronyms.

I. F. Contacts

If questions arise on the use or technical aspects of this document, please contact the following:

Assessment Methods:
Brandon Montgomery – 651-757-2230 – Brandon.Montgomery@state.mn.us or
Cody Robinson – 651-757-2535 – Cody.Robinson@state.mn.us

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Single Pass Sand Filter Design:
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Recirculating Sand Filter Design:
Brian Fitzpatrick – 218-316-3859 - brian.fitzpatrick@state.mn.us

Registered Proprietary Treatment Products:
Katie Dowlding – 651-757-2301 – Katie.Dowlding@state.mn.us

Soil Dispersal System Design:
Brandon Montgomery – 651-757-2230 – Brandon.Montgomery@state.mn.us or

Cody Robinson – 651-757-2535 – Cody.Robinson@state.mn.us

Distribution System Design:
Gabe Posteuca – 651-757-2783 – Gabriel.Posteuca@state.mn.us

Pressure Sewer Collection System Design:
Randy Thorson – 651-757-2779 – randy.thorson@state.mn.us

Gravity Sewer Collection System Design:
Randy Thorson – 651-757-2779 – randy.thorson@state.mn.us

Operation and Maintenance:
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Cody Robinson – 651-757-2535 – Cody.Robinson@state.mn.us

II. Assessment methods

II. A. Suitable waste for subsurface sewage treatment systems

II. A. 1. Introduction

This section is to aid in the design of systems that serve establishments which have a domestic waste source (e.g., sewage) and a non-domestic waste source. This section contains an overview and background on non-domestic waste sources and an associated assessment methodology. The purpose is to determine if a waste is considered domestic or non-domestic in nature, and if federal rules apply.

II. A. 2. Definitions

Before starting the discussion, it may be helpful to define the terms which may be unfamiliar. Please review the list of terms below:

a. Class IV wells – Wells that inject hazardous or radioactive wastes into or above an Underground Source of Drinking Water (USDW). These wells are banned unless authorized under a federal or state groundwater remediation project.

b. Class V wells – Wells that inject non-hazardous fluids into or above a USDW and are typically shallow, on-site disposal systems; however, this class also includes some deeper injection methods. An SSTS is considered a Class V Injection Well if:
   - The system serves more than a single family dwelling
   - The system serves a non-dwelling establishment, if the establishment has the capacity to serve 20 or more persons/day
   - The system serves any size dwelling or establishment and receives non-sewage (non-domestic) waste

c. Hazardous waste – "Hazardous Waste" is a waste which meets the qualifications as hazardous as determined by Minn. R. ch. 7045.

d. Injection – The subsurface discharge of fluids through a well.

e. Industrial waste disposal well – A class V injection well that receives wastes other than sanitary waste is known as an industrial waste disposal well.

f. Large capacity cesspool – A covered pit that receives sanitary waste from multiple dwellings or a non-residential location and has the capacity to serve 20 or more persons per day.

g. Large capacity septic systems – Class V wells that dispose of sanitary waste through a septic tank and serve multiple dwellings, or a non-residential location and have the capacity to serve 20 or more persons per day.

h. Motor vehicle waste disposal well – A septic system that may receive vehicular repair or maintenance waste is known as a motor vehicle waste disposal well.

i. Noncontact cooling water wells – Class V wells that are used to inject noncontact cooling water that contains no additives and has not been chemically altered.

j. Other industrial wells – The proposed "other industrial well" categories are: (1) wells used to inject fluids from carwashes that are not specifically set up to perform engine or undercarriage washing; (2) wells used to inject noncontact cooling water that contains no additives and has not been chemically altered; (3) wells used to inject fluids from laundromats where no onsite dry cleaning is performed or where no organic solvents are used for laundering; and (4) wells used to inject wastewater from food processing operations.

k. Point of injection – The last accessible sampling point prior to waste fluids being released into the subsurface environment through a Class V injection well.

l. Sanitary waste – Is liquid or solid waste originating solely from humans and human activities. This category includes waste collected from toilets, showers, wash basins, sinks used for cleaning domestic areas, sinks used for food preparation, clothes washing operations, and sinks or washing machines where food and beverage-serving dishes, glasses, and utensils are cleaned (40 CFR § 144.3).

m. Sewage – "Sewage" means waste produced by toilets, bathing, laundry, or culinary operations or the floor drains associated with these sources, and includes household cleaners, medications, and other constituents in sewage restricted to amounts normally used for domestic purposes (Minn. R. 7080.1100 subp. 73).
n. Sewage treatment effluent wells – Class V wells that are used by privately or Publicly Owned Treatment Works (POTWs) to inject treated or untreated domestic sewage through a vertical well or a leachfield.
o. Subsurface Sewage Treatment System (SSTS) – "Subsurface Sewage Treatment System" or "SSTS" means a sewage treatment system that employs sewage tanks or other treatment devices with final discharge into the soil below the natural soil elevation or elevated final grade (modified from Minn. R. 7080.1100 subparts 41 and 82). These systems include in-ground trenches, in-ground seepage beds, at-grade systems, mound systems, drip dispersal, and other similar systems.
p. Underground Source of Drinking Water (USDW) – An aquifer or portion of an aquifer that supplies any public water system or that contains a sufficient quantity of groundwater to supply a public water system, and currently supplies drinking water for human consumption, or that contains fewer than 10,000 milligrams per liter (mg/l) total dissolved solids and is not an exempted aquifer.
q. Well or injection well – Is a bored, drilled, or driven shaft, or a dug hole, whose depth is greater than its largest surface dimension; an improved sinkhole, or a subsurface fluid distribution system used to discharge fluids underground (40 CFR § 144.3). An SSTS (aka septic system) is considered an injection well (dependent on waste stream and flow amounts).

For other definitions please refer to: https://www.epa.gov/uic.

II. A. 3. Regulations

Both federal and state regulations control the discharge sewage and non-sewage waste into the soil. It should be understood that this overview is only addressing discharge into a subsurface soil treatment system. This overview does not address surface soil dispersal systems, such as rapid infiltration basins, spray irrigation of effluent or land spreading sites, and does not address deeper injection well systems. The applicable regulations for subsurface dispersal of non-sewage waste are:

- 40 CFR pt. 144 – Underground Injection Control Regulations (federal)
- Minn. R. ch. 7080 – Individual Sewage Treatment Systems (state)
- Minn. R. ch. 7081 – Midsized Sewage Treatment Systems (state)
- Minn. R. ch. 7060 – Underground Waters (state)
- Minn. R. ch. 7045 – Hazardous Waste Rules (state)

a. 40 CFR part 144 – Underground Injection Control (UIC) Regulations

Class V wells are regulated under the authority of Part C of Safe Water Drinking Act (SDWA). Congress enacted the SDWA to ensure protection of the quality of drinking water in the United States, and Part C specifically mandates the regulation of underground injection of fluids through wells. The United States Environmental Protection Agency (EPA) has promulgated a series of UIC regulations under this authority.

Owners or operators of Class V wells are required to submit basic inventory information under 40 CFR § 144.26. When the owner or operator submits inventory information and is operating the well such that a USDW is not endangered, the operation of the Class V well is authorized by rule. The UIC inventory form can be found at: https://www.epa.gov/sites/production/files/2015-09/documents/r5-uic-class-5-inventory-form.pdf
Moreover, under section 144.27, the EPA may require owners or operators of any Class V well, in EPA-administered programs, to submit additional information deemed necessary to protect USDWs.

Owners or operators who fail to submit the information required under sections 144.26 and 144.27 are prohibited from using their wells.

Some major environmental provisions of the UIC regulations are:

- Injection wells may not cause contamination to USDW.
- Injection wells must not violate of any primary drinking water regulation (defined as 40 CFR pt 142).
- Injection wells must not adversely affect the health of persons.
- Class IV injection wells are banned.
- New motor vehicles waste disposal wells are banned.
- Large-capacity cesspools are banned.

Please see 40 CFR § 144.12(a):
https://www.ecfr.gov/cgi-bin/text-idx?SID=d23d939fc8ba906c72f93aec1364ccbb&mc=true&node=se40.25.144_112&rgn=div8

The UIC program applies throughout Minnesota and is administered by the EPA. The federal UIC program encourages voluntary compliance through education and technical assistance, but will penalize owners and operators of injection wells who violate UIC requirements. The UIC program is administered at:

US EPA Region 5
Mail Code WP-16J
77 W. Jackson Blvd.
Chicago, IL 60604-3590
Fax: 312-886-4235

b. Minn. R. ch. 7080 and 7081 – Subsurface Sewage Treatment Systems (SSTS)

All subsurface treatment systems which receive domestic sewage with a design flow of 10,000 gpd or less are regulated under Minnesota rules unless the State Disposal System (SDS) permit conditions are met (see section II D). An SSTS which also qualifies as a Class V injection must also meet the federal UIC regulations described above. Those SSTS which qualify as a UIC are based upon the system size, or receiving non-domestic wastes (see UIC criteria above).

The SSTS rules allow a mixture of domestic and non-domestic waste as stated in Minn. R. 7080.1550 as stated below:

7080.1550 Acceptable and Prohibited Discharges

"Subpart 1. Sewage. This chapter provides design standards for ISTS that exclusively receive sewage. If ISTS receive both sewage and nonsewage, the requirements of this chapter and requirements governing the nonsewage portion of the waste apply."

"Subp. 2. System influent. Footing or roof drainage and chemically treated hot tub and pool water must not be discharged into any part of a system. Products containing hazardous chemicals and hazardous waste must not be discharged to a system other than in normal amounts of household products and cleaners designed for household use. Substances not intended for use in household cleaning, including but not limited to solvents, pesticides, flammables, photo finishing chemicals, paint, and dry-cleaning chemicals must not be discharged to the system. Other unused products or substances, or unused medicines, must not be

discharged to the system solely as a method of disposal. Floor drains from garages serving dwellings must not be connected to the system."

Minn. R. 7081.0130 subpart 1 item A:

"Waste other than sewage is only allowed to be discharged into the system if the waste is suitable to be discharged to groundwater."

Therefore, non-sewage can be discharged into the SSTS under the conditions of these provisions.

If a subsurface system is to receive non-sewage wastes (either mixed with sewage or not), please contact the Water Quality Permits Unit of the Industrial Section of the MPCA at 800-657-3864. If the subsurface system does not receive domestic sewage, but only non-sewage, then Minn. R. chs. 7080 and 7081 **do not apply** (7080.1050 and 7081.0010). Please contact the Water Quality Permits Section.

Regulatory Jurisdiction	Sewage Only	Sewage mixed with non-sewage	Non-Sewage Only
Local SSTS Ordinance, and Design Guidance	x	x	
Water Quality Permits Unit – Industrial Section		x	x

The SSTS program applies throughout Minnesota and is administered by local units of government.

c. Minn. R. ch. 7060 – Underground Waters

The purpose of chapter 7060 is to preserve and protect the underground waters of the State by preventing any new pollution and abating existing pollution (7060.0100).

The Agency's policy is to consider the actual or potential use of the underground waters for potable water supply as such to provide maximum protection to all underground waters. The policy is designed to maintain underground waters in its natural condition; therefore this chapter is a non-degradation policy to prevent pollution of the underground waters of the State (7060.0020).

A classification is established to protect the underground waters as potable water supplies by preventing and abating pollution (7060.0040).

It is the policy of the Agency that the disposal of sewage, industrial waste, and other wastes shall be controlled to ensure that to the maximum practicable extent, the underground waters of the State are maintained at their natural quality unless a determination is made by the Agency that a change is justifiable by reason of necessary economic or social development, and will not preclude appropriate beneficial present and future uses of the waters (7060.0500)

This chapter states that no sewage, industrial waste, or other wastes shall be discharged directly (e.g., needs some separation distance) into the zone of saturation by such means as injection wells or other devices used for the purpose of injecting materials into the zone of saturation, except that the discharge of cooling water under existing permits issued by the Agency may be continued (7060.0600 subpart 1)

This chapter further states that no sewage, industrial waste, other waste, or other pollutants shall be allowed to be discharged to the unsaturated zone or deposited in such place, manner, or quantity that the effluent, upon reaching the water table, may actually or potentially preclude or limit the use of the underground waters as a potable water supply, nor shall any such discharge or deposit be allowed which may pollute the underground waters. All such possible sources of pollutants shall be monitored at the discharger's expense as directed by the Agency.

Toxic pollutants including, but not limited to, radioactive substances, chemicals, metals, solvents, petroleum products, plating wastes, and acids and bases, shall not be discharged or deposited in any manner such as to endanger the quality or uses of the underground waters.

d. Minn. R. ch. 7045 – Hazardous Waste

   The State hazardous waste rules do not allow the discharge of hazardous waste into an SSTS. There are no provisions in Minn. R. ch. 7045 prohibiting discharge of hazardous waste into an SSTS; however, following all the provisions of the hazardous waste rule would result in a prohibition.

II. A. 4. Assessment methodology

The following criteria will aid in determining the federal and state classification of the system. It should be understood that the system may fall under multiple regulations. For UIC injection well determination, this assessment is limited to Class IV or Class V criteria for fluids discharged into soil dispersal systems. This assessment will not make a determination for all classes of injection wells (e.g., inject brines for oil and gas production, solution mining, etc.). An assessment worksheet formatted with the following provision is provided in Appendices A and A-2.

a. A system is a SSTS if meeting the State's definition contained in part 7080.1100.
b. A subsurface system which receives sewage requires an SDS permit if meeting the criteria contained in 7081.0040.
c. The subsurface system is a Class IV (4) UIC Well if one or more of the fluids discharged to the well are a hazardous waste. Class IV wells are prohibited.
d. The system is a Class V (5) UIC Injection Well if one or more of the fluids discharged to the well are a non-hazardous and non-domestic waste, or the system receives domestic waste from more than one dwelling or from an establishment which has the capacity to serve more than 20 people per day.

II. A. 5. Instructional help for methodology

A treatment and disposal system that does not discharge below the ground surface or final grade is not considered an SSTS. Other dispersal methods, such as Rapid Infiltration (RI) basins or surface sprayed irrigation require an SDS permit (at any flow amounts). Land spreading of sewage wastes does not qualify as a subsurface method even if injected into the soil with injectors.

Sewage means waste produced by toilets, bathing, laundry, or culinary operations, or the floor drains associated with these sources, and includes household cleaners, medications, and other constituents in sewage restricted to amounts normally used for domestic purposes (Minn. R. 7080.1100 subp. 73).

A soil dispersal system (trench, bed, mound, at-grade system) is included in the definition of a well for the UIC program.

All fluids not considered sewage are considered non-domestic wastes. A careful reading of the definition indicates that household cleaners, medications and other constituents are restricted to amounts used for domestic purposes. Therefore an argument can be made waste from all non-dwellings will not have the same amounts of cleaners, etc. used for domestic purposes. A brief waste categorization is provided below for wastes from non-dwellings (aka Other Establishments):

- Toilets = sewage
- Hand-washing sink from bathroom use = sewage

- Showering = sewage
- Laundry (if worker's clothes are not exposed to pesticides or other chemicals) = sewage
- Culinary (food preparation) = sewage
- Food processing (cannery, slaughter house, milkhouse) = non-sewage
- Cleaners = likely non-sewage, unless in amounts which are the same as domestic sewage

In most cases, the owner of the establishment will know if they generate hazardous waste. Therefore, questioning the owner on hazardous waste generation and possible discharge to the subsurface system, must take place with the owner's understanding that discharge of hazardous wastes into a subsurface system is strictly prohibited.

Environmental Guide for Small Businesses in Minnesota, Hazardous Waste Chapter:
http://www.pca.state.mn.us/index.php/view-document.html?gid=5577

For a complete list of hazardous waste information guides, please refer to:
http://www.pca.state.mn.us/waste/pubs/business.html#hazardous.

To assist the owner regarding Class V waste issues for specific waste streams, please refer to the following EPA Class V fact sheets:

- Industrial waste disposal wells
  https://www.epa.gov/uic/class-i-industrial-and-municipal-waste-disposal-wells#muni_well
- Other Class V well types
  https://www.epa.gov/uic/more-information-about-class-v-well-types
- Car washes
  https://www.epa.gov/sites/production/files/2015-08/documents/2007_12_12_uic_class5_study_volume04-carwash.pdf
- Experimental wells
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume15-experimental.pdf
- Food processing waste
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume06-foodprocessingdisposal.pdf
- Laundromats without dry cleaning facilities
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume08-laundromats.pdf
- Wells that receive non-contact cooling water
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume22-noncontactcoolingwater.pdf
- Sewage treatment effluent
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume22-noncontactcoolingwater.pdf
- For other establishments/facilities
  https://www.epa.gov/uic/more-information-about-class-v-well-types
- Large capacity septic systems
  https://www.epa.gov/sites/production/files/2015-08/documents/classvstudy_volume05-largecapacitysepticsystems.pdf

- Large capacity cesspools (banned by the EPA)
  https://www.epa.gov/uic/large-capacity-cesspools
- Motor vehicle waste disposal wells
  https://www.epa.gov/uic/motor-vehicle-waste-disposal-wells

More UIC informational resources:

- EPA Class V webpage
  https://www.epa.gov/uic/class-v-wells-injection-non-hazardous-fluids-or-above-underground-sources-drinking-water
- State implementation guide revisions to the Underground Injection Control Regulations for Class V injection wells
  https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program
- Fact sheet - When Is a septic system regulated as a Class V well?
  https://www.epa.gov/sites/production/files/2015-08/documents/fs_septic_sys.pdf

I. A. 6. References

EPA Publication 813F94001 - Underground Injection Wells and Your Drinking Water – 1994.

EPA Publication 816F02010 - Fact Sheet: Class 5 Injection Wells, June 2002

EPA Publication 816F040 - US EPA's Program To Regulate The Placement Of Waste Water And Other Fluids Underground – 2004.

EPA Publication 816F01009 - Class V Injection Wells EPA Proposes to Continue with its Existing Approach for Managing Class V Injection Wells – 2001.

EPA UIC – Class V Homepage:
https://www.epa.gov/uic/class-v-wells-injection-non-hazardous-fluids-or-above-underground-sources-drinking-water

EPA Publication 816-R-99-014d - The Class V Underground Injection Control Study
Volume 4 - Wells That Inject Fluids from Carwashes without Engine or Undercarriage Cleaning, September 1999.

II. B. Waste strength assessment

II. B. 1. Introduction

Hydraulic performance, treatment performance, and longevity of an SSTS can drastically be affected by the concentration of organic substances and solids in the waste. The concentration of organic substances and solids in the sewage is referred to as "waste strength". The compounds causing high strength waste are generally derived from food wastes and are not to be confused with other organic compounds such as petroleum products, solvents, volatile cleaners, etc., which are dealt with previously in Section A.

The concern with waste strength is not with environmental protection, but with soil system longevity. If excessive organic material or solids reach the soil system, the biological clogging mat can become restrictive to the point of hydraulic failure. In addition, excessive oil and grease can clog pipes.

Soil system longevity is of great importance, especially if the soil system prematurely clogs and there is limited or no area for a replacement system. Another concern is an economic one, as the life of the soil system may be limited to the point that the gallons treated per system costs are very high. It has been reported that designs that did not account for high strength waste failed within a matter of months.

a. Definitions

The terms used in describing waste strength are as follows:

- Biochemical oxygen demand - "Biochemical oxygen demand" (BOD) means the measure of the amount of oxygen required by bacteria while stabilizing, digesting, or treating biodegradable organic matter under aerobic conditions over a five-day incubation period.
- Oil and grease - “Oil and grease” (O&G) means a component of sewage typically originating from foodstuffs such as animal fats or vegetable oils or consisting of compounds of alcohol or glycerol with fatty acids such as soaps and lotions (also known as FOG or fats, oil, and grease).
- Settleable Solids - “Settleable solids” means the solids which are of sufficient size and weight to settle in a given period of time.
- Total suspended solids or TSS - "Total suspended solids" (TSS) means solids that are in suspension in water and that are removable by laboratory filtering.

b. Domestic strength waste

The following table lists the maximum waste strength concentrations from a typical dwelling. Waste strength that is less than these concentrations is considered “domestic strength waste”.

	Influent (Raw Sewage)	**Final Sewage Tank Effluent**
Biochemical Oxygen Demand (BOD5)	<300 mg/l	< 170 mg/l (125 mg/l CBOD5)
Total Suspended Soils (TSS)	<200 mg/l	<60 mg/l
Fats, Oils and Grease (FOG)	<50 mg/l	<25 mg/l

These concentrations can be achieved if the raw waste is domestic in nature, the flow amounts are typical, septic tanks are sized in accordance with applicable rules, and the tanks are maintained (pumped, baffled and watertight). Domestic strength waste is a combination of high strength waste from plumbing fixtures such as toilets, which is diluted with low strength waste from plumbing fixtures such as showers or laundry.

For typical residences with systems meeting Type I septic tank criteria, no assessment of high strength waste is necessary. However, it may be prudent to determine if atypical household practices and uses may be present or anticipated. Atypical use could be a home businesses, extensive hobbies, or use of water conservation devices.

c. High strength waste

High strength waste is defined as concentrations that exceed those set for domestic waste (see table above).

High strength waste can be caused by the following:

- High inputs of BOD, TSS and Oil & Grease
- Lack of dilution from low waste strength inputs (shower, laundry, etc.)
- Chemical upset of the septic tank
- Operational/maintenance issues (lack of tank pumping or missing baffles)

It should be understood that waste concentration thresholds are based on Type 1 flow estimates, and Type I sizing of septic tanks and soil dispersal systems. In other words, the size and treatment abilities of a Type 1 system drive the acceptable concentrations in the waste.

To clarify the previous paragraph, the actual concentration is not the issue; it is the concentration along with the volume of flow. The concentration multiplied by the flow equals the amount (or mass) of the contaminant. If water conservation is used, the mass remains the same. For example, if the flow is reduced by 15 percent, then the concentration will increase by 15 percent but the mass would remain the same. However, it is assumed in this guidance that the Type 1 flow values will be generated, so an increase in concentration will result in an increase in mass.

Therefore, if the concentrations are in excess of Type 1 values, chapter 7080 stipulates that the system must be designed with additional treatment (7080.1550 subp. 2 item A).

d. At-risk waste

At-risk waste is a waste that is difficult to ascertain if the waste strength will cause operational, hydraulic, or longevity problems.

II. B. 2. Waste strength assessment methods

a. Existing establishments

The designer needs to conduct a general assessment if the waste strength is clearly domestic, clearly high strength, or is uncertain (at-risk waste). The estimation methods in section b. below can be used to help make this determination. If the waste is at-risk or clearly high strength, then measuring the waste strength is highly recommended. Please see Sections 1) and 2) below.

1) Measuring waste strength

Due to variation in flow and waste strength, knowing when to sample to collect representative samples is very important. Incorrect sampling can result in over or under design of the system. Over-design may result in unnecessary costs and under-design can result in shorter system life.

Good sampling methods should be:

- Representative
- Reproducible
- Defensible
- Useful

Things to consider when wastewater strength measurements are to be taken:

- The suitability of the collection point (static water sample in a tank versus flowing water from a monitoring port)
- Number and timing of samples to get representative concentrations (a single grab sample is likely not to be representative)
- Sampling order (sample the cleanest water first)
- Sample preservation and shipping
- The type of analysis to be conducted (BOD_5, $CBOD_5$, COD, O&G, etc.). It is recommended to analyze for BOD_5, TSS and O&G.
- Expected concentrations so the lab can use the appropriate dilution
- How interpretation of sample results will impact design

2) Other things to consider along with the measured value
    - If working with a manufacturer of a registered product that treats high strength waste, the measured value can be used in conjunction with the knowledge and experience of the manufacturer.
    - Determine the life of the current soil system as compared with the level of treatment before the soil.
    - Ask the system's maintainer of issues or estimation of the concentration of the waste.
    - Take a survey of number and use the plumbing fixtures (those that generate high strength waste and those that dilute the waste) – do a mass balance estimate.

b. New establishments

1) The first step is to make the determination if the proposed system will initially be designed for domestic, at-risk, or for high strength waste. The methods provided in this section can be used for guidance to make this determination.
    - If it is decided to initially design for high strength waste (such as for a restaurant), then a concentration or mass must be determined for design purposes. This may best be done by contacting a manufacturer of a registered high strength waste treatment device.
    - If initially designed for at-risk waste, the newly operating system (after a period of start-up), should be sampled to see the adequacy of the at-risk design standards. System design should also leave options available in case waste strength comes back higher than expected and modification is required.

    The recommended sampling procedure for a newly operating at-risk system is as follows. This can be included in the Operating Permit.
    - After three months, but before six months of facility operation, the owner(s) will test the effluent prior to soil system discharge on three separate occasions during peak use.
    - The parameters tested will be BOD, TSS, and O&G, if oil and grease are identified as a possible problem.
    - If the concentrations of these parameters exceed those of domestic wastes, the at-risk design and system operation must be assessed for adequately. The system must be retrofitted within the current or next construction season if system performance is found to be inadequate.
    - The owner(s) will take full responsibility for the system's performance and operation. If failure occurs, the owner(s) will discontinue use of the system and it will be repaired or replaced.

2) Estimation methods if waste may be at-risk or high strength.
    The following methods are provided to assist in the determination if the waste is high strength or at-risk.

Method #1 - Facility chart

The following chart is offered as guidance of which wastes are likely candidates as at-risk or high strength wastes:

Facility	At-Risk Waste	High Strength Waste
Dwelling Units		
Dwelling, groups of Dwellings, Apartment Buildings > 2500	x	
Hotel (no restaurant or bar)	x	
Motel (no restaurant or bar)	x	
Rooming House	x	
Day Care (in-home, no meals)	x	
Day Care (in-home, with meals)		x
Day Care (commercial)		x
Group homes	x	
Dormitory	x	
Labor Camp	x	
Labor (semi- permanent)	x	
Commercial/Industrial		
Retail Store		x
Shopping Center		x
Office		x
Medical Office		x
Industrial Building		x
Laundromat		x
Barber Shop	x	
Beauty Shop (sewage only)	x	
Flea Market		x
Eating and Drinking Establishments		
Eating and Drinking Establishment with commercial kitchen(all types)		x
Entertainment Establishments		
Drive-in Theater		x
Theater/Auditorium		x
Bowling Alley		x
Country Club		x
Fairground and similar gatherings		x
Stadium		x
Dance Hall		x
Wedding Venue (no meals)	x	
Wedding Venue (Catered Meals)	x	
Wedding Venue (with meals)		x
Health Club	x	
Outdoor Recreation Facilities		
Campground	x	
Day Camp (with meals)		x
Day Camp (w/o meals)	x	
Camp - day and night (w/meals)		x
Resort/Lodge	x	
Resort Cabin	x	
Park		x
Swimming Pool	x	
Visitor Center		x

Facility	At-Risk Waste	High Strength Waste
Transportation		
Gas Station/Convenience Store (sewage only)	x	
Service Station (sewage only)		x
Car Wash – (sewage only)		x
Airport, bus and train station		x
Institutional		
Hospital	Call the MPCA	
Mental health hospital	Call the MPCA	
Prison or Jail		x
Nursing home or similar facility	Call the MPCA	
Other Public Institution	x	
School – no cafeteria, no showers		x
School –cafeteria, no showers		x
School – no cafeteria, showers	x	
School –cafeteria and showers		x
School - Boarding		x
Church		x
Assembly Hall	x	
Miscellaneous		
Public Lavatory		x
Public Shower	x	

Method #2 - Measuring similar establishments

One problem with estimation from data received from similar establishments is that seemingly similar establishments are affected by subtle and often intangible influences that can cause significant variation in wastewater characteristics. For example, popularity, price, cuisine, management, and location can produce substantial variations in wastewater flow and waste strength among seemingly similar restaurants. These differences are also prevalent at franchises, no two establishments are identical.

Method #3 - Published waste strength data

Waste strength data is limited for most types of establishments. Therefore it is difficult to apply this data with any degree of confidence. Limited estimated waste strength values are available from:

- The University of Minnesota Onsite Sewage Treatment Program Basic Design Form – Waste Strength tab(https://septic.umn.edu/sites/septic.umn.edu/files/5.7.2020_master_design_forms_2020_final.xlsx), or in Appendix B-2.
- Research literature
- Engineering textbooks or manufacturers of treatment systems engineered specifically for high strength wastes

If a specific establishment is not listed in a publication, average concentrations of pollutants from specific plumbing fixtures are typically provided in the University of Minnesota Onsite Design Manual – Section 5 (https://septic.umn.edu/sites/septic.umn.edu/files/section_5_2017.pdf), or in Appendix B. These documents may assist the designer in determining potential influent characteristics.

A recommended estimated waste strength value for design of a new restaurant would be a BOD5 concentration of 1500 mg/l (Leskiar et. al, 2005).

Method #4 – Survey and query

The designer can ask questions about the waste type from the owner of the establishment. Helpful areas to explore would be:

- If the establishment will have high toilet paper use
- If the establishment will require frequent sanitation
- If the establishment will have significant surge/peak flows
- If the establishment will have flow from equipment or building wash-down
- Any establishment that gives a designer "pause"
- Look at the plan sheet of the proposed establishment for the number and use of the plumbing fixtures (those that generate high strength waste and those that dilute the waste) – do a mass balance estimate

II. B. 3. At-risk design recommendations

The design recommendations for at-risk waste or for high strength waste brought down to Treatment Level C concentrations are as follows:

- Based on the assessment methods provided and professional judgment, increase the Type I system components with the intention that the soil dispersal system does not exceed Type I waste strength loading rates (see Section IV. F. 6.). Note: Septic tanks do not remove soluble BOD
- Provide the required cleanouts
- Install sampling ports
- Consider pressure distribution to minimize biomat formation
- If pressure distribution is used, use larger perforations and greater distal head
- Employ an effluent filter on the outlet of the last septic tank
- Include in Management Plan that solids levels in the tank be measured more frequently
- Soil dispersal system inspection pipes can be finished above the ground surface and include in Management Plan that ponding in the soil dispersal system must be measured yearly
- Provide space for a future advanced treatment unit and additional soil dispersal capacity
- Recommend that the system be operated under an operating permit (already required for Type IV Treatment Level C systems)
- Annual visit with the system owner about waste strength concerns

II. B. 4. High strength waste design standards

a. Existing establishment
    - An existing establishment will be designed on the measured waste strength in combination with any other relevant information gathered about the establishment.

b. New establishment
    - If a new establishment will initially be designed for high strength waste an estimated concentration needs to be determined. Since an advanced treatment device will likely be necessary, it is best to contact the manufacture for a design recommendation for their product.

      Factors of safety should be incorporated in the design concentration.

II. B. 5. Who can do the work

a. Basic or intermediate designers

Basic or intermediate designers can:

- Sample existing establishments for waste strength
- Determine if the initial design should be an at-risk or high strength waste design
- Assess if an at-risk design is adequately performing
- Design an at-risk system

b. Advanced designers

Advanced designers can:

- Do all the functions of a basic/intermediate designer
- Design a system to treat and disperse high strength waste

II. B. 6. Additional assistance

Additional helpful information is found in the publication: *Analyzing Wastewater Treatment Systems for High Strength and Hydraulic Loading* developed by the Consortium of Institutes for Decentralized Wastewater Treatment. Select documents can be located by contacting the MPCA or at the following location: https://septic.umn.edu/ssts-professionals/forms-worksheets#CIDWT

Additional helpful information can be found in paragraphs 11.251 to 11.253 in the document: *Recommended Standards for Wastewater Facilities* issued by the Great Lakes Upper Mississippi Board of State and Provincial Public Health and Environmental Managers (aka – "10 State Standards") at: https://www.broward.org/WaterServices/Engineering/Documents/WWSTenStateStandardsWastewater.pdf.

II. B. 7. Literature reviewed

Metcalf and Eddy, Wastewater Engineering Treatment Disposal and Reuse – 1972.

Minnesota Pollution Control Agency, Minnesota Rules Chapter 7081 – Mid-Sized Subsurface Sewage Treatment Systems Office of the Revisor of Statutes – 2011

R. L. Siegrist, D. L. Anderson, and J.C. Converse – 1984.Commercial Wastewater On-site Treatment and Disposal pp. 210 to 219.*In* Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems, American Society of Agricultural Engineers, St. Joseph Missouri.

United States Environmental Protection Agency, Onsite Wastewater Treatment Systems Manual, February 2002 pages 3-11.

Recommended Standards for Wastewater Facilities issued by the Great Lakes Upper Mississippi Board of State and Provincial Public Health and Environmental Managers (10 states), 2004 Edition.

State of Maine – Septic System Code 2008

University of Minnesota – Onsite Sewage Treatment Manual – Appendix A-5, 2009

B.J. Lesikar, O.A.Garza, R.A.Persyn, A.L.Kenimer, and M.T.Anderson, Food-Service Establishment Wastewater Characterization, 2005

Consortium of Institutes for Decentralized Wastewater Treatment. Analyzing Wastewater Treatment Systems Serving Residential and Commercial Facilities for High Strength and Hydraulic Loading, 2009.

Policy for Processing High-Strength Wastewater POWTS Plans, April 2009. Wisconsin Department of Safety and Professional Services.
https://dsps.wi.gov/Documents/Programs/POWTS/HighStrengthWastewaterPlans.pdf

II. C. Flow determination criteria

II. C. 1.Introduction

The determination of sewage design flow is one of the most important items in the planning of a new or expanded SSTS. Sewage is defined in Minn. R. 7080.1100 subp. 73:

> *"Sewage" means waste produced by toilets, bathing, laundry, or culinary operations or the floor drains associated with these sources, and includes household cleaners, medications, and other constituents in sewage restricted to amounts normally used for domestic purposes."*

The following methods and tables can be used to determine the sewage flow for all systems regulated under chapters 7080 and 7081. To determine the design flow, the correct flow method must be chosen. Helpful explanatory notes, worksheets, tables, and examples are found in Appendices C through G.

These methods provide guidance on estimating volume of sewage flow only. For systems anticipated to receive both sewage and non-sewage, the non-sewage volume must be determined. It should be noted that non-sewage may only be discharged if the waste is suitable for discharge into the soil and in accordance with applicable local, state, and federal regulations. Please refer Section I A.

Choose the appropriate method to determine the flow. The choices are as follows:

- Flow estimation for SSTS serving multiple dwellings
- Flow estimation for SSTS serving *Other Establishments*
- Flow determination from measured flow for SSTS serving *Other Establishments*
- Flow determination from measured flow for SSTS serving multiple dwellings
- Flow determination for campgrounds and resorts open 180 days or less

In addition to using of one of the above flow determination methods, a Final Flow Worksheet (Appendix G) must be completed to account for any additional flow that may enter the system.

Flow amounts determined by these methods plus final flow calculation are used for system design but not for system classification (ISTS, MSTS, or systems needing an SDS permit) and therefore the type of permit needed (local or state). For most systems, it is expected that system design flow and system permit flow are one in the same; however, that may not always be the case. As such, more information on determining SDS permit requirements can be located in section II. D. Flow amounts may need to be modified when designing specific system components (e.g., collection system design, groundwater mounding, phosphorus mitigation, surge capacity, timed dosing, etc.) as well.

II. C. 2. Definitions

The following definitions are provided to aid in understanding this section:

> *"Dwelling" means any building with provision for living, sanitary, and sleeping facilities (*7080.1100 subp. 25). For more detail on bedroom determination, please refer to the MPCA fact sheet on bedroom determination at http://www.pca.state.mn.us/index.php/view-document.html?gid=5323

*"Other establishment" means any public or private structure other than a dwelling that generates sewage that discharges to an SSTS (*7081.0020 subp. 6).

II. C. 3. Flow estimation for SSTS serving multiple dwellings

a. Introduction

This method is to be used for estimating flow from multiple dwellings. The governing rule is found at Minn. R. 7081.0120 subp. 1 and 2 as follows:

> *"Subpart 1. Sum of design flow for existing dwellings.*
> *The design flow for MSTS serving existing dwellings is determined by the following calculation in conjunction with part 7080.1850:*
> *the total flow from the ten highest flow dwellings + (total flow from the remaining dwellings * 0.45)"* (NOTE: I and I will be added during the final calculation)
>
> *Subp. 2. New housing developments.*
> *"For new housing developments to be served by a common SSTS, the developer must determine and restrict the total number of bedrooms for the development. Proposed dwellings are determined to be Classification I dwellings for flow determination purposes unless different classifications are approved by the local unit of government. The determined classification system must be used in conjunction with the flow calculation method in subpart 1. If the ultimate development of phased or segmented growth meets or exceeds the thresholds in part 7081.0040, subpart 1, item B, the initial system or systems and all subsequent systems require a state disposal system permit."*

The above calculation method can also be used for SDS permit determination on systems which have multiple dwellings connected to one large SSTS, multiple dwellings connected to several small SSTS, SSTS found on individual lots, or any combination of the above, see section II. D. 2 for more information.

If *Other Establishments* are to be included with multiple dwellings, their flows are to be included with the total flow and included in the ranking to determine the ten highest flow units.

b. Method

1) Determine the number of bedrooms and dwelling classification for each dwelling. For new developments, the developer must limit the total number of bedrooms for the development.
2) Determine the flow based on the dwelling classification and number of bedrooms. For new developments, dwellings must be classified as Classification I, unless strong evidence exists that the dwellings will not be Classification I.
3) Add the flow together for the ten dwellings/other establishments with the highest flow.
4) Multiply the flow for the remaining dwellings/other establishments by 0.45 and add together.
5) Add the values in Step 3 and Step 4.
6) Go to final flow determination.

An example is provided in Appendix D.

II. C. 4. Flow estimation for SSTS serving Other Establishments

a. Introduction

The method in this section is to be used to estimate the sewage flow if the SSTS will serve *Other Establishments*. The governing rule is found at Minn. R. 7081.0120 subp. 2.

If non-domestic/non-hazardous wastes will also be discharged with the sewage, that waste must be suitable for soil discharge. Please see Section II A. The non-sewage flow, if found suitable, must be added to the values determined by this worksheet.

b. Method

Determine the flow based on Table I in the Appendix E (e.g., Table I in 7081.0130). For some establishments, more than one way to determine the flow is provided (e.g., either number of meals served or square foot of the restaurant). All methods provided should be calculated and the highest volume chosen. Be sure to include 15 gallons per employee per eight-hour shift unless the table indicates that employees are already included in the flow. If average seven-day use amounts are to be used, consideration should be given to whether peak hourly or other sub-daily flow values should be used to design some SSTS components. Systems designed for average seven-day use must size septic tanks for the maximum flow value calculated under Minn. R. 7081.0130 item A. Please refer to Section IV A for flow equalization methodology that is required to be used for using average seven-day flow to determine permit applicability. Note – local units of government must approve of using flow equalization in order to utilize seven-day average flows under Minn. R. 7081.0130 subp. 1 A (2).

II. C. 5. Flow determination from measured flow for SSTS serving Other Establishments

a. Introduction

This method is to be used to determine the design flow by measurements of flow from *Other Establishments*. Measured flow data cannot be used if one or more of the following conditions apply:

1) If the flow measuring device has not been calibrated within six months from the start of the measurement
2) If the data is old as compared to the current use of the facility
3) If the facility is planning on a change of use or expansion greater than 25% of measured flow
4) The peak 90-day flow has not been measured in daily measurements
5) If the daily use (e.g. percent occupancy or percent capacity of use) cannot be reasonably estimated

Note – flow measurement to determine design flow is not the same as flow measurement to determine SDS permit flow. See section II. D. for information on determining SDS permit flow under Minn. R. 7081.0040 subp. 1 B and Minn. R. 7081.0040 Subp. 1a

b. Method

The method to determine design flow from measured flow is provided as follows:

1) Measure the anticipated peak 90-day flow values along with percent occupancy or capacity of use of the facility each day of the flow reading (e.g., percent of the campgrounds occupied)
2) Divide each day's flow value by the percent occupancy/capacity (in decimal form)
3) Determine the peak consecutive seven-day flow from values calculated in Step 2.
4) Average the values in Step 3.
5) Determine if water use was significantly reduced to mitigate treatment or hydraulic problems, the system may have been experiencing. If reduced flows occurred, or are suspected, flow values should be adjusted appropriately. Failure to assess and correct for this situation could result in premature failure.

6) The computed measured flow value must be compared with the estimated flow values provided in rule or other published documents if values are not found in rule (if available). The result of the comparison must be evaluated to assure the measured flow value is reasonable.
7) Follow Final Flow Determination method to complete this process.

It is desirable that the average daily operating flow volume be approximately 70 percent of the daily design flow. This 70 percent value is chosen for average flow values with the intent that maximum daily flows do not exceed the design flow.

c. Cautions with using measured flow

Much care and discernment should be used if measured flow values are to be used for design. It is important to look at the measured values with a holistic mindset. For example, the measured flow values should be viewed against:

1) Did the business just change ownership?
2) Will the business change its business plan?
3) What is the anticipated future growth plans for the business?
4) What is the future growth of the area that could increase business of the facility?

It is thought that underestimation of flow values is one of the main reasons for system failure. Therefore, it is strongly recommended that the chosen design flow value be conservative. Use of a conservative flow volume will not result is a wasteful expenditure, as a more conservative design will decrease operation and maintenance requirements and increase system longevity.

II. C. 6. Flow determination from measured flow for SSTS serving multiple dwellings

a. Introduction

Currently, Minnesota rule does not allow measured flow to be utilized to determine system design for SSTS serving multiple dwellings. Minn. R. 7081.0120 specifies how design flow must be determined. See section II. D. for information on determining SDS permit flow for SSTS serving multiple dwellings under Minn. R. 7081.0040 subp. 1 B and Minn. R. 7081.0040 Subp. 1a

II. C. 7. Flow determination for campgrounds and resorts open 180 days or less

a. Introduction

This method is to be used to determine the design flow by measurements of flow from campgrounds and resorts existing as of June 14, 2015, open 180 days per year or less, as authorized under Minn. R. 7081.0040 subp. 1a D. Campgrounds and resorts open for more than 180 days, or facilities opened after June 14, 2015 should use the measurement procedure in Section II.C.5. Measured flow data cannot be used if one or more of the following conditions apply:

1) If the flow measuring device has not been calibrated within six months from the start of the measurement
2) If the data is old as compared to the current use of the facility
3) If the facility is planning on a change of use or expansion greater than 25% of measured flow
4) The peak flow has not been measured in daily measurements
5) If the daily use (e.g. percent occupancy or percent capacity of use) cannot be reasonably estimated

Note – flow measurement to determine design flow is not the same as flow measurement to determine SDS permit flow. See section II. D. for information on determining SDS permit flow under Minn. R. 7081.0040 subp. 1 B and Minn. R. 7081.0040 Subp. 1a

b. Method

The method to determine design flow from measured flow is provided as follows:

1) Measure the daily flow rate and daily occupancy rate (e.g., percent of the campgrounds occupied) for a minimum of two weeks centered on and including July 4. Weekly measurements must also be done for an additional, continuous two weeks before and two weeks after July 4.
    a. Flow measurements must be taken only from:
        i. a sewage lift station pump with a runtime meter and counter;
        ii. a sewage flow meter;
        iii. flow meters on wells; or
        iv. a water softener system with flow measurement when the measurement includes all flow to the subsurface soil treatment system, including backwash.
2) Flow measurements must be divided by the percent occupancy expressed as a decimal percent.
3) Determine the peak consecutive seven-day flow from values calculated in Step 2.
4) Average the values in Step 3.
5) Determine if water use was significantly reduced to mitigate treatment or hydraulic problems, the system may have been experiencing. If reduced flows occurred, or are suspected, flow values should be adjusted appropriately. Failure to assess and correct for this situation could result in premature failure.
6) The computed measured flow value must be compared with the estimated flow values provided in rule or other published documents if values are not found in rule (if available). The result of the comparison must be evaluated to assure the measured flow value is reasonable.
7) Follow Final Flow Determination method to complete this process.

It is desirable that the average daily operating flow volume be approximately 70 percent of the daily design flow. This 70 percent value is chosen for average flow values with the intent that maximum daily flows do not exceed the design flow.

c. Cautions with using measured flow

Much care and discernment should be used if measured flow values are to be used for design. It is important to look at the measured values with a holistic mindset. For example, the measured flow values should be viewed against:

1) Did the campground or resort just change ownership?
2) Will the campground or resort change its business plan?
3) What is the anticipated future growth plans for the campground or resort?
4) Is their future growth in the area that could increase business of the campground or resort ?

It is thought that underestimation of flow values is one of the main reasons for system failure. Therefore, it is strongly recommended that the chosen design flow value be conservative. Use of a conservative flow volume will not result is a wasteful expenditure, as a more conservative design will decrease operation and maintenance requirements and increase system longevity.

II. C. 8. Final flow determination

Other factors affecting flow amounts must be added to the flow amounts calculated in Methods a. to c. as described below:

a. Flow volumes must be increased if construction of additional dwellings or bedrooms, the installation of water-using devices or other factors likely to affect the operation of the system can be reasonably anticipated (Minn. R. 7081.0120 subp. 3).
b. For clustered development of dwellings, the flow must be determined by the total developed area if the development is to be phased or segmented over time (7081.0120 subp. 2). The developer must place restrictions on the lots so the total number of bedrooms cannot be exceeded.
c. If the system is served by a sewage collection system, the leakage (infiltration) into the collection system must be estimated. The amount is equal to 200 gallons per inch diameter of pipe per mile per day (minimum pipe diameter of two (2) inches) (Minn. R. 7081.0140).
d. If non-sewage is to be discharged into the system, its volume must be added to the flow. **CAUTION**: 1) the non-sewage flow must be suitable for treatment in the soil, and may require a MPCA permit (see Section II. A. 3 b.); 2) the quantities must be reliably known; and 3) if non-sewage flow will widely fluctuate, the system must be designed based on peak flow or flow equalization must be used.

The final step is to add the flow amounts from Sections II. C. 3 through II. C. 5 with the flow calculated from items a. to c. above. An assessment should be made regarding the variation in the flow amount calculated. The variation can be a variation within one day's time (e.g., all the flow in a two-hour period), or a weekly, monthly or seasonal variation or any special events. This variation should also consider the time of year of the variation to reduce the potential for system freezing. Please refer to Section IV A for flow equalization methodology.

Flow amounts determined by the provided methods (plus final flow calculation) are to be used for system classification (ISTS, MSTS or if a State permit is needed) and therefore the type of permit needed (local or State). This flow value may be modified when designing specific system components (e.g., collection system design, groundwater mounding, phosphorus mitigation, surge capacity timed dosing, etc.).

II. D. Permit determination

II. D. 1. Introduction

Before the determination of the system classification and permit type, the discharge point (surface or subsurface) and flow amount must be determined. The following criteria determine the system classification and permit type.

If the system will discharge to a lake, stream, ditch, or other surface feature which conveys water, the system requires a National Pollutant Discharge Elimination System (NPDES) Permit. This is a federal permit issued by the MPCA. This system type is not considered an SSTS.

If the system will discharge to the ground surface, such as a spray irrigation system or rapid infiltration basin, the system requires a SDS Permit. This is a State permit issued by the MPCA. This system type is not considered an SSTS.

Systems which do not qualify under the above criteria are defined as an SSTS or a subsurface system which requires an SDS permit. The regulatory jurisdiction of the subsurface system is dependent on the system size. The following criterion determines the SSTS classification and permit type. It should be noted that if the system does not receive sewage, it is not an SSTS. For these circumstances, please contact the Water Quality Permit Unit of the Industrial Section of the MPCA at 1-800-657-3864.

The owner or owners of an SSTS must obtain an SDS permit from the agency according to chapter 7001 when:

> (1) a single proposed or existing soil dispersal area receives a flow greater than 10,000 gallons per day; or
>
> (2) when all proposed and existing SSTS soil dispersal areas that are under common ownership and within one-half mile of each other have a combined flow greater than 10,000 gallons per day. Flow from an SSTS with low impact to potable water as defined in Minn. R. 7081.0020 subp. 7a is not counted in this determination.

In addition, if an SSTS or group of SSTS may cause adverse public health or environmental impacts; if not regulated under a State permit (such as systems in environmentally sensitive areas, unsubstantiated or unexpected flow volumes, or systems requiring exceptional operation, monitoring, and management), then an SDS Permit may be required. Please see the following for design and permit requirements regarding SSTS: https://www.pca.state.mn.us/water/design.

Note- New systems serving multiple dwellings must be permitted based on the final, fully built system flow (Minn. R. 7081.0120 subp. 2). Any systems serving multiple dwellings, wishing to use measured flow to determine SDS permit requirements after initial permitting, should have at least 75% of final permitted capacity constructed to ensure accurate flow measurement occurs.

Systems not meeting the above rule criteria are regulated under a local permit. Please contact the local permitting authority (either county environmental health or planning and zoning office, township office, or city building official.)

If the design flow for the system is 5,001 gpd to 10,000 gpd, the system is classified as a Mid-sized Subsurface Sewage Treatment System (MSTS) and regulated by a local SSTS ordinance in compliance with Minn. R. ch. 7081. If the design flow for the system is 5,000 gpd or less, the system is classified as an Individual Sewage Treatment Systems (ISTS) and regulated by a local SSTS ordinance in compliance with Minn. R. ch. 7080.

Important note: All multiple family dwellings, cluster of dwellings, or establishments that have the capacity to serve over 20 people that have subsurface discharges, must register as a Class V injection well with EPA. The following link provides information and requirements for registration: https://www.pca.state.mn.us/water/design. Please see Section II A for Class V injection well requirements.

II. D. 2. Flow Determination Protocol for Permit Requirements

The following scenarios exist as it relates to determining permit flows for SSTS. Please review the appropriate for any system in question to determine how permit flow is calculated. Measured flow data that cannot be used to determine the permitting flow for the system in question may be useful to use in conjunction with the estimated flow values for design purposes. In the event that any questions arise please contact the appropriate MPCA SSTS or Wastewater staff for assistance.

A. New system serving multiple dwellings

> For determining permit flow values on new systems serving multiple dwellings please refer to section II. C. 3 above.

B. New system serving other establishment

To determine permit flow values for new systems serving other establishments please refer to section II. C. 4 above.

C. New system for campground or resort after June 14, 2015 or campgrounds and resorts open more than 180 days

Campgrounds and resorts created after June 14, 2015 or campgrounds and resorts that are open more than 180 days should determine permit flow in accordance with section II.C.4 above.

D. System for campground or resort existing as of June 14, 2015 open for 180 days or less

In order to determine permit flow for campgrounds and resorts existing as of June 14, 2015 which are open 180 days or less please refer to Minn. R. 7081.0130 subp. 1a D. Please note that flow measurement plans for campgrounds and resorts existing as of June 14, 2015 which are open 180 days or less must be reviewed, and verified, by the agency.

E. Existing systems serving multiple dwellings

Existing SSTS should determine ISTS, LIST, or MSTS permit flows and thresholds according to Minn. R. 7080.0120.

SDS permit applicability for existing systems serving multiple dwellings should be determined using the following procedure, or according to section II. C. 3. Both the calculation method from section II. C. 3 and the following procedure can be used for SDS permit determination on systems having multiple dwellings connected to one large SSTS, multiple dwellings connected to several small SSTS, SSTS found on individual lots, or any combination of the above. These methods are allowed to be used as the smaller number of units has a higher peaking (safety) factor. If a factor of safety is added to the calculated flow amount that added safety factor flow does not change permit determination according to Minn. R. 7081.0040 subp. 1a item C. Depending on system configuration and permit versus design flows it is possible for SSTS design flows to be greater than 10,000 gpd while permit flows are less that 10,000 gpd; specifically, in instances where Minn. R. 7081.0120 subp. 1 is used to determine permit flow on properties with multiple smaller SSTS.

An MPCA review engineer should be contacted to ensure compliance with all applicable rules, including Minn. R. 7081.0040 subp. 1 D when determining SDS permit applicability for existing systems serving multiple dwellings.

Measured flow data cannot be used if one or more of the following conditions apply:

1) If the flow measuring device has not been calibrated within six months from the start of the measurement
2) If the data is old as compared to the current use of the facility
3) If the facility is planning on a change of use or expansion greater than 25% of measured flow
4) If the facility is not at 75% or greater build-out
5) The peak flow has not been measured in daily measurements
6) If the daily use (e.g. percent occupancy or percent capacity of use) cannot be reasonably estimated

Note – Measured flow data that cannot be used to determine the permitting flow for the system in question may be useful to use in conjunction with the estimated flow values for design purposes.

Method

The method to determine permit flow from measured flow is as follows:

1) Measure the daily flow rate and daily occupancy rate (e.g., percent of dwellings occupied) for 90 consecutive daily flow measurements capturing the maximum use.
2) Weekly measurements must also be done for an additional 40 additional, consecutive, weeks to ensure that daily flow measurements occurred during maximum use.
    a. Flow measurements must be taken only from:
        i. a sewage lift station pump with a runtime meter and counter;
        ii. a sewage flow meter;
3) Flow measurements must be divided by the percent occupancy expressed as a decimal percent.
4) Determine the peak consecutive seven-day flow from values calculated in Step 3.
5) Average the values in Step 4.
6) If appropriate, determine if "SSTS with low impact to potable water" should be evaluated according to Minn. R. 7081.0020 subp. 7a.
7) Subtract any flow from "SSTS with low impact to potable water" from the averaged value in Step 5.
8) This averaged value represents the systems permit flow as it related to SDS permitting

F. Existing systems serving other establishments

Existing SSTS should determine ISTS, LIST, or MSTS permit flows and thresholds according to Minn. R. 7080.0130 subp. 1 B.

SDS permit applicability for existing systems serving other establishments should be determined using the following procedure. Additionally, an MPCA review engineer should be contacted to ensure compliance with all applicable rules, including Minn. R. 7081.0040 subp. 1 D.

Measured flow data cannot be used if one or more of the following conditions apply:

1) If the flow measuring device has not been calibrated within six months from the start of the measurement
2) If the data is old as compared to the current use of the facility
3) If the facility is planning on a change of use or expansion greater than 25% of measured flow
4) The peak flow has not been measured in daily measurements
5) If the daily use (e.g. percent occupancy or percent capacity of use) cannot be reasonably estimated

Note – Measured flow data that cannot be used to determine the permitting flow for the system in question may be useful to use in conjunction with the estimated flow values for design purposes.

Method

The method to determine permit flow from measured flow is as follows:

1) Measure the daily flow rate and daily occupancy rate (e.g., percent campsites occupied) for 90 consecutive daily flow measurements capturing the maximum use.
2) Weekly measurements must also be done for an additional 40 additional, consecutive, weeks to ensure that daily flow measurements occurred during maximum use.
    a. Flow measurements must be taken only from:
        i. a sewage lift station pump with a runtime meter and counter;
        ii. a sewage flow meter;
3) Flow measurements must be divided by the percent occupancy expressed as a decimal percent.
4) Determine the peak consecutive seven-day flow from values calculated in Step 3.
5) Average the values in Step 4.
6) If appropriate, determine if "SSTS with low impact to potable water" should be evaluated according to Minn. R. 7081.0020 subp. 7a.
7) Subtract any flow from "SSTS with low impact to potable water" from the averaged value in Step 5.
8) This averaged value represents the systems permit flow as it related to SDS permitting

It is important to note the differences between using measured flows for determining SDS permit flows versus permit flows as it relates

II. D. 3. Examples

In dealing with small communities it is sometimes difficult to determine the classification of the system (ISTS, MSTS or Large Subsurface Sewage Treatment System (LSTS)) and which type of permit is required (local or state/SDS permit). The following examples are offered to interpret the rule requirements:

Example 1

What kind of permit is needed for a small community with 26 four-bedroom dwellings?

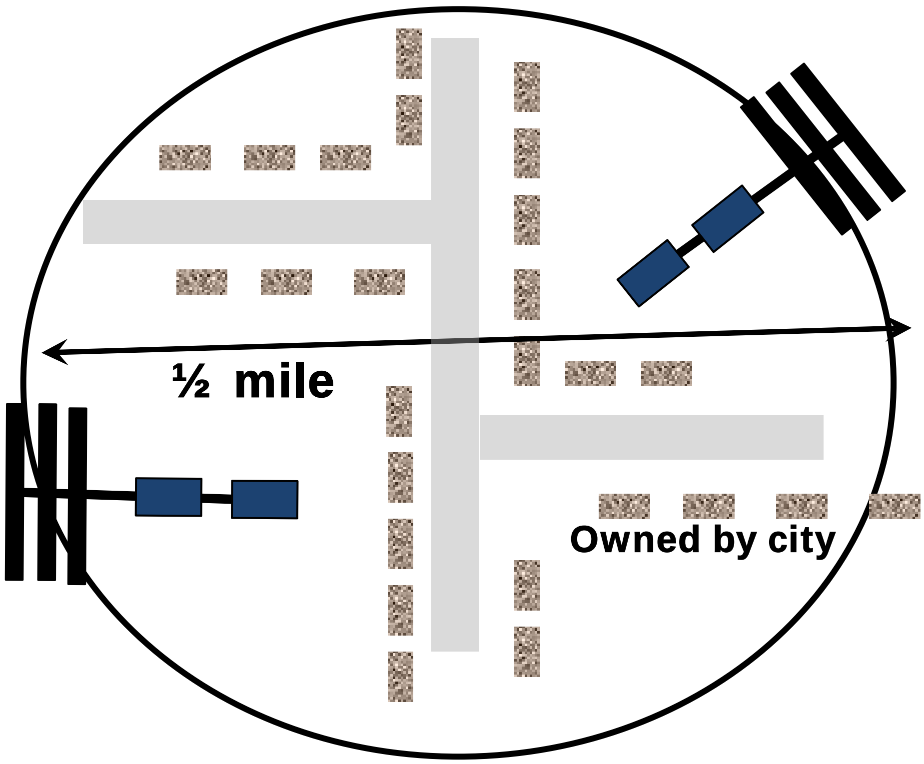
- One cluster – 16 four-bedroom dwellings
- One cluster – 10 four-bedroom dwellings
- Both clusters owned by city
- Soil systems within ½ mile

To calculate the flow to determine the permit, take the top 10 water-using dwellings and add them to the remaining dwelling's flow multiplied by 0.45 as follows:

Dwelling	Flow	Dwelling	Flow
1	600	14	270
2	600	15	270
3	600	16	270
4	600	17	270
5	600	18	270
6	600	19	270
7	600	20	270
8	600	21	270

9	600	22	270
10	600	23	270
11	270	24	270
12	270	25	270
13	270	26	270
Total – 10,320 gpd			

This project needs a SDS (state) permit with 10,320 gpd, with single ownership within ½ mile. However, it should be realized that 16 dwelling cluster will be designed for 9,600 gpd and the 10 dwelling cluster designed for 6,000 gpd (total flow of 15,600 gpd). Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for this system.



Example 2

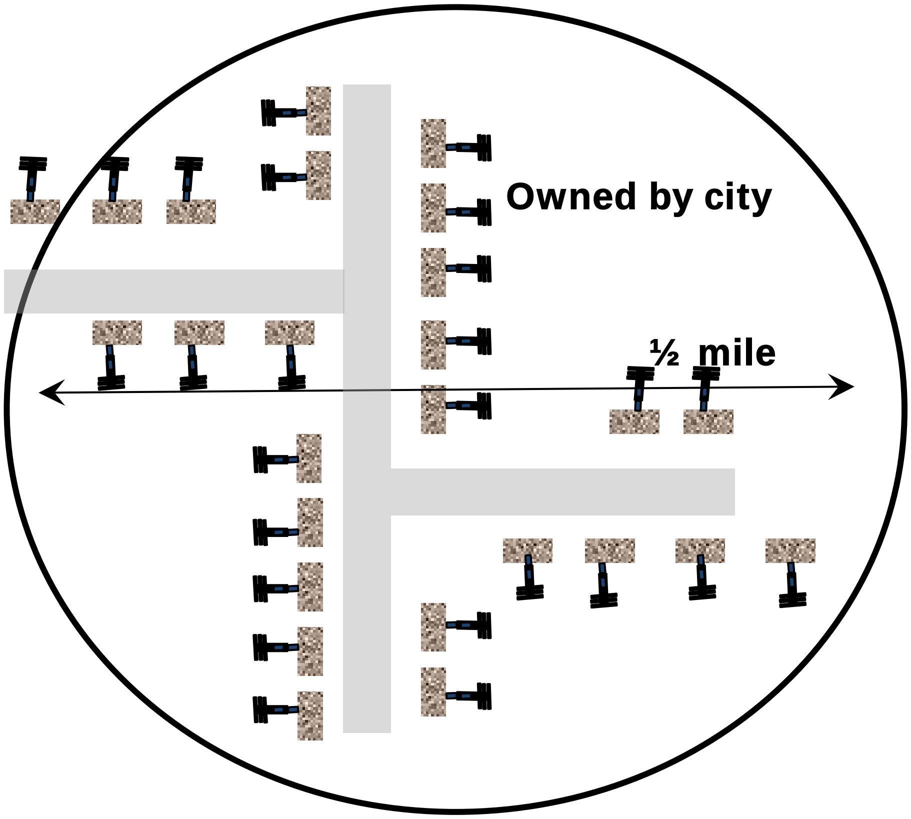
What kind of permit is needed for a small community with 26 dwellings in which the city will own all the individual systems?

- The 26 dwellings all within ½ mile of each other
- All four bedroom dwellings

To calculate the flow to determine the permit, take the top 10 water using dwellings and add them to the remaining dwelling's flow multiplied by 0.45 as follows:

Dwelling	Flow	Dwelling	Flow
1	600	14	270
2	600	15	270
3	600	16	270
4	600	17	270
5	600	18	270
6	600	19	270

7	600	20	270
8	600	21	270
9	600	22	270
10	600	23	270
11	270	24	270
12	270	25	270
13	270	26	270
Total – 10,320 gpd			



This project needs an SDS (state) permit with 10,320 gpd, with single ownership within ½ mile. However it should be realized that all 26 dwelling cluster will be designed for 600 gpd (total flow of 15,600 gpd). Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for this system.

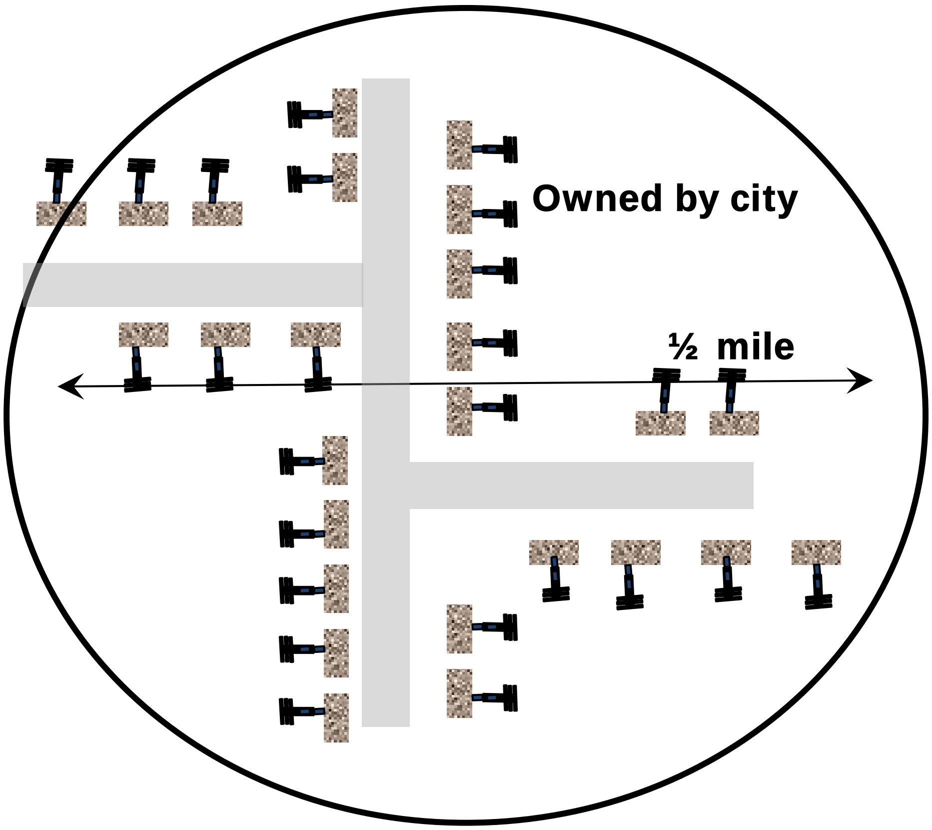
Example 3

What kind of permit is needed for an existing small community with 26 dwellings, at full build out, which the city owns and has an SDS permit for currently?

- The 26 dwellings are all within ½ mile of each other
- All four bedroom dwellings

To calculate the flow to determine the permit – calculate the average of the maximum measured daily flow for a consecutive seven-day period. 90 consecutive daily flow measurements, capturing the maximum use, corrected for occupancy or use according to section II C. 5 must be used for the determination. Also, 40 additional, consecutive, weekly flow measurements validating that the 90 daily measurements captured the maximum system use must be collected.

If the average of the maximum measured daily flow for a consecutive seven-day period is less than 10,000 gpd then then a local permit may be an option contingent on the issuance of a local permit and agreement by the commissioner to cancel the existing SDS permit. Note – flow measurement data generated for making the determination that a local permit may be issued must be submitted to the commissioner for review prior to the local permit issuance.



This project needs an SDS (state) permit with 10,320 gpd, with single ownership within ½ mile. However it should be realized that all 26 dwelling cluster will be designed for 600 gpd (total flow of 15,600 gpd). Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for this system.

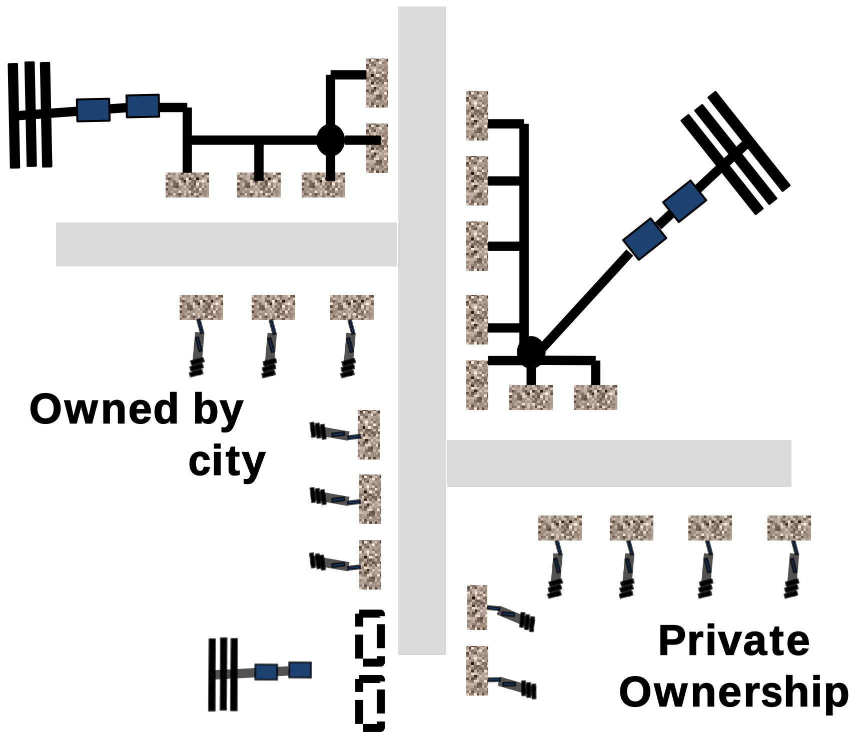
Example 4

What kind of permit is needed for a small community with 20 four-bedroom dwellings?

- § One new cluster of seven existing dwellings
- § One new cluster of five existing dwellings
- § Six new individual systems on existing dwellings - owned by city
- § Two empty lots to be hooked into a third city owned cluster (assume four bedroom dwellings)
- § Six existing individual systems privately owned

Dwelling	Flow	Dwelling	Flow
1	600	14	270
2	600	15	270
3	600	16	270
4	600	17	270

5	600	18	270
6	600	19	270
7	600	20	270
8	600	21	0
9	600	22	0
10	600	23	0
11	270	24	0
12	270	25	0
13	270	26	0
Total – 8,700 gpd			



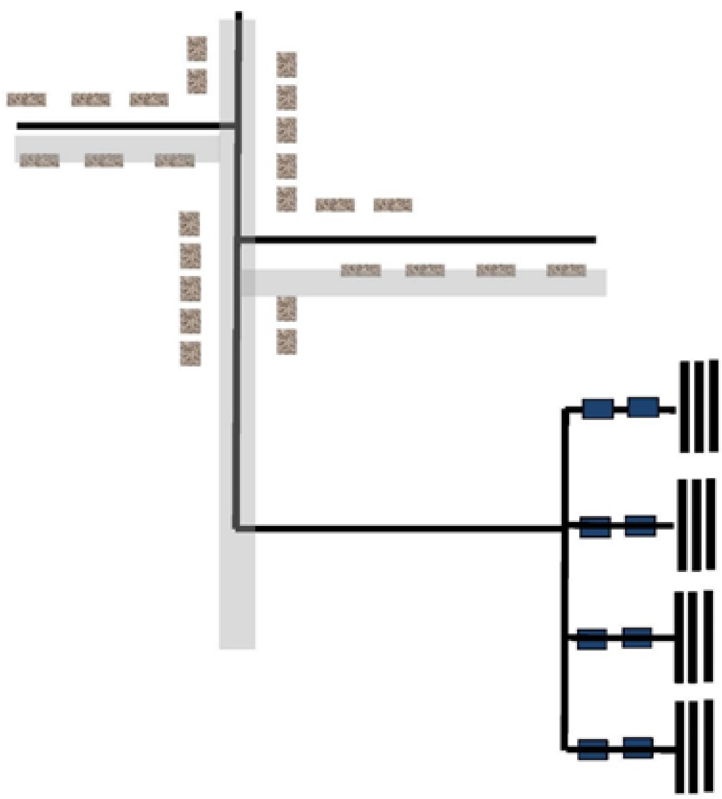
The project does not need a state (SDS) permit. However what is the classification of the systems? It should be understood that the rule establishes criteria when a state permit is needed. However there are no corresponding criteria between MSTS and ISTS. Therefore, the seven-dwelling cluster is sized at 4,200 gpd and is a LISTS. The five-dwelling cluster is sized at 3,000 gpd and is a LISTS. The two-dwelling cluster and the individual systems are ISTS. Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for both the seven and five connection systems.

Example 5

What kind of permit is needed for a new small community system with 20 - four bedroom dwellings?

- One collection system for the 20 dwellings
- Flow split into four tank/soil systems

Dwelling	Flow	Dwelling	Flow
1	600	14	270
2	600	15	270
3	600	16	270
4	600	17	270
5	600	18	270
6	600	19	270
7	600	20	270
8	600		
9	600		
10	600		
11	270		
12	270		
13	270		
Total – 8,700 gpd			



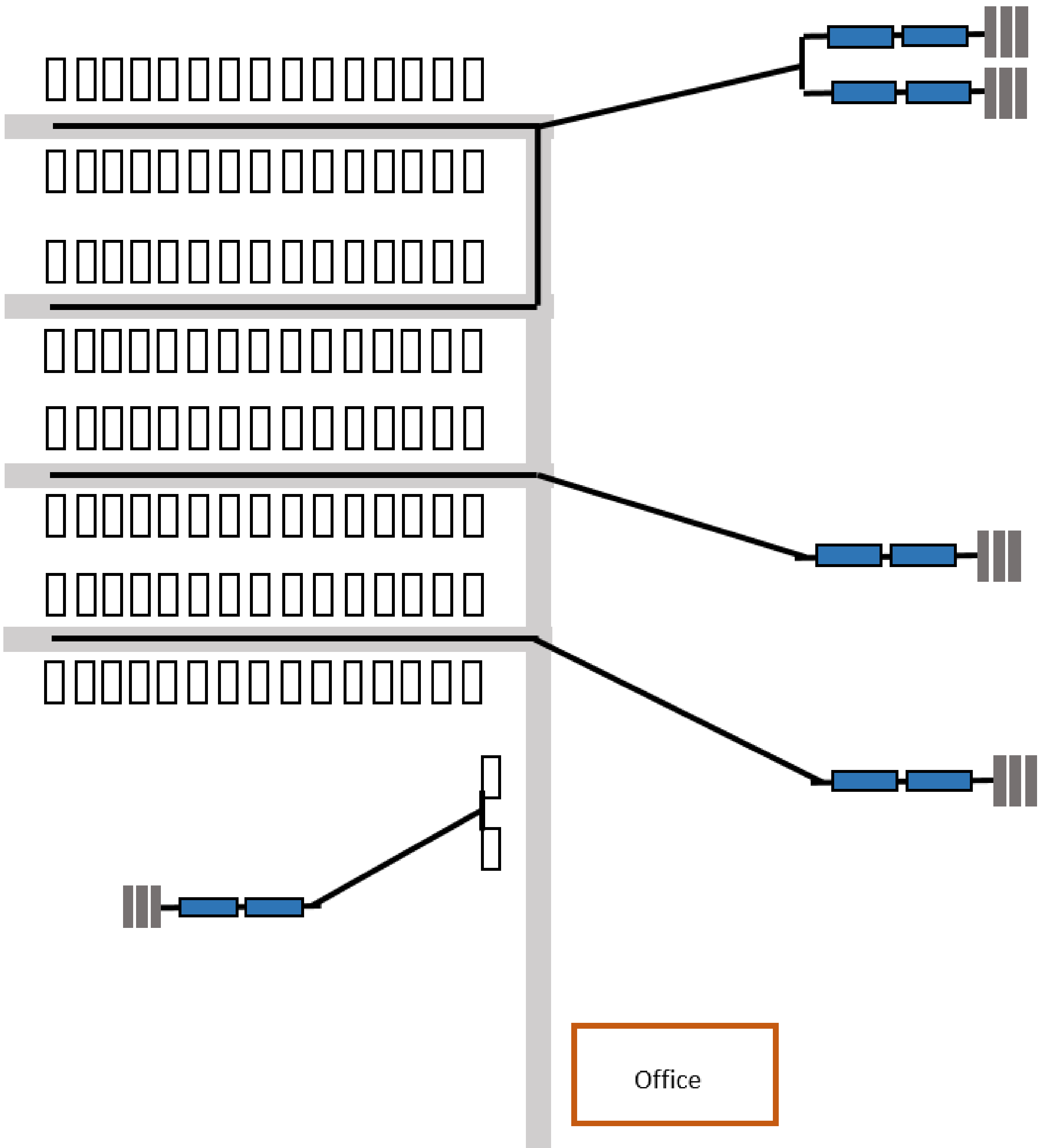
Since one of the components receives 8,700 gpd (the collection system), the system is classified as an MSTS. Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for this system.

Example 6

What kind of permit is needed for a new campground with 122 sewer hook-up campsites?

§ Four collection systems for the 122 campsites

- Flow split into four tank/soil systems all drainfield areas are not within ½ mile of each other
- Total flow is 12,200 gpd
- One system serving 60 campsites
- Two systems serving 30 campsites each
- One system serving 2 campsites

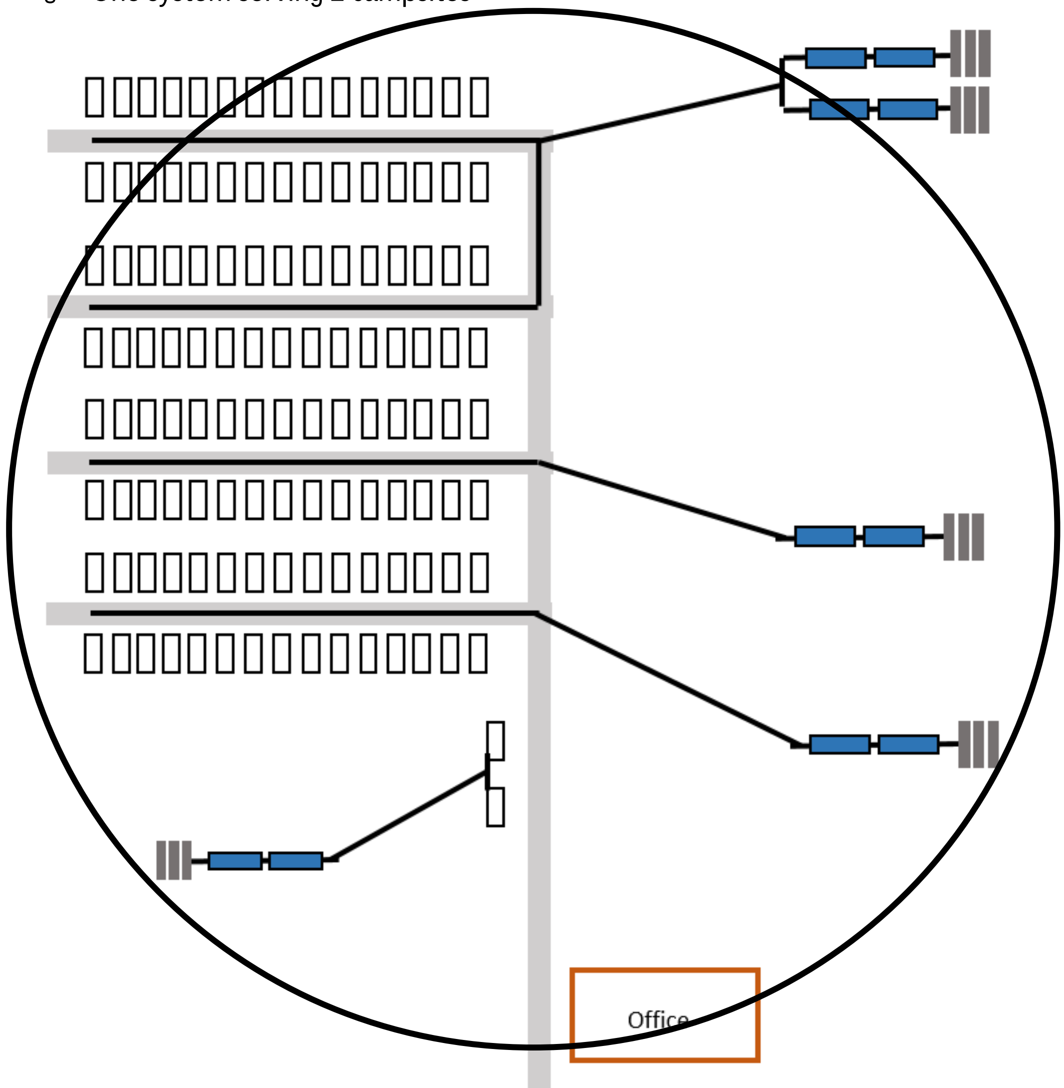


None of the components receives >10,000 gpd and the sum of the flows within ½ mile is not greater than 10,000 gpd therefore this facility does not need an SDS permit. This facility has one ISTS, two LISTS, and one MSTS on the property. Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for the two LIST systems and the MSTS system.

Example 7

What kind of permit is needed for a new campground with 122 sewer hook-up campsites?

- Four collection system for the 122 campsites
- Flow split into four tank/soil systems all drainfield areas within ½ mile of each other
- Total flow is 12,200 gpd
- One system serving 60 campsites
- Two systems serving 30 campsites each
- One system serving 2 campsites

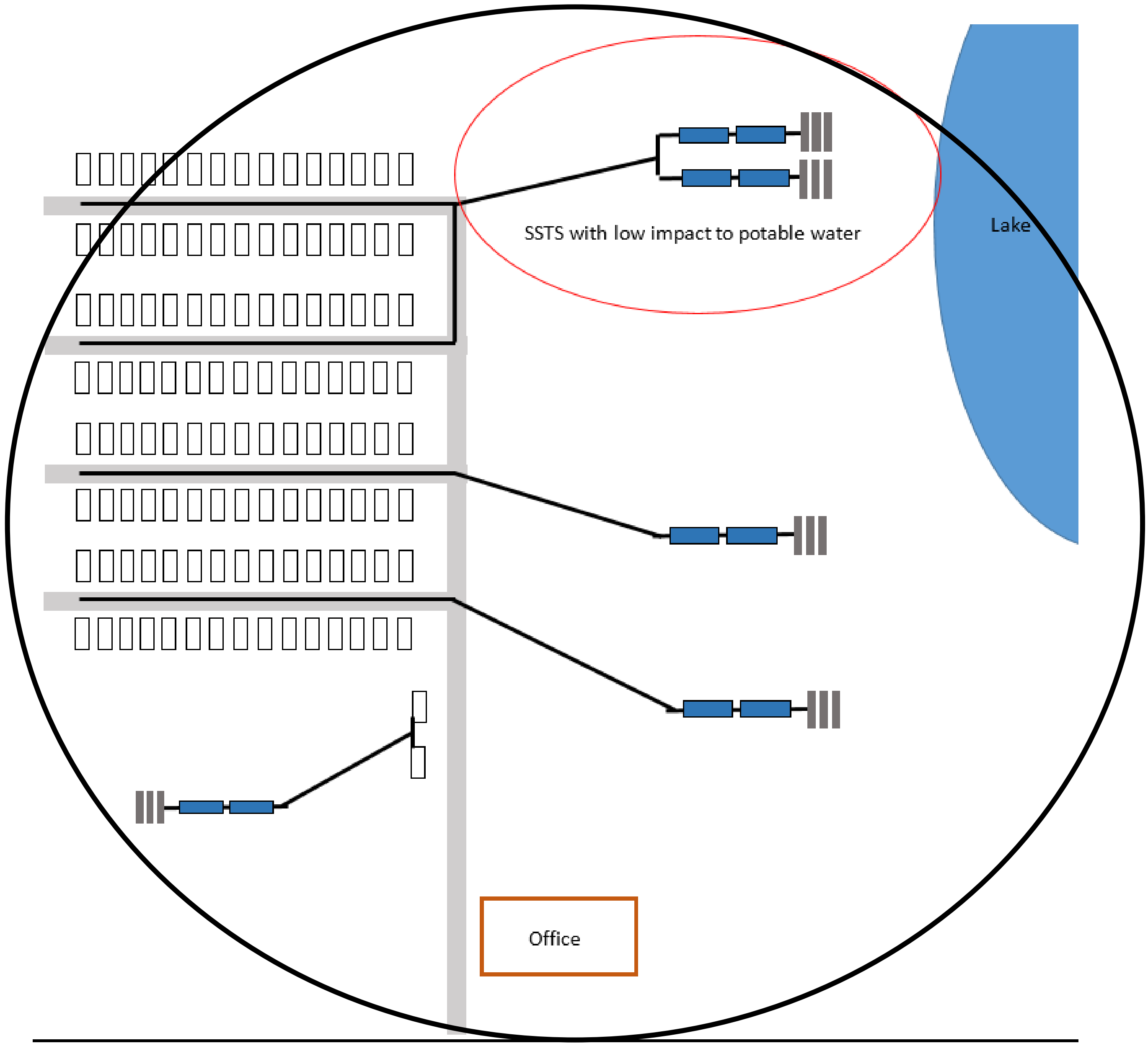


While none of the components receives >10,000 gpd the sum of the flows within ½ mile is greater than 10,000 gpd therefore this facility needs an SDS permit. Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for the two LIST systems and the MSTS system.

Example 8

What kind of permit is needed for a new campground with 122 sewer hook-up campsites?

- Four collection system for the 122 campsites
- Flow split into four tank/soil systems all drainfield areas within ½ mile of each other
- Total flow is 12,200 gpd
- One system serving 60 campsites – designated as an SSTS with low impact to potable water by an AELSLAGID professional
- Two systems serving 30 campsites each
- One system serving 2 campsites



While none of the components receives >10,000 gpd and the sum of the flows within ½ mile is greater than 10,000 gpd the flow from the SSTS with low impact to potable water is not used to calculate SDS permit applicability. Therefore, the flow for permit determination is 6,200 gpd and an SDS permit is not required. This facility has one ISTS, two LISTS, and one MSTS on the property. Please note that I&I (Minn. R. 7081.0140) would also be included in the permit flow for the two LIST systems and the MSTS system.

II. E. Site suitability assessment

II. E. 1. Introduction

The site assessment consists of a preliminary site evaluation and field evaluations (Minn. R. 7080.1700). These assessments are to adequately assess the site conditions for sewage treatment and dispersal by SSTS.

II. E. 2. Preliminary site evaluation

The preliminary site assessment shall consist of gathering the following information about the following (extracted from Minn. R. 7080.1710):

a. Design flow for the dwelling, dwellings, or other establishments; proposed or existing
b. Water supply wells within 100 feet of the proposed ISTS or MSTS
c. Noncommunity transient public water supply wells within 200 feet of the proposed ISTS if alternative local standards are in effect
d. A community or noncommunity, nontransient water supply in a drinking water supply management area if alternative local standards are in effect
e. Existing and proposed buildings or improvements on the lot or site
f. Buried water supply pipes within 50 feet of the proposed system
g. Easements on the lot or site
h. Current and past land use (if can be determined)
i. The ordinary high water level of public waters, if the public water is within 150 feet of the proposed system
j. Floodplain designation and flooding elevation from published data or data that is acceptable to and approved by the local unit of government or the Department of Natural Resources, if applicable
k. Property lines
l. All required setbacks from the proposed system
m. The soil characteristics at the proposed soil treatment and dispersal areas as obtained from the soil survey report, if available, including the soil map, map units, landscape position, parent material, flooding potential, slope range, periodically saturated soil level, depth to bedrock, texture, color, depth to redoximorphic features, and structure and consistence of soil horizons
n. A township, range, and section number and other unique property identifiers as required by local government and lot or site dimensions
o. Names of property owners
p. The inner wellhead management zone or wellhead protection area of a public water supply, if applicable
q. The lot or site dimensions and estimated size of the soil dispersal system(s)
r. For systems over 5,000 gallons per day, a determination if the soil dispersal system(s) will be within 500 feet of the ordinary high water level of a surface water
s. Advanced designers are encouraged to check with local units of government for any special considerations for Well Head Protection Areas

II. E. 3. Field site evaluation

The field site assessment shall consist of gathering the following information about the site (extracted from Minn. R. 7080.1720). For systems with a design flow of greater than 5,000 gpd the designer must consult with the local unit of government to determine the scope of the evaluation.

a. Lot or site boundaries shall be established to the satisfaction of the property owner. Lot or site improvements, required setbacks, and easements must be identified.
b. The percent and direction of the slope at the proposed system location.
c. Dominate vegetation types (e.g, water loving plants or non-water loving plants).
d. Geologic parent material(s).

e. Any evidence of cut or filled areas or disturbed or compacted soil.
f. The flooding or run-on potential.
g. A geomorphic description.
h. A minimum of three soil observations for both the initial and replacement soil dispersal area with at least one soil observation performed in the portion of the soil treatment dispersal area anticipated to have the most limiting conditions. A minimum of three soil observations are required for the total area if the initial and replacement soil treatment areas are adjacent.
i. The soil observations can occur via a hand auger, probe or soil pit. If the system is to be sized based on soil texture/structure and consistence, the observation method must allow for examination of undisturbed soil structure. If percolation tests are also used, the most conservative soil hydraulic loading rate (SHLR) should be used for the design.
j. For systems over 5,000 gpd, the observations must be made from a soil pit. Required safety precautions must be taken before entering soil pits.
k. The soil observations must be conducted within or on the borders of the proposed site.
l. Underground utilities must be located before soil observations are undertaken.
m. The minimum depth of the soil observations must be to the periodically saturated layer, to the bedrock, or three feet below the proposed depth of the system, whichever is less. Other soil characteristic need to be described that will affect the design of the system; such as hardpans or restrictive layers.
n. All characteristics must be classified according to the Field Book for Describing and Sampling Soils, which is incorporated by reference under Minn. R. 7080.1100, subp. 36.
o. Each soil profile observed must be evaluated under adequate light conditions with the soil in a moist and unfrozen state.
p. The depth of each soil horizon must be measured from the ground surface. Soil horizons are differentiated by changes in texture, color, redoximorphic features, bedrock, structure, consistence, and any other characteristic that affects water movement or treatment of effluent;
q. Soil colors shall be described for each horizon according to the Munsell Soil Color Chart
r. Observed standing water levels must be recorded.
s. Determination of loading rate and absorption area size by texture, structure and consistence or percolation test (or other approved hydraulic test). For systems over 5,000 gpd, both soil morphology and water measurement methods must be used.
t. The proposed soil treatment and dispersal area site shall be protected from disturbance, compaction, or other damage by staking, fencing, posting, or other effective method.

II. E. 4. Site evaluation interpretation

The information gathered must be interpreted for system design. An interpretation worksheet can be found in Appendix L.

II. E. 5. Site evaluation reporting

The information gathered for the preliminary and field site evaluations shall be reported. The report shall also contain the following:

a. Any construction related issues such as rocks, tree stumps, high clay contents, slope and topography.

b. An initial recommendation of the type and number of soil dispersal areas, size of those areas, system layout, geometry, and distribution methods used to mitigate concerns from groundwater mounding and nitrogen impacts to groundwater.
c. The elevation of the limiting layer (periodically saturated soil or bedrock) and elevation of the bottom of the dispersal distribution media.
d. Any special design considerations (coarse fragments, floodplain, disturbed soil, slow percolation rate, or saturated hydraulic conductivity measurements, etc.).
e. Impacts from upslope run-on areas.
f. Uniformity of the soil conditions.
g. Future surrounding land use changes (if known).
h. For systems over 5,000 gpd, the location of the system on a United States Geological Survey quadrangle and the area within one mile.
i. A map drawn to scale or dimensioned showing the information gathered from the evaluations. For systems over 5,000 gpd, the map must include two-foot contour lines.
j. A narrative of the weather conditions during the field evaluation
k. Any problems encountered and how they were resolved.

II. F. Assessing nitrogen impacts to aquifers

II. F. 1. Introduction

A compliant SSTS will convert a large percentage of the total nitrogen in the sewage to nitrate. This conversion occurs in advanced treatment devices or in the soil treatment zone. Once the nitrate-laden effluent reaches the groundwater, concerns arise about human ingestion of the nitrate in water-supply wells. Therefore, groundwater aquifers, which will be adversely impacted by inputs of nitrogen, need to identified and protected. The term "aquifer" means any unconsolidated material or rock capable of producing water to supply a well (Minn. R. 4725.0100 subp. 21).

In order to mitigate the effects of nitrogen on aquifers, an understanding of the generation, treatment and dilution of nitrogen from SSTS is important along with protective features that may be present in the soil or geology. A list of mitigation factors is provided below:

a. Generation of nitrogen - most of the nitrogen is generated in the toilet wastes.
b. Treatment of nitrogen – nitrogen can be treated in the following ways:
    1) Nitrogen pretreatment device (see MPCA product registration list)
    2) Soil denitrification – Please refer to: https://decentralizedwater.waterrf.org/research_project_DEC1R06A.asp
    3) Natural denitrification in groundwater - Please refer to: Estimating Ground Water Sensitivity to Nitrate Contamination - Fact Sheet
c. Dilution of nitrogen – nitrogen can be diluted in the following ways:
    1) Dilution by precipitation over system.
    2) Dilution by precipitation over downgradient area.
    3) Dilution by upgradient groundwater (if dilution capacity exists).
d. Protective processes – The soil/geology can protect the aquifer in the following ways:
    1) Groundwater/effluent mixture discharged into surface water at property boundary.

2) Groundwater/effluent mixture moves laterally to riparian soil denitrification area at or before property boundary.
3) Slow time-of-travel to aquifer (with possible denitrification/dilution/dispersion).
4) Separation distance from water supply wells.

These factors will be used to determine if an aquifer will be impacted.

II. F. 2. Aquifer impact assessment for ISTS with a flow between 2,501 gpd and 5,000 gpd (LISTS)

a. Criteria

An ISTS with a flow between 2,501 and 5,000 gpd (a.k.a. large ISTS or LISTS) must assess the impacts to the aquifer beneath the system from nitrogen. If the aquifer is found to be adversely impacted, the system must employ a Nitrogen reduction Best Management Practice (NBMP) (Minn. R. 7080.2150, subp. 4).

There are two ways that a determination can be made to determine if an aquifer will be impacted. One method is using the step-by-step methodology in this design guidance. The second method is to hire an AELSLAGID Board Professional (BP). The following methodology has been developed for use by advanced designers. If an unfavorable answer is derived by this method the system must be redesigned or hire an AELSLAGID professional.

b. Theory

For LISTS the method to determine what constitutes an adverse impact to an aquifer is based on the presence or absence of a protective layer above the aquifer. In addition constraints are to be placed on location of water supply wells and groundwater recharge areas.

c. Methodology for advanced designers

The aquifer impacts from nitrogen assessment for systems between 2,501 and 5,000 gpd is a desktop approach along with a shallow soil boring to determine the potential for an LISTS to unacceptably impact an aquifer with nitrate nitrogen. This assessment is accompanied by a worksheet with instructions which contains protocols, location of the necessary information, and definitions. Please refer to Appendix I. Before beginning this assessment, contact the local unit of government to see if any sensitive groundwater areas have been locally designated.

Criteria for advanced designers to determine potential impacts to an aquifer for SSTS with a flow between 2,501 gpd to 5,000 gpd (LISTS)

1) The proposed site for the dispersal system is **not suitable** if a public water supply well is located within 200 feet of the proposed soil dispersal system.
2) An aquifer is considered to be adversely impacted, and an NBMP must be employed, if one or more of the following is true:
   a. If any private water supply wells are within 200 feet of the proposed soil dispersal system.
   b. If future private water supply wells could be placed within 200 feet of the proposed soil dispersal system.
   c. If the proposed soil dispersal system is to be located in a Drinking Water Supply Management Area with a high sensitivity rating.
   d. If the “Aquifer Assessment (MN)” rating is sensitive as determined from the Web Soil Survey for the majority of the land area, within a quarter mile radius of the proposed soil dispersal system (see instruction sheet).

e. If the sensitivity rating is "sensitive" for the majority of the land area, within a quarter mile radius of the proposed soil dispersal system as determined by any published sensitivity mapping.

f. If the soil texture of the proposed soil dispersal system (as determined by multiple field borings), six feet below the bottom of the proposed soil dispersal system is a United States Department of Agriculture (USDA) texture of sand (i.e., fine sand, loamy sand, etc.)

d. Results and next steps

If the assessment determines that an NBMP must be employed, please go to: Nitrogen Reduction Best Management Practice Selection Process in Section III H. Employing one or more of these Best Management Practices (BMPs) will satisfy the rule requirement. If the assessment determines that an NBMP must be employed or the site is not suitable, an AELSLAGID BP can be hired to conduct a more thorough soil and groundwater investigation to determine impacts. Please see Section II. F. 4.

II. F. 3. Aquifer impact assessment for MSTS (flow between 5,001 gpd and 10,000 gpd)

a. Criteria

An MSTS (flow between 5,001 and 10,000 gpd) must be assessed if the aquifer beneath the system will be adversely impacted from nitrogen. The aquifer is considered impacted if the concentration of total Nitrogen (N) at the property boundary or nearest receptor (at any depth in the soil/groundwater), whichever is closest, exceeds the 10 mg/l total nitrogen concentration limit (7081.0080 subp. 4 item D).

There are two ways that a determination can be made to determine if an aquifer will be impacted. One method is using the methodology in this design guidance. The second method is to hire an AELSLAGID BP.

The following methodology has been developed for use by advanced designers. If an unfavorable answer is derived by this method the system must be redesigned or hire an AELSLAGID professional.

b. Definitions

The following meanings of terms used in this section are provided below:

1) Aquifer - "Aquifer" means any unconsolidated material or rock capable of producing water to supply a well (Minn. R. 4725.0100 subp. 21).

2) Lawn Area - "Lawn Area" for trench systems means the bottom absorption area plus the area between the trenches. For seepage beds and at-grade system, lawn area means the bottom absorption area, and for mound systems, lawn area means the natural soil area designed to absorb effluent.

c. Modeling nitrogen impacts for advanced designers

The method used by advanced designers includes well setbacks, determination of contaminant inputs, system design, dilution from precipitation and estimated soil denitrification rates to effectively treat and dilute the effluent to meet 10 mg/l total N before discharge into the uppermost saturated zone (perched, periodic or regional watertable). This model assumes that all the effluent will recharge an aquifer. If not treated/diluted to a 10 mg/l total N or less in the uppermost saturated layer then the aquifer is considered to be adversely impacted. If the aquifer is found to be impacted by the simple methodology, the system design will need to be modified to meet 10 mg/l total N goal, or the soil and geologic conditions must be more rigorously assessed to determine their treatment or dilution capacity.

d. Methodology for advanced designers

1) A proposed soil dispersal system must not be placed within 200 feet of any drinking water supply well.
2) Constraints must be in place to prohibit future drinking water supply wells to be within 200 feet of the soil dispersal system.
3) A proposed soil dispersal system must not be placed in a Drinking Water Supply Management Area with a high or very high sensitivity rating.
4) The following prescriptive methods below are offered to reduce N concentrations. It is very likely that multiple methods must be employed to meet the 10 mg/l total N treatment goal. The assessment steps should be conducted in the following order:

   a) Employ an MPCA Registered N treatment device. In addition, to qualify as treatment, the operating permit must specify adequate operation, maintenance and sampling of the nitrogen reducing treatment device to ensure adequate reductions.

      To determine the treatment effectiveness of the N treatment devices and the anticipated effluent concentration of total N, please refer to: https://www.pca.state.mn.us/water/registered-treatment-products

      The concentration of total N discharged from the treatment device will be assessed for treatment in the soil in item ii below.

   b) The soil treatment zone provides nitrification and possibly some denitrification of sewage effluent. The chart found in Appendix O provides the estimated percentage of the total nitrogen remaining after passing through the designed soil treatment zone (unsaturated zone) depth.

      Lastly, the estimated concentration exiting the soil treatment zone will be used as the starting point for the final reduction step of nitrogen dilution from precipitation in Step c):

   c) Calculate a reduction from dilution from precipitation to the property boundary or nearest receptor, whichever is closest. The assessment will be based on the following dilution mass balance and soil denitrification formula

$$\text{N concentration of treated effluent (mg/l)} = \frac{(Cs * Qs) + (Ci * Qi)}{Qs + Qi}$$

      Where Cs is the concentration of total N in the sewage effluent to be discharged from the soil treatment zone in mg/l, Qs is the quantity of sewage in gallons/year, Ci is the concentration of total N in the annual infiltration recharge into the groundwater, and Qi is the quantity of infiltration recharge into the groundwater over the soil dispersal system and to the nearest property boundary in gallons per year.

      A step-by-step method to calculate the N concentration of the treated effluent in found in Appendix O.

e. Results and next steps

If the N concentration of total N in the treated effluent is calculated to be greater than 10 mg/l, the mitigation approaches are to redesign the system and repeat the above calculation to determine if the final concentration is 10 mg/l total N or less. Another option is to hire an AELSLAGID BP to assess if a concentration of total N will be 10 mg/l total N or less at the property boundary or nearest receptor, whichever is closest. An AELSLAGID BP can also be used to make a determination of impact if the system fails to meet the well setbacks established for advanced designers or systems that are located within a Drinking Water Supply Management Area with a high or very high sensitivity rating. Please refer to section II. F. 4.

II. F. 4. Aquifer impact assessment conducted by a AELSLAGID Board Professional

Another option to determine N impacts from a LISTS or MSTS to an aquifer is to conduct a more rigorous determination of the impacts to the aquifer. This more rigorous assessment must be made by an AELSLAGID BP with experience in environmental groundwater assessments.

a. LISTS assessment

   The BP must determine if a protective layer exist. It is recommended that the Level II assessment methodology stipulated in the DNR publication Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota be used. It can be found at: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/sensitivity.html#references. Adequate information about the site conditions must be gathered to make this assessment.

b. MSTS assessment

   The BP must determine whether concentrations of total N of the aquifer will be 10 mg/L total N or less at the property boundary or nearest receptor, whichever is closest.

   Enhanced assessment - In order to aid the BP in making the above assessments, the following list of criteria is offered as a guide to conduct a more rigorous determination of the impacts to the aquifer:

   1) Determination of the general geology of the area.
   2) Determination of the regional groundwater setting, and aquifers used for water supply.
   3) Determination of the general site hydrology characteristics, including, but not limited to, identification and estimated depth measurements to geologic units and aquifers, and identification of groundwater confining strata.
   4) Assessment of all nearby water supply wells with a minimum assessment of well locations and casing depths from well construction log records.
   5) Determination of lateral movement of shallow groundwater to surface water at or within the property boundary.
   6) Estimated or measured soil denitrification rates.
   7) Determination of the denitrification rates in groundwater. See: Estimating Ground Water Sensitivity to Nitrate Contamination - Fact Sheet
   8) Determination of the denitrification rates in riparian areas (if the discharge is into a riparian area before the property boundary).
   9) Design and employ a denitrification wall.
   10) Enhanced determination of dilution by precipitation over the system.
   11) Determination of the dilution by upgradient groundwater.
   12) Determination of groundwater flow direction and discharge point. However, careful consideration needs to be given on any changes to the native groundwater direction due to mounding of the groundwater beneath the system and the groundwater drawn- down by nearby wells, and consideration of any future use of downgradient groundwater.

   A report should be prepared by the AELSLAGID BP and submitted with the design explaining the impacts to the aquifer and how that determination was arrived. The BP should be prepared to answer questions that are posed by the local unit of government during the permitting process.

Lastly, the local unit of government may require monitoring of the groundwater to determine impacts. The BP must design the monitoring network for N impacts.

II. F. 5. Literature reviewed

Metcalf and Eddy, 3rd Edition Table 3-16, p. 109.

Minnesota Pollution Control Agency. Minnesota Rules Chapter 7081 – Mid-sized Subsurface Sewage Treatment Systems, Office of the Revisor of Statutes – 2008.

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

Minnesota Department of Natural Resources. Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota. Minnesota Department of Natural Resources, June 1991.

H. O. Pfannkuch. Geological Sensitivity Assessment of Groundwater System; A Pilot Study Minnesota Department of Health. Minnesota Rules Chapter 4717 – Environmental Health, Office of the Revisor of Statutes – 2008.

Minnesota Department of Health. Minnesota Rules Chapter 4725 – Wells and Borings – Office of the Revisor of Statutes – 2008.

United States Environmental Protection Agency. Onsite Wastewater Treatment Systems Manual, February 2002 pages 3-29 – 3-30.

Scott County Minnesota – Summary and Evaluation, July 1998.

Minnesota Pollution Control Agency. Ground Water Contamination Susceptibility in Minnesota, Minnesota Pollution Control Agency, July 29, 1989.

Minnesota Department of Health. Class V Sensitivity, Minnesota Department of Health, December 20, 2005.

Water Environment Research Foundation. State of the Science: Review of Quantitative Tools to Determine Wastewater Soil Treatment Unit Performance – 2009.

Water Environment Research Foundation. Quantitative Tools to Determine the Expected Performance of Wastewater Soil Treatment Units – 2010.

II. G. Groundwater mounding assessment

II. G. 1. Introduction

Research has indicated that sewage effluent discharged into the soil from subsurface sewage treatment systems may not disperse laterally at a fast enough rate to prevent an artificial rise in the water table beneath the operating soil dispersal system. This phenomenon is termed 'groundwater mounding' and causes increased concerns for larger systems that serve multiple-unit housing developments or large commercial establishments.

SSTS add substantial amounts of water into the soil over the normal recharge to the groundwater from precipitation. The chart below specifies the amounts:

Soil texture	Approximate natural recharge to groundwater (in/day)	Recharge to groundwater from absorption area* of SSTS - based on 100% of design flow (in/day)
Sand	0.3	2.0
Sandy loam	0.02	1.2
Loam	0.01	1.0
Silt loam	0.01	0.8
Clay loam	0.01	0.7

* Used absorption area only, not based on the total lawn area.

The daily application rate is fairly low as compared to the saturated hydraulic conductivity of the soil as shown in the next chart:

Soil texture	Typical saturated hydraulic conductivity (in/day)	Effluent loading rate from SSTS - based on 100% of design flow (in/day)
Sand	960	2
Sandy loam	30	1.2
Loam	10	1.0
Silt loam	10	0.8
Clay loam	1	0.7

Groundwater mounding reduces the thickness of the unsaturated soil beneath the system. This is problematic for the following reasons:

- Reduced removal of pathogenic organisms.
- Reduced breakdown of the biological clogging mat.
- Higher potential for surface breakout of effluent.

Groundwater modeling has indicated there are increased concerns for larger systems that serve multiple-unit housing developments or large commercial establishments. This artificial rise in saturation may be a concern on both the periodically saturated soil layer (the layer typically used for design of the vertical separation distance) and the deeper regional water table.

The determination of saturated hydraulic conductivity is one of the most important inputs in the determining the height and extent of the groundwater mound. Therefore, the chosen method to determine the saturated hydraulic conductivity should be carefully considered. An erroneous saturated hydraulic conductivity value can drastically affect the predicted mound height and extent.

Groundwater mounding must be determined for mid-sized subsurface sewage treatment systems which have a design flow between 5,001 to 10,000 gpd (7081.0180 subp. 1 item I), and it is recommended that groundwater mounding also be determined for smaller systems.

Groundwater mounding for ISTS (1 to 5,000) gpd can be determined by the ANTM model. Applying this model gives the advanced designer a starting point for the application of mounding values. This tool estimates the potential mounding applying the same design values used in chapter 7080 and can be used to determine mounding on Type IV systems with reduced separation. In addition groundwater mounding is mitigated in chapter 7080 by restricting the contour loading rate to 12 gallons/day/linear foot.

This document was prepared to provide advanced SSTS designers with an analytical method to determine the height of a potential groundwater mound.

II. G. 2. Definitions

ASTM – (American Standard of Testing and Materials) American Standard of Testing and Materials International is a voluntary standards development organization for technical standards for materials, products, systems, and services at: http://www.astm.org/ABOUT/aboutASTM.html#_1

County geologic atlases - A County Geologic Atlas is a systematic study of a county's geologic and ground-water resources - Geologic Atlas are found at: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/index.html

Regional hydrogeologic assessment - A Regional Hydrogeologic Assessment similar to an atlas in that both geology and groundwater are studied. A regional assessment covers four to nine counties. A regional assessment emphasizes near-surface geology, groundwater properties, and sensitivity to pollution. These documents are found at: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/index.html

Lawn area - The lawn area for trenches is the bottom area absorption surface plus the spaces between the trenches. Lawn area for seepage beds and at-grades is the bottom absorption area. Lawn area for mound systems is the native soil absorption area.

Loading rate - The effluent loading rate from the system, for all mounding determinations, is calculated by dividing the average flow (gpd) value by the lawn area size (sq. ft.) for trenches and native soil absorption area for beds at-grades and mounds.

Constant head permeameter - A sampling device with a specific height and cross-sectional area which is attached to a constant-head reservoir. Water flows through the sampler at a constant rate. The discharge through the sampler is measured by measuring the volume of water that flows through the sample over a period of time.

Saturated hydraulic conductivity (Ksat) – Saturated hydraulic conductivity measures of the rate at which water infiltrates the soil under saturated conditions

Specific yield – Specific yield is the ratio of the volume of water that a rock or soil will yield by gravity drainage to the total volume of the rock or soil

Thickness of the saturated layer – The thickness of the saturated layer is the depth between the uppermost saturated layer to the barrier condition.

Unified soil classification system - The Unified Soil Classification System is a soil classification system used in engineering and geology disciplines to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials, and is represented by a two-letter symbol as follows:

First and /or second letters		Second letter	
Letter	**Definition**	**Letter**	**Definition**
G	Gravel	**P**	Poorly Sorted (uniform particle size)
S	Sand	**W**	Well Sorted (diverse particle size)
M	Silt	**H**	High Plasticity
C	Clay	**L**	Low Plasticity
O	Organic		

Well log – A well log is the record of the character of a soil/geologic formation penetrated by a drill hole during the installation of a well.

II. G. 3. Site conditions that affect mounding

Site conditions that affect mounding are found in Table IIA below:

Table IIA – Site conditions that affect mounding

Site parameter	Condition	Mounding potential
Depth to Periodically Saturated Soil	Shallow	Higher
	None	Lower
Depth to Regional Watertable	Shallow	Higher
	Deep	Lower
Soil Texture (hydraulic conductivity)	Non- Sandy	Higher
	Sandy	Lower
Restrictive Layers	Thick, Shallow, and/or Slow Permeability	Higher
	None	Lower
Slope	Flat	Higher
	Sloping	Lower
Landscape Position	High Run-on (swales, foot slopes, etc…)	Higher
	Low Run-on	Lower
Soil Dispersal System Geometry	Short and Wide along Contour	Higher
	Long and Narrow along Contour	Lower
	Single hill slope	Higher
	Multiple hill slopes (crown of hill with slopes in both directions)	Lower

II. G. 4. Two mounding determinations must be considered - MSTS

There are two hydraulic conditions in Minnesota which need to be evaluated for potential for mounding; 1) the potential development of an effluent mound in an unsaturated restrictive layer, and 2) groundwater mounding on the saturated zone.

II. G. 5. Effluent mounding in an unsaturated restrictive layer – MSTS

a. Introduction

In some situations in Minnesota there may be a hydraulically restrictive layer between the bottom of the soil dispersal system and the upper most saturated layer. If this situation exists, an assessment must be made to determine whether the addition of sewage effluent will create a new saturated layer above (or in) this restrictive layer. A restrictive soil layer is defined as a layer of soil below the trenches or absorption bed having slower hydraulic characteristics than the loading rate of the effluent.

It should be noted that additional effluent from a SSTS is added in relatively small daily increments and usually added at a much lower rate than the saturated hydraulic conductivity (Ksat) of most soils in Minnesota. This is because in Minnesota the size of the soil dispersal system is based on a very restrictive clogging mat which has a low Ksat value. Therefore, unless the effluent loading rate from the system (e.g., clogging mat) is greater than the hydraulic conductivity of the identified soil restrictive layer, a perched mound will not form.

b. Determining the height of an effluent mound on a unsaturated restrictive soil layer

1) Preliminary evaluation
An evaluation to determine the potential for an effluent mound on an unsaturated restrictive soil layer consists of gathering and evaluating the following information:

- Flow amount (gallons/day)
- System type (trench, bed, at-grade, mound)
- Soil dispersal system size (lawn area for trench, absorption area for beds and at-grades and native soil absorption area for mounds)
- Effluent loading rate (gallons/ft^2/day which needs to be converted to ft^3/ft^2/day - aka ft/day)
- Soil dispersal system width (ft)
- Saturated hydraulic conductivity of the upper soil material (K_{sat}) (ft/day)
- Saturated hydraulic conductivity of the perceived restricting layer (K_{sat}) (ft/day)

2) Field evaluation
The field evaluation will consist of a minimum of one deep boring per 10,000 square feet of lawn area. The deep boring should be to a depth of 20 feet or to the uppermost saturated layer, whichever is shallower. The soil description must include the soil texture and consistence and presence of cementation (sands).

c. Modeling effluent mounding over a restrictive layer

There are two different models that can be used to estimate effluent mounding – the Kahn equation and GMOUND.

1) The Kahn equation
The Kahn equation (Kahn et al – 1976) can be used to determine effluent mounding in the unsaturated zone as follows:

$$H_{max} = (0.5*W) * [q'/K_1 (q'/K_2-1)]^{1/2}$$

Where: H_{max} is the maximum height of the perched mound (ft)
q' is the lawn area loading rate (ft/$ft^{2/}$day)
K_1 is the saturated hydraulic conductivity of the upper layer (ft/day)
K_2 is the saturated hydraulic conductivity of the restrictive layer (ft/day)
W is the width of the soil dispersal area (ft)

If the lawn area loading rate (q') is less than or equal to the saturated hydraulic conductivity of the restrictive layer (K_2), a perched mound is not expected to develop and no further evaluation is necessary.

Please see Appendix M to estimate a perched mound height for conditions where $q' > K_2$

2) GMOUND
GMOUND is a computer interface of MODFLOW – a numeric groundwater flow model. The program has a tutorial which will explain how to use the model. For effluent mounding determination, choose "Low Permeability Perched Layer Present above the Water Table" under Section #3 – Hydrogeologic Setting.

d. Determination of the saturated hydraulic conductivity

The saturated hydraulic conductivity of the soil material is one of the most important parameters in determining the extent of mounding. The determination is based on either detailed soil descriptions of the texture and consistence, or measurements of the saturated hydraulic conductivity. The saturated hydraulic conductivity determination will be needed for the soil layer that was used for system sizing (K1) and of the most restrictive layer found in the upper 20 feet which is above the uppermost saturated layer (K2).

1) Estimated Ksat values from detailed soil borings
Estimates of the saturated hydraulic conductivity are provided in Table IIB. These estimates are provided to give an idea of the possible extent of mounding under typical conditions for the soil conditions provided.
2) Determination from hydraulic testing
The Ksat values can be determined by hydraulic testing. The testing can include such devices as permeameters. The test results must be able to be converted into a saturated hydraulic conductivity value to be used in the calculation. The advanced designer must be trained in the testing method used, and the testing protocol must be in accordance with the manufacturer's instructions or standard procedure (e.g., ASTM) for the device used.
3) Determination from laboratory texture analysis
Samples can be brought into a lab for determination of Ksat based on particle sized distribution. This procedure is only recommended for sandy soils with loose consistence and not soils which have developed soil structure. Sample size, sampling method and transport should be in accordance with laboratory instructions.

Table IIB – Estimated Ksat values (ft/day) for effluent mounding on a restrictive layer for effluent mounding restrictions

Soil Texture (USDA)	Ksat (ft/day)		
	Structured Soil and Friable Consistence	Massive Structure and Friable Consistence	Massive Structure and Firm, Cemented, or Dense Consistence
sands	70	70	Need to measure
loamy sands	10	3.0	
sandy loam	3.0	2.0	
loam	2.0	1.0	
silt loam	0.60	0.50	
clay loams	Need to measure	Need to measure	
clays	Need to measure	Need to measure	

a. Results and next steps

If the above exercise indicates that a groundwater mound will form, the height of mound must be added to the top of the restrictive layer that caused the mound. This new and shallower depth will then be used as the restrictive layer for design of the vertical separation distance.

If the above exercise indicates no mounding on the restrictive layer, then the depth to the redox features or bedrock can be used as the depth to the limiting layer.

However, in either case, the limiting layer for design must still be determined by assessing groundwater mounding on a saturated layer as determined in the next Section II G. 6.

Design options to mitigate groundwater mounding can be found at Section III. G.

II. G. 6. Groundwater mounding on a saturated layer - MSTS

In addition to effluent mounding in the unsaturated zone, an assessment must also be made on effluent mounding in the uppermost saturated zone. This uppermost saturated zone includes the shallow periodically saturated soil commonly used as the limiting layer for SSTS design.

a. Preliminary evaluation

A preliminary evaluation to determine mounding on a saturated layer consists of gathering the following information:

- Flow amount
- System type
- Soil dispersal system size (lawn area for trench, absorption area for beds and at-grades and native soil absorption area for mounds)
- Loading rate
- System geometry
- Nearby well logs, hydrogeologic atlas and other published information with some indication of Hydraulic Conductivity of soil material (Ksat)
- Specific yield of soil material
- Thickness of the saturated layer

b. Field evaluation

The field evaluation will consist of a minimum of one deep boring per 10,000 square feet of lawn area. The deep boring should be 20 feet in depth and note the soil texture and consistence, density, moisture content, and presence of cementation (sands).

c. Modeling groundwater mounding on a saturated layer

There are two different models that can be used to estimate effluent mounding – the Hantush equation and GMOUND.

1) The Hantush equation
The determination of mounding on a saturated layer can be determined by the Hantush equation (Hantush 1976). The equation is complex as is the approximation of the equation. For this reason, a spreadsheet is used to calculate the height of the mounding. For more information about the model please refer to pages 3-30 in the: *Guidance for Evaluation of Potential Groundwater Mounding Associated with Cluster and High-Density Wastewater Soil Absorption Systems* which can be found at:
https://decentralizedwater.waterrf.org/documents/WU-HT-02-45/WUHT0245_Electronic.pdf

The spreadsheet to calculate mounding using the Hantush equation can be found at:
https://decentralizedwater.waterrf.org/documents/WU-HT-02-45/WUHT0245_Electronic.pdf
clicking the hyper-text link: Watertable Mounding Spreadsheet on the bottom of the page. An example problem is found in Appendix N.

2) GMOUND

GMOUND is a computer interface of MODFLOW – a numeric groundwater flow model. A CD of the program for downloading is available from Scott County Environmental Health Department; call 952-496-8475 for this information. The program has a tutorial which will explain how to use the model. For mounding on a saturated layer choose “Low Permeability Perched Layer Not Present” under Section #3 – Hydrogeologic Setting.

3) Determination of model inputs

The models can be run with data from each of the 20 foot soil boring(s), and/or hydraulic testing. In addition, helpful information may be gained from published information such as well logs, geologic atlases, etc. The inputs needed for the calculation are as follows:

- The estimated Ksat derived from the soil boring(s) will be chosen from the saturated soil material and will be based on values provided in Table IIB in the previous section, or measured hydraulic test data.
- The length and width of each zone or unit.
- The number of units/zones.
- The lawn area loading rate calculated using ½ of the design flow.
- The saturated thickness of the saturated zone shall be considered to be five feet unless a more realistic value can be ascertained from the required 20-foot boring(s), nearby well logs, or other geologic information.
- Timeframe of concern (choose 10 years).
- The specific yield shall be derived from Table IIC.

Table II C – Specific yield

USDA Soil Texture	Well Log Texture	Unified Texture	Specific Yield
Sand	Any combination of sand and gravel terms that does not include the term "clay"	GM-SL SP, SW	0.32
Sandy Loam	Any combination of sand and gravel terms that includes the term "clay"	SP-SM, SP-SW	0.25
Loam		SM, SM-SC	0.17
Silt Loam		ML, ML-CL	0.17
Clay Loam		SC, CL	0.07
Clay	clay, hardpan. bedrock	CH, MH	0.02

4) Determination of the saturated hydraulic conductivity

The saturated hydraulic conductivity of the soil material is one of the most important parameters in determining the extent of mounding. An erroneous determination can drastically affect the predicted mound height. Any error will be caught as the system will be monitored to determine the extent of mounding and the operating vertical separation distance. The saturated hydraulic conductivity determination will be needed for saturated soil material. The procedure will be the same as used in Section II. G. 5.c. 3). If the 20-foot boring is not sufficient to characterize the saturated zone, then professional help is needed. Addition helpful information may be gained from well logs, published geologic information or other special studies.

5) Results and next steps

If the above exercise indicates that a ground water mound will form, the height of mound must be added to the top of the saturated layer. This new and shallower depth will then be used as the restrictive layer for design of the vertical separation distance.

Design options to mitigate groundwater mounding can be found at Section III. G.

II. H. Surface water impact from phosphorus

II. H. 1. Introduction

Limiting the growth of aquatic vegetation in Minnesota lakes can be achieved by limiting the input of phosphorus to the surface waters such as lakes and rivers. Phosphorus additions can come from many sources, with one of the potential sources being effluent from SSTS.

Domestic sewage contains a phosphorus concentration above limits set for surface water with sewage containing 6 to 12 mg/l Total Phosphorus (TP) and surface water standards for most surface waters being 1 mg/l TP or less. Most soils have a significant capacity to attenuate phosphorus, with the current understanding that greater attenuation occurs in the unsaturated zone as compared to the saturated layers. Even if the soil has a high capacity to attenuate phosphorus, the attenuation is not limitless. Therefore, after many years of loading effluent into the soil, the soil's ability to attenuate phosphorus may become exhausted. At that point phosphorus enriched groundwater can be discharged into nearby surface waters, ultimately providing additional phosphorus inputs for aquatic vegetation.

The risk of phosphorus impacts increases in the following situations:

- If a full three-foot vertical separation is not employed (for example if Type IV separation distances are used).
- If sandy soil conditions are present.
- If a BOD_5 /TSS reduction component is used (as the soil dispersal system may never clog and will accept phosphorus effluent for a very long time).

II. H. 2. Individual sewage treatment systems

Individual subsurface sewage treatment systems do not have a phosphorus requirement. However, ISTS designers may voluntarily modify the ISTS design to minimize impacts to lakes. Please refer to Section III. I. (Design Options for Surface Water Protection) for BMPs to mitigate phosphorus impacts.

II. H. 3. Mid-sized sewage treatment systems

MSTS discharge of phosphorus to a surface water cannot exceed the phosphorus standard to the receiving water. This discharge will come via the groundwater discharge to the surface water. This phosphorus impact is a concern only if the soil dispersal system is to be located within 500 feet of a surface water (Minn. R. 7081.0080 subp. 4 item (E)). Surface waters include lakes and may include rivers and wetlands. If an MSTS is planned to be placed within 500 feet of any surface water, contact the MPCA to determine if a phosphorus standard applies.

If it has been determined that a phosphorus standard will be applied to the proposed MSTS, an assessment must be made to determine if the system will meet the requirement. This would typically mean that an assessment of the soil's capacity to attenuate phosphorus is needed. At this time this assessment must be conducted by a BP Geoscientist or Engineer with adequate training and experience. During this assessment the Professional must consider:

a. The life of the soil dispersal system before ultimate clogging and hydraulic failure resulting in soil dispersal system replacement. This will largely depend on the waste strength loading to the soil. Soil systems receiving treatment level A, A2, B or B2 effluent may have an extremely long soil dispersal system life and loading of phosphorus.

b. The results of any analytical tests for phosphorus attenuation in regards to initial absorption and long-term precipitation.

III. Design selection

III. A. Introduction

Once the waste and site have been adequately characterized, consideration needs to be given to the design of the system which will match the waste and site conditions to achieve the goals stated in the Introduction, Section I D. Once the design has been selected, proceed to Section IV, Component Design, which will contain the actual methods and calculations of each of the system's chosen components.

This section is divided into subsections based on waste characteristics or site conditions identified in Section II.

III. B. Design options for non-domestic waste sources

If non-domestic waste is identified in the assessment process, the following information is provided to assist in disposal of this waste:

- Hazardous waste must be segregated from the waste stream and disposed of in accordance with federal and state hazardous waste rules. Hazardous waste cannot be discharged to a SSTS.
- Non-hazardous, non-domestic waste which is not suitable for subsurface discharge must be segregated from the waste stream. Whether the waste can be adequately treated before discharge into a soil dispersal system is beyond the scope of this document.
- The Agency should be contacted to determine if the non-hazardous, non-domestic waste may be suitable for subsurface discharge.

The following information is provided to help in determining what wastes may be suitable for subsurface discharge. Please also refer to Section II. A.

1) The following wastes are prohibited to be discharged into an SSTS by State rules:
    a. Clear water
        1) Footing or roof drainage water
        2) Chemically treated hot-tub or pool water
    b. Hazardous chemicals and hazardous wastes (other than normal amounts of household cleaning products and cleaners)
        1) Substances not intended of use in household cleaning
        2) Solvents, pesticides, flammables
        3) Photo-finishing chemicals
        4) Paint and dry cleaning chemicals
        5) Commercial hair treatments
        6) Unused products or unused medicines as a method of disposal
    c. Discharge from home garage floor drains
2) The following information is derived from federal regulations:

   a. Only waste that will not violate any primary drinking water standards (defined as 40 CFR pt. 142), or waste that will not adversely affect the health of persons may be discharged to the system.
   b. For Large Capacity Septic Systems (LCSS), the "point of compliance", where LCSS must meet the minimum federal requirement, is determined on a case by case basis, using site- specific factors such as soil, hydrogeology, wastewater characteristics, and system design. Soil is an integral part of the design for an LCSS receiving solely sanitary waste and generally should be considered when determining the point of compliance.
3) Motor vehicle waste disposal wells are banned in the following cases:
   a. Nationwide if the Class V well was constructed after April 5, 2000.
   b. If located in groundwater protection areas. Groundwater protection areas are areas near public water systems that provide groundwater used for drinking.
   c. If located in other sensitive ground water areas. Other sensitive groundwater areas are those areas outside of groundwater protection areas that need protection from motor vehicle waste disposal wells.
   d. If located on an Indian reservation.
   e. Check to find out if the motor vehicle waste disposal well is in a groundwater protection or other sensitive groundwater area (or to find out if wells are banned statewide). https://www.epa.gov/uic/motor-vehicle-waste-disposal-wells
4) Large-capacity cesspools (for new construction or existing cesspools) have been banned by the EPA.
5) Water cooled ice machines can continually discharge very large quantities of water. It is recommended that this water not be discharged into the SSTS. The discharge of water conditioning units may void the warranty of some registered treatment products.

III. C. Design options for high strength wastes

The goal of treating high strength waste is to not clog upstream components and not to exceed an organic loading rate to the soil as found in Section IV F. 6. In Chapter 7080, this means discharging a waste strength that meets Treatment Level C (TLC). TLC has a maximum BOD_5 of 170 mg/l, $cBOD_5$ of 125 mg/l, TSS of 60 mg/l, and Oil and Grease of 25 mg/l. This goal can be accomplished by one of two methods: (1) additional septic tank capacity with a larger soil dispersal system, or if TLC cannot be met by this method, (2) employ a secondary treatment device designed specifically for high strength waste applications. A grease interceptor may also be needed in either design option if oils and grease are problematic.

Typically increasing the septic tank capacity will not adequately reduce the waste strength to TLC, unless the waste strength is just slightly above domestic strength waste and the BOD input is not soluble.

Therefore, designing SSTS to treat high strength to TLC typically requires the use of a secondary treatment device. If conventional soil loading rates for septic tank effluent are to be used, the advanced treatment device must meet TLC before discharge to the soil dispersal system. Therefore the advanced treatment device must be capable of treating high strength wastes.

The Agency currently registers treatment devices that treat high strength wastes. The list of proprietary treatment products registered for use in Minnesota to treat high strength waste is found on the MPCA's Product Registration webpage at: https://www.pca.state.mn.us/water/registered-treatment-products.

Besides the list of registered proprietary treatment products for high strength waste, the webpage provides the individual approval letters sent to each manufacturer specifying ‘conditions of product use’ in Minnesota. For high strength waste applications, the advanced designer is required to work directly with the manufacturer’s designated representative during system design as specified in each approval letter. The following are two general conditions specified in MPCA’s approval letters to manufacturers of high strength waste treatment products:

- The manufacturer’s designated representative is required to review all designs provided by advanced designers (i.e.: evaluation worksheets for high strength wastewaters) for treatment systems proposed to use the treatment product. Designers need to work directly with the manufacturer to ensure the wastewater is properly characterized and that the product and other related components used in the treatment train (i.e. septic tanks and grease interceptors) are properly sized and compatible to meet designed performance requirements.
- The manufacturer’s designated representative will issue a review letter to the designer documenting: a) details of the manufacturer’s review, and b) agreement that the product is an appropriate fit for the planned system at the facility. The review letter will be signed by the manufacturer’s designated representative.

If a non-registered treatment device is to be employed to reduce waste strength, it must be designed by a BP engineer with adequate training and experience.

Below is a list of additional design considerations and management practices that can be used in conjunction with the advanced or secondary treatment to assist in reducing the waste strength.

1) System operation
    a. Provide and maintain internal grease trap
    b. Minimize the use of garbage disposals. Scrape food waste into garbage cans versus use of garbage disposal. Avoid large amounts of waste food (buffets and salad bars are examples).
    c. Use water conservation and eliminate clean water additions.
2) System design for high strength waste
    a. If oil and grease are excessive
        1) Place a building sewer clean-out outside the structure.
        2) Keep the first outside tank close to the establishment (e.g., a short building sewer) to keep the sewage from cooling and grease solidifying in the building sewer
        3) Segregate the waste stream with the oils and grease waste discharged into a separate exterior grease interceptor. The exterior grease interceptor should be designed for a minimum of one day’s detention time with longer baffle lengths. If the waste cannot be segregated, then place the external grease interceptor first in the series of tanks. The volume of the external grease interceptor cannot be counted as part of the required septic tank capacity.
        4) Use more and smaller septic tanks to meet tank volume requirements. The required tank volume is based on the manufacturer’s recommendation for advanced treatment devices. The required tank volume for high strength waste without advanced treatment devices will need to be more than the three to four times the daily flow. More and smaller tanks better cool the sewage due to greater surface area contact with the soil. However an individual septic tank in series must still have at least 25 percent of the total liquid capacity (Minn. R. 7080.1940 item B).
    b. Effluent screens should be used on the final tank in series (a must for all MSTS regardless of waste strength).

c. For high strength waste applications, it is recommended that the orifice size for pressure distribution system be no smaller than ¼ inch and that the distal head should be no less than two (2) feet. Cleanouts must be provided (Minn. R. 7080.2050 subp. 4(J)). More frequent doses are preferable (minimum of four (4) doses/day is required by rule), as long as the dose volume equals or exceeds four distribution pipe volumes plus the volume of the supply pipe.

d. If the waste strength has cyclic variations, flow equalization methods can be employed to store and dilute the high strength wastes with flow from lesser waste strength periods. The flow equalization methods use for flow volume variation can be used for waste strength variation. Please see Section IV. A.

e. The soil absorption area should be sized based on the greater of the maximum hydraulic load or the maximum organic load. See Table IV. H. in Section IV F 6 to determine the maximum organic loading. It may be advisable to oversize the absorption area by 50 percent and divide the system into three (3) zones for dosing and resting cycles if advanced/secondary treatment is not employed (a must for MSTS without advanced treatment regardless of waste strength (Minn. R. 7081.0270 subp. 5 (A)(3)).

f. It is preferable, if possible, to run gravity from the kitchen to an external grease interceptor and not to sump the waste and lift it into the grease interceptor.

III. D. Design options for variation in flow

Flow variation is another major concern for the proper operation of an SSTS, with steady, even flow patterns and consistent waste strength allowing for better operation. Flow variations can be hourly, daily, weekly, monthly, seasonally or during special events. Variations in flow are mitigated by surge storage tanks with dosing over a long period of time. Dosing can be accomplished by timed dosing of the surge storage. Timed dosing is preferred as it gives the greatest control over the flow. To determine if the use of flow equalization has economic advantages over designing based on peak flow, please see Section IV A for design of flow equalization.

Other design considerations include increasing the soil dispersal area or employing portable toilets when necessary.

III. E. Soil dispersal design options for site conditions

1) Slope
   a. Slope – Flat (approximately one (1) percent slope or less)
      1) Move system to an area with slope to facilitate water movement away from the system (recommendation)
      2) Maximize separation from saturated conditions (recommendation)
      3) In-ground system preferred (if soils are suitable)
      4) Pressure distribution preferred (required for MSTS)
   b. Slope –Steep (greater than six (6) percent slope)
      1) Move system to an area with less slope area (recommendation)
      2) No beds on slopes greater than or equal to six (6) percent (required)
      3) No at-grades on slopes greater than 25 percent (required)
2) Undulating contours
   a. Move to less undulating contours (recommendation)
   b. Employ multiple small systems (recommendation)

c. Employ drip dispersal (recommendation)

3) Swales, concave, run-on
   a. Move system to better landscape position (recommendation)
   b. Provide surface water diversions (required)
4) Floodplain
   Follow Minn. R. 7080.2270 as follows:
   a. An SSTS must not be located in a floodway and, whenever possible, placement within any part of the floodplain should be avoided.
   b. There must be no inspection pipe or other installed opening from the distribution media to the soil surface.
   c. An SSTS must be located on the highest feasible area of the lot and must have location preference over all other improvements except the water supply well. If the 10-year flood data is available, the bottom of the distribution media must be at least as high as the elevation of the 10-year flood.
   d. If a pump is used to distribute effluent to the soil treatment and dispersal system, provisions shall be made to prevent the pump from operating when inundated with floodwaters.
   e. When it is necessary to raise the elevation of the soil treatment system to meet the vertical separation distance requirements, a mound system, as specified in Minn. R. 7080.2220 is allowed to be used with the following additional requirements:
      1) The elevation of the bottom of the mound bed absorption area must be at least one-half foot above the 10-year flood elevation if 10-year flood data is available.
      2) Inspection pipes must not be installed unless the top of the mound is above the 100-year flood elevation.
      3) The placement of clean sand and other fill must be done according to any community-adopted floodplain management ordinance.
      4) Backflow prevention of liquid into the building when the system is inundated must be provided. If a holding tank is used, the system must be designed to permit rapid diversion of sewage into the holding tank when the system is inundated.
5) Site is too small (due to - flow volume, available area, soil texture or organic loading)
   a. Reduce flow by reducing the number of flow generating units (recommendation)
   b. Flow restriction or equalization by timed dosing (recommendation)
   c. Type III or IV system (reduced sizing allowed) (recommendation)
6) Setback constraint
   a. Relocate site or move limiting constraint (recommendation)
   b. Seek variance to setbacks

III. F. Design options for soil conditions

1) Sandy soil conditions
   a. Trench and bed systems receiving a flow of less 5,000 gpd which are not Type IV and have distribution media is in contact with any sand or loamy sand or soils with less than 35 percent rock fragments or soils with a percolation rate of 0.1 to 5 minutes per inch must employ one or more of the following measures:
      1) Employ pressure distribution according to Minn R. part 7080.2050, subp. 4; [NOTE: All systems over 5,000 gpd or are a Type IV system must be pressurized]

2) Divide the total dispersal area into multiple units that employ serial distribution, with each dispersal unit having no greater than 15 percent of the required bottom absorption area; or
3) Have a vertical separation distance of at least five feet

b. All types and sizes of SSTS in which the distribution media would be in contact with any sand or loamy sand or soils with 35 percent or more rock fragments or soils with a percolation rate of less than 0.1 minutes per inch must employ one or more of the following measures:

1) One foot of clean (medium) sand liner material in contact with the distribution material. The system would also need to meet the requirements of item "1. a." above along with meeting the needed vertical separation distance; or
2) A mound system with a minimum of one foot of clean (medium) sand depth, or a sand depth needed to meet the needed vertical separation distance.

c. For all types and sizes of SSTS, any soil layers that have a sand soil texture with 35 to 50 percent rock fragments or loamy sand with 35 to 50 percent rock fragments must be credited at only one-half their thickness as part of the necessary treatment zone. Soil layers, regardless of soil texture, with greater than 50 percent rock fragments must not be credited as part of the necessary treatment zone. Mitigative design measures for these conditions include:

- Clean (medium) sand liner at a thickness to provide adequate separation distance
- Mound system with the clean (medium) sand thickness meeting the needed vertical separation distance

2) Clayey soil conditions
   a. Mound systems are not Type I systems if the mound absorption ratio is not contained in Tables IX or IXa in Minn. R. chapter 7080. (required)
   b. Trenches, seepage beds and at-grade systems are not Type I systems if the loading rate in Table IX (in Minn. R. chapter 7080) is less than 0.45 g/ft^2/day (or is not listed) or the percolation rate is greater than 60 MPI. (required)

3) Soil lacks 12 inches of suitable surface soil
   a. Relocate site (strongly recommended)
   b. Extensive clean sand fill – Type III system (results are uncertain, likely very risky)

4) Meeting the required separation distance (to periodically saturated soil and bedrock)
   a. Mound system
   b. Type IV system
      1) Treatment Level B – 18 to 24 inches of separation (18 inches for ISTS; 24 inches for all MSTS)
      2) Treatment Level A – 12 to 24 inches of separation (12 inches for ISTS; 24 inches of separation for all MSTS)
   c. Type V system

5) Disturbed soil
   a. Relocate site (recommendation)
   b. Use tillage - Type III (results are uncertain)
   c. Remove damaged soil and backfill with clean sand – Type III system (results are uncertain)
   d. Construct below the disturbed soils – Type III system (results are uncertain). Be sure to correctly identify all limiting conditions.
   e. Terra-Lift – Type III system (results are uncertain)
   f. Wait (freeze-thaw cycles) – Type III system (results are uncertain)

g. Advanced treatment devices (Lower BOD_5/TSS) (results are uncertain)
h. Pressure distribution (results are uncertain)
i. Restrict flow use timed dosing and limit discharge – Type III (results are uncertain)
j. Oversize system – Type III system (results are uncertain)
k. Rip distribution that applies effluent in small doses and more evenly on the site (results are uncertain).

III. G. Design options for groundwater mounding

The mounding on a saturated zone is **mainly** affected by the lawn area loading rate and hydraulic conductivity of the soil. Groundwater mounding can be mitigated by the following design options:

1) Do not reduce bottom area with additional sidewall height.
2) Do not reduce bottom area due to pretreatment.
3) Reduce the lawn area loading rate (flow/lawn area) by increasing the distance between dispersal units.
4) Design the system long and narrow.
5) Place the system on a sloping area (and on multiple slopes if available).
6) Crown the final grade to promote run-off (do not exceed the maximum four foot depth from the system bottom to final grade).
7) Provide upslope diversion for precipitation and snow melt runoff events.
8) Have detailed mounding assessment conducted before design.
9) Multiple smaller systems at the same lawn area loading will effectively lower the groundwater mound. However, the smaller systems need to be placed far enough apart so mounding is not problematic and placed on different hill slopes if possible. The Hantush and GMOUND models determine the mound height at distances from the center of the soil dispersal system.

   If multiple systems are designed and spread apart, calculate mounding per the entire area and then calculate per an individual system and see which mounding is greatest.

   For construction purposes, so as not to damage the absorption area, it is recommended that bed type systems (seepage beds, at-grades and mounds) be spaced at least 35 feet apart, which may should help reduce the groundwater mound.

III. H. Design options for nitrogen sensitive aquifers

ISTS and MSTS Nitrogen BMPs are as follows:

- Blackwater separation with only grey water discharge to the system
- Recirculating media filter
- Mound systems placed on loamy or finer textured topsoil which has medium or high in organic matter content
- Use registered treatment products that reduce nitrogen to 20 mg/l or less of Total Nitrogen (TN)
- Use known natural nitrogen reduction from the soil or groundwater, or use dilution
- Detailed hydrogeologic assessment showing that the desktop assessment indicating an impact is incorrect.

In many cases multiple methods are needed to reduce the concentrations of nitrogen in sewage to meet the goal of 10 mg/l TN at the property boundary or nearest receptor, whichever is closest. Design of a non-registered nitrogen treatment component must be designed by a BP engineer. Any natural nitrogen treatment processes in the groundwater, or dilution of nitrogen by upgradient groundwater must be made by a BP geoscientist or engineer with adequate training and experience. In addition, monitoring wells placement and depth shall be determined by a trained and experienced BP.

III. I. Design options for surface water protection

1. Individual sewage treatment systems
   The following are some BMPs that can be employed to voluntarily mitigate phosphorus impacts from individual sewage treatment systems:
   - Educate the system owner to use phosphate-free cleaning products and practice water conservation.
   - Pump tanks per rule requirements, check for leakage from the tanks.
   - Discourage the installation and use of a garbage disposal.
   - Grow and harvest plants which will maximize phosphorus removal.
   - Use an effluent filter on the outlet of the septic tank.
   - Use pressure distribution with closer lateral and orifice spacing than one orifice per nine square feet.
   - Increase the size of the soil dispersal system by 50 percent and divide into three zones to provide long-term dosing and resting cycles.
   - Maximize the separation distance to the periodically saturated soil.
   - Maximize the distance from the soil dispersal system to the lake.
   - Employ a MPCA registered advanced treatment for TP removal, if registered specifically for phosphorus removal
2. Midsized subsurface sewage treatment systems
   If the system is required to meet a phosphorus standard, the soil is commonly used as a major part of the design to provide treatment for phosphorus. A general description of this process is found in Section II H. If the soil is not found to be sufficient protection, the design needs to:
   - Be modified to better utilize the soil, or
   - Enlarge the system to utilize more soil, or
   - Employ a registered phosphorus reduction product

   The soil's capacity to attenuate phosphorus must be conducted by a BP geoscientist with adequate training and experience. The phosphorus reduction product must be on the MPCA's product registration list or designed by a BP engineer.

III. J. Advanced treatment devices considerations

As noted in the previous subsections, advanced treatment can be used to overcome waste and site difficulties. Those difficulties and the appropriate treatment device choices are summarized in the Table III A below:

Table III A

Design Issue	Treatment Level Desired
Desire to reduce domestic strength BOD_5/TSS	A, A2, B, or B2
Reduce concentrations in high strength waste	A, A2, B, B2, or C
Small site	A, A2, B, or B2
Heavy soils	A, A2, B, or B2
Disturbed Soil	A, A2, B, or B2
Desire Reduced Separation Distance	A or B
System discharging into sensitive aquifer	TN
Surface water protection from phosphorus	TP

* In many instances the BOD_5 and TSS must be removed first before removal of other contaminants – not shown in the Table III A.

There are many different types of advanced treatment devices that can be used to treat for the contaminants listed in Table III A. The groupings of treatment options are described below in Table III B along with their relative treatment abilities (G = Good, S = Some, L = Little, NR = Not Recommended). The Product Registration Process provides numerical values for the level of treatment for specific products. Please refer to the Product Registration webpage for additional information at: https://www.pca.state.mn.us/water/registered-treatment-products.

	Aerobic Treatment Units			Filters			
Contaminant	**Fixed Film**	**Suspended Growth**		**Recirculating Sand**	**Single Pass Sand**	**Peat**	**Recirculating Gravel**
Domestic BOD_5/TSS	G	G		G	G	G	S
High Strength Waste	Dependent on Unit			NR	NR	NR	S
Fecal*	S	S		S	G	G	L
Nitrogen	L	L		G	S	S	S
Phosphorus	L	L		S	S	S	L

*Treatment abilities for fecal reductions can be greatly enhanced by use of a disinfection device.

The various advanced treatment devices rely on different mechanisms to provide treatment. This results in differences in cost and operation for each device. Below is a list the designer should consider when choosing an advanced treatment device.

- Capital cost
  - Treatment unit cost
  - Installation Cost
- Operation and maintenance cost
  - Operator cost
    - frequency and extent of visits
    - sampling
    - system adjustments
    - labor for repair and replacement
    - reporting
  - Analytical (Lab) costs
  - Operating permit cost

- § Power costs
- § Component replacement costs

· Other considerations

- § Support/interest of the owners to properly operate the system
- § Type of soil dispersal component
- § Variation in flow volumes
- § Size of unit vs. available area
- § Noise/odor

IV. Component design

IV. A. Flow equalization

IV. A. 1. Introduction

Flow equalization is a method of storage to regulate the flow for a more consistent flow rate over time. Flow rate equalization is used to overcome operational problems by variation in flow or variation in waste constituents. Flow equalization can also be used to reduce the size of downstream components by allowing them to design on an average rather than a peak flow volume or peak waste concentrations.

IV. A. 2. When to employ flow equalization

It should be understood that flow equalization is not required to be employed as the system can be designed on a peak flow. Flow equalization can be used if the designer determines an economic advantage to do so. It appears to be economically advantageous to use flow equalization when the peak-to-average flow ratio exceeds 2.0. In addition, flow equalization may be advantageous for some Aerobic Treatment Units (ATU) and fixed media treatment devices which perform better with a consistent flow volume and waste strength. Any treatment device that is timed dosed needs to consider flow equalization.

IV. A. 3. Methodology to determine flow equalization

a. Periodicity of flow variation

   Flows can vary seasonally, monthly, weekly, daily, hourly or during special events. It is important investigate each of these time periods. Generally is felt that flow equalization is not economically feasible for seasonal flow variation due to the very large storage capacity that would be required. However, the system may also experience wide flow variation during the season that it is operating, so calculating a peak to average flow variation on a shorter periodicity may be beneficial.

b. Flow data available

   To determine variation in flow, flow readings must have been taken at a frequency suitable to the periodicity of concern. For example daily flow reading will not answer the question if hourly flow variations are suspected of being the problem. Flow estimation methods are provided below.

c. Peak analysis

   The sizing of a flow equalization tank is based on the peak analysis. The analysis can be used with the periodicity of concern. If the peak-to-average ratio is greater than 2.0, then flow equalization may be economically feasible.

d. Design example one – measured flow

The following is an example of a daily flow variation from a church. This method can be used with any periodicity of concern. The shaded boxes are the step that is being performed.

- **Facility** – Church
- **Periodicity** – One worship service per week, Wednesday night activities, staff flow on weekdays
- **Concern** – Daily variation

Step 1 – Fill in the periodicity of concern (in this example "days" are used). Fill in days of highest flow in the first rows. So for this church example, we start with Sunday.

Time Interval Daily Flow for a Peak Week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday			
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Total Weekly Flow		(sum of all daily inflow volumes)	
Peak Daily Flow		(choose maximum daily inflow volume)	
Average Daily Value			
Peak to Average Flow			

Step 2 – Fill in the measured flow for each period (for this example, for each day)

Time Interval Daily Flow for a Peak Week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	**1000**		
Monday	**0**		
Tuesday	**50**		
Wednesday	**500**		
Thursday	**50**		
Friday	**50**		
Saturday	**50**		
Total Weekly Flow		**(sum of all daily inflow volumes)**	
Peak Daily Flow		**(choose maximum daily inflow volume)**	
Average Daily Value			
Peak to Average Flow			

Step 3 – Total the daily flow readings to get a weekly total

Time Interval Daily Flow for a Peak Week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000		
Monday	0		
Tuesday	50		
Wednesday	500		
Thursday	50		
Friday	50		
Saturday	50		
Total Weekly Flow	**1700 gal**	(sum of all Daily Inflow Volumes)	
Peak Daily Flow		(choose Maximum Daily Inflow Volume)	
Average Daily Value			
Peak to Average Flow			

Step 4 – Record the highest peak day

Time Interval Daily Flow for a Peak Week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000		
Monday	0		
Tuesday	50		
Wednesday	500		
Thursday	50		
Friday	50		
Saturday	50		
Total Weekly Flow	1700 gal	(sum of all Daily Inflow Volumes)	
Peak Daily Flow	**1000 gal**	(choose Maximum Daily Inflow Volume)	
Average Daily Value			
Peak to Average Flow			

Step 5 – Average the total flow value (divide the total weekly flow by 7 days (or more to be more conservative))

Time Interval Daily Flow for a peak week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000		

Monday	0		
Tuesday	50		
Wednesday	500		
Thursday	50		
Friday	50		
Saturday	50		
Total Weekly Flow	1700 gal	**(sum of all Daily Inflow Volumes)**	
Peak Daily Flow	1000 gal	**(choose Maximum Daily Inflow Volume)**	
Average Daily Value	**243 gal** *(1700 gallons/7 days),*		
Peak to Average Flow			

Step 6 – Determine the peak to average ratio (divide the peak flow by the average daily flow)

Time Interval Daily Flow for a peak week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000		
Monday	0		
Tuesday	50		
Wednesday	500		
Thursday	50		
Friday	50		
Saturday	50		
Total Weekly Flow	1700 gal	(sum of all Daily Inflow Volumes)	
Peak Daily Flow	1000 gal	(choose Maximum Daily Inflow Volume)	
Average Daily Value	243 gal		
Peak to Average Flow	**4.1** *(1000 gal/243)*		

Step 7 – Fill in the timed dose column with the calculated average daily flow

Time Interval Daily Flow for a peak week (Easter Sunday week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000	**243**	
Monday	0	**243**	
Tuesday	50	**243**	
Wednesday	500	**243**	
Thursday	50	**243**	
Friday	50	**243**	
Saturday	50	**243**	
Total Weekly Flow	1700 gal	(sum of all Daily Inflow Volumes)	

Peak Daily Flow	1000 gal	(choose Maximum Daily Inflow Volume)
Average Daily Value	243 gal	
Peak to Average Flow	4.1	

Step 8 – Calculate the surge volume (storage) (remaining storage from previous day plus the daily flow volume minus the dose volume. It is easiest to start with the first day storage is needed.

Time Interval Daily Flow for a peak week (Easter Sunday Week)	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Sunday	1000	243	**757** *(1000 – 243)*
Monday	0	243	**514** *(757 + 0 – 243)*
Tuesday	50	243	**321** *(514 + 50 – 243)*
Wednesday	500	243	**578** *(321 + 500 – 243)*
Thursday	50	243	**385** **(***578 + 50 – 243)*
Friday	50	243	**192** *(385 + 50 – 243)*
Saturday	50	243	**0** *(192 + 50 – 243)*
Total Weekly Flow	1700 gal	(sum of all Daily Inflow Volumes)	
Peak Daily Flow	1000 gal	(choose Maximum Daily Inflow Volume)	
Average Daily Value	243 gal		
Peak to Average Flow	4.1		

Step 9 - Calculate the required equalization tank volume.

Step 9A - Select the maximum surge volume

The maximum storage volume is 757 gallons.

Step 9B - Select the minimum surge volume

The minimum storage volume is 0 gallons.

Step 9C - Subtract the maximum surge volume from the minimum

757 gallons – 0 gallons = 757 gallons

Note: if you have a negative number for the minimum value then subtracting a negative number is like adding the number, example: 7 – (-2) = 9.

Step 9D - Sum of the Step 9 surge volume plus the timed dosed volume.

757 gal + 243 gal = 1000 gal

Step 9E - Add a minimum peaking factor (use 20 percent)

1000 gal x 1.2 = 1200 gal

The storage capacity would need to be 1200 gallons. The total tank capacity would be 1200 gallons plus the additional capacity necessary to cover the pump.

Step 9F - Flow value for soil dispersal system (timed dose volume divided by 0.7)

243 gallons/0.7 = 347 gallons/day

Things to consider:

- Minimum peaking factor chosen of 20 percent. This should incorporate potential growth in the system or other design considerations.
- As peak to average flow ratio increases, peaking factor may need to increase. For example at a 5 to 1 ratio consider increasing to 30 percent peaking factor.
- It may be advantageous to divide the total weekly flow by less than 7 days to be more conservative, for such things as weddings and funerals (e.g., (1,700 gal ÷ 5 days = 340 gpd design average)

e. Design example two – using estimated flow

If no flow data is available the system is designed based on an estimated design flow found in Minn. R. ch.7081.0130. At this point the decision needs to be made on the variation in flow. This can be estimated based on how the flow volumes are determined and the operation of the facility.

For example, consider a drive-in movie theater which has a design flow of five (5) gallons per car stall (per chapter 7081 estimated flow), with the following:

- 100 car stalls
- Use maximum stalls for design (5 gpd/stall x 100 stalls = 500 gpd)
- The drive-in theater is open for three (3) months per year
- The drive-in shows movies on Friday and Saturday nights from 8:30 p.m. to 2:30 a.m.

In evaluating this situation there are three obvious variation in flows; seasonal, daily and hourly. It is determined that daily flow is the variation to be managed; therefore the daily flow variation will be examined.

Step 1 - Complete the chart as in the previous example:

Time Interval Daily Flow for a peak week	Daily Inflow Volume (gal)	Timed Dose Volume (gal)	Surge Volume (gal)
Friday	500	156	344
Saturday	500	156	688
Sunday	0	156	532
Monday	0	156	376
Tuesday	30	156	250
Wednesday	30	156	124
Thursday	30	156	0
Total Weekly Flow	1090 gal	(sum of all Daily Inflow Volumes)	
Peak Daily Flow	500 gal	(choose Maximum Daily Inflow Volume)	
Average Daily Value	156 gal		
Peak to Average Flow	3.2		

Step 2 – Select the maximum surge volume
Maximum surge volume = 688 gallons

Step 3 – Select the minimum surge volume
Minimum surge volume = 0 gallons

Step 4 – Subtract the minimum surge volume from the maximum surge volume.
688 gal – 0 gallons = 688 gal

Note: if you have a negative number for the minimum value then subtracting a negative number is like adding the number, example: 7 – (-2) = 9.

Step 5 - Sum of the Step 4 volume plus the timed dosed volume.
688 gal + 156 gal = 844 gal

Step 6 - Add a minimum Peaking Factor (use 20 percent)
844 gal x 1.2 = 1013 gal

The storage capacity would need to be 1013 gallons. The total tank capacity would be 1013 gallons plus the additional capacity necessary to cover the pump.

Step 7 - Flow value for soil dispersal system (timed dose volume divided by 0.7)
156 gallons/0.7 = 223 gallons/day

Things to consider:

- As peak to average flow ratio increases, peaking factor may need to increase. For example at five to one consider increasing to 30 percent peaking factor.
- May want to divide the total weekly flow by less than 7 days to be more conservative.

IV. A. 4. Methods of flow equalization

The method to equalize the flow is with the use of an adequately-sized storage tank, pump and timer. All components downstream of this equalization tank can be based on an average flow volume divided by 0.7 (Step 9F in the example).

IV. A. 5. Maintenance concern

Flow equalization tanks shall be designed with maintenance holes similar to septic tanks. The maintenance holes in the flow equalization tanks are required to provide access to remove accumulated solids at regular intervals, similar to the septic tanks.

IV. B. Tank requirements and tank sizing

IV. B. 1. - General

This section deals with requirements and sizing for all SSTS tanks for advanced systems. The tanks that are used for advanced systems are:

- Septic
- Stilling
- Flow equalization (EQ)
- Recirculating
- STEP pump tanks
- Common pump tanks

- Tanks use for dual purposes

This section also deals with how the design/capacity of these tanks is affected if a collection system is employed.

IV. B. 2. – Definitions

a. Collection system: “Collection system” means a system that transports sewage from multiple connection points to a central treatment location.

b. Collection system manholes: “Collection system manholes” means a device installed in a collection system for proper operation and maintenance of the collection system.

   Manholes are installed in sewer lines at least every 100 feet and whenever there is an intersection, change of direction, or change the in elevation or slope of a line.

c. Common pump tank: “Common pump tank” means a tank with a pump, which is downstream of the collection system whose purpose is to store sewage until a pump is activated.

d. Common septic tank: “Common septic tank” means a septic tank which treat sewage from multiple connection points which is downstream of the collection system.

e. Flow equalization (EQ) tank: “Flow equalization tank” means a tank whose purpose is to reduce peak flow by storage and timed dosing of effluent to equalize the flow to downstream components.

f. Gravity sewer collection: “Gravity sewer connection” means a system in which individual dwellings discharge into a sewage collection system in which sewage flows by gravity to common septic tanks. Gravity sewer collection may employ lift stations to lift the sewage as desired.

g. Individual septic tank: "Individual septic tank" means a septic tank that treat sewage from an individual dwelling or other establishment.

h. Pressure sewer collection: Pressure sewer collection means a system that the individual dwellings employ grinder or ejector pumps which are discharged into a collection pipe under pressure which discharges into a common septic tank(s).

i. STEG sewer collection: “STEG sewer collection” means a system in that each dwelling/establishment on each lot treats the sewage in a septic tank and discharges the effluent to a gravity collection pipe which discharges to a stilling tank or stilling/septic tank.

j. STEP sewer collection: “STEP sewer collection” means a system in which each dwelling/establishment on each lot treats the sewage in a septic tank and discharges the effluent to a pressure collection pipe that discharges to a stilling tank.

k. STEP pump tank: “STEP pump tank” means a tank with a pump, which received septic tank effluent from an on-lot septic tank, and discharges effluent with a pump into a pressure collection system.

l. Stilling tank: “Stilling tank” means a tank at the downstream end of a collection system intended to dissipate the energy of flowing water before discharge to the next downstream component. Stilling tanks also add additional settling, filter out particles that can be introduced into the collection system and mitigate an illegal discharge.

m. Process tank: “Process tank” means a tank that serves as both a septic tank and a recirculation tank.

n. Recirculation tank: “Recirculation tank” means a tank that receives both septic tank effluent and effluent from a recirculating treatment device. The effluent from the tank is discharged back to the recirculating treatment device, with a portion of the effluent discharged to the soil dispersal system.

IV. B. 3. - Requirements/specifications

All tanks, except collection system manholes, must meet all requirements (design, location, access, etc.) in Minn. R. 7080.1900 for ISTS and 7081.0240 for MSTS. All common tanks will need to be properly vented. The following tanks have some special requirements:

a. Collection system manholes
   - *Collection system manhole requirements are found in Section V.*

b. Common septic tank(s)
   - *If a series of tanks is used to meet the capacity requirements, no tank can be less than 25 percent of the total required capacity.*
   - *Common septic tanks must be used for gravity and pressure collection systems, and may be used for STEP and STEG collection systems.*

c. Stilling tanks
   - *Stilling tanks must be installed for all pressure sewers, gravity sewers, STEP or STEG collection systems with a design flow of 2,500 gpd to 10,000 gpd.*

d. Combination tanks
   - *A single compartmented tank cannot be used for **more than** two purposes. The allowable two function purposes are described Section IV. B. 4. A dual compartment tank may be used for two purposes, given the capacity of each compartment meets the capacity requirements for each purpose.*

IV. B. 4. – Septic tank sizing

Septic tank sizing can be complex due to a variety of design decisions. Septic tanks are sized as follows:

a. Individual septic tanks on each lot

   Individual septic tank capacity is determined as follows:
   - Full septic tank capacity at each dwelling/establishment (i.e. no additional downstream septic tank capacity is required)
     - For a dwelling
       Use Type I sizing criteria (bedrooms, garbage disposal, basement sump)
     - For an Other Establishment use:
       Design flow (gpd) x 3.0 (gravity flow)
       Design flow (gpd) x 4.0 (fed by pump)
     - Registered products and high strength waste:
       See product registration for septic tank capacity.
   - Partial septic tank capacity at each dwelling/establishment (STEP or STEG)

Minimum septic tank capacity for STEP or STEG[1]

Number of Bedrooms	Septic Tank Capacity (gallons)
3 or less	750
4 or 5	1,000
7 or 7	1,500
8 or 9	2,000

b. Common septic tank(s) – (stand-alone septic tank capacity not in combination with stilling tank capacity)

   Common septic tank capacity is determined as follows:

- No septic tank capacity at individual dwellings/establishments:
  - 10 dwellings or less:
    Add Type I septic tank capacities for each dwelling
  - More than 10 dwellings:
    - If less than 25 percent of dwelling have garbage disposal or sewage ejector pump with gravity collection system does not have a lift station:
      Design flow multiplied by 3.0
    - If twenty five percent or more of the dwellings have garbage disposal or sewage ejector pump or the gravity collection system has a lift station or if pressure sewer.
      Design flow multiplied by 4.0
  - For an Other Establishment use:
    Design flow (gpd) x 3.0 (gravity flow)
    Design flow (gpd) x 4.0 (fed by pump)
  - Registered products and high strength waste:
    See product registration for septic tank capacity
- Partial septic tank capacity at individual dwellings/establishments:

  Take the calculated value for "no septic tank capacity at individual dwellings/establishments" (above) and subtract the septic tank capacity at each dwelling.

IV. B. 5. – Stilling tank sizing

Stilling tank sizing can be complex due to a variety of design decisions. Stand-alone stilling tanks (not in combination with septic tank capacity) are sized as follows:

- *Stilling tank capacity (gal) = Design flow (gpd) x 0.5*

IV. B. 6. – Combined septic tank and stilling tank sizing (one compartment tank)

Common septic capacity can also count for the required stilling tank capacity.

- *It is calculated by taking the larger of the common septic tank capacity and stilling tank capacity.*

IV. B. 7. – STEP pump tank sizing

The size of the pump tank that follows the on-lot septic tank and discharged into a collection system is determined as follows:

- Dwellings with a flow of 600 gpd or less:
  500 gallons or dual alternating pumps
- Dwellings with a flow of greater than 600 gallons:
  100 percent of design flow or dual alternating pumps

IV. B. 8. – Common pump tank sizing

The size of a common pump tank which follows the collection system is determined as follows:

- ISTS
  Design flow (gpd) x 0.50 (with two alternating pumps or have a minimum total capacity of the design flow). NOTE: employing two pumps for larger ISTS (2501 to 5,000 gpd) is recommended.
- MSTS
  Design flow (gpd) x 0.50 (with two alternating pumps)

IV. B. 9. – Combination stilling/ pump tank sizing (one compartment tank, all septic tank capacity is at the dwellings)

The capacity will be 100 percent of the design flow.

IV. B. 10. – Flow equalizing tank sizing

See Section IV. A.

IV. B. 11. – Combination stilling/flow equalizing tank sizing (one compartment tank)

The capacity would be the largest of the required stilling tank or flow EQ tank storage, with a minimum of 100 percent of the design flow.

IV. B. 12. - Recirculation tank sizing

The size of a recirculation tank is determined as follows:

- Recirculating sand filters (public domain registered device):
  100 percent of Design flow
- Proprietary registered products:
  See the product registration requirements

IV. B. 13. – Combination septic/recirculation tank (one compartment tank)

- The required common septic tank capacity can also be counted as recirculation tank capacity.
  The sizing would be specific to the recirculating requirements of the recirculating treatment device, but never be less than 100 percent of the design flow.

IV. C. Recirculating Media Filter (RMF) Design Guidance

The specifications and guidance on the design of recirculating media filters can be found in the MPCA's *Recirculating Sand Filter Recommended Standards and Guidance*. This document can be found at: http://www.pca.state.mn.us/publications/wq-wwists4-41.pdf

IV. D. Single Pass Sand Filter (SPSF) Design Guidance

The specifications and guidance on the design of single pass sand filters can be found in the MPCA's *Single Pass Sand Filter Recommended Standards and Guidance Document*. This document can be found at: http://www.pca.state.mn.us/publications/wq-wwists4-42.pdf

IV. E. Registered proprietary treatment and distribution products

IV. E. 1. Introduction

The process for listing registered treatment and distribution products for SSTS was established in January 2009. The product listing and accompanying information, provides guidance on the use of registered treatment and distribution products; how and where these products are appropriately used, along with design, installation, operation, and maintenance requirements.

The products on the list are registered for use in Minnesota. What this means is that listed products have demonstrated they meet minimum requirements contained in the current rules (https://www.revisor.leg.state.mn.us/rules/?id=7083.4000). Manuals specific to Minnesota's requirements are prepared by manufacturers, and include design, installation, and operation, and maintenance requirements. For more information on the MPCA's Product Registration Process, please see the main SSTS Product Registration webpage at: https://www.pca.state.mn.us/water/ssts-product-registration-process .

IV. E. 2. How to use the list of registered products

There are two lists for registered SSTS treatment products: 1) for residential strength sewage treatment products and 2) commercial or high-strength sewage treatment products. The lists provide the name of the company, along with a link to the company website and contact information. There is also a list of registered distribution media products, such as chambers and other rock substitutes.

The treatment product name and model are listed, along with its rated capacity (design flow in gallons per day) for each model. Other information related to each model is listed. For example, if the product needs to be operated in a certain way (i.e. in Mode 1 operation) or if ultraviolet (UV) light disinfection is required as part of the treatment process, this is specified in the listing. A brief description of the treatment process is also provided.

IV. E. 3. Proprietary treatment products and treatment levels

Proprietary treatment products are listed by their ability to treat sewage to a specific treatment level. There are seven 'Treatment Levels' at which treatment products can be registered (Table 1). Products that meet the requirements of *Treatment Level A* meet the highest treatment standard in removing organic matter (15 mg/L $cBOD_5$), total suspended solids (15 mg/L TSS), and pathogenic indicator organisms (1,000 cfu/100 ml fecal coliform bacteria).

Table 1. The seven treatment levels for proprietary treatment products in Minnesota

Treatment Level	$cBOD_5$ (mg/L)	TSS (mg/L)	Fecal Coliform (#/100ml)	Nutrient (mg/L)
A	15	15	1,000	-
A2	15	15	-	-
B	25	30	10,000	
B2	25	30	-	
C	125	60	-	-
Total Nitrogen	-	-	-	20 or actual value
Total Phosphorus	-	-	-	5 or actual value

Products that meet Treatment Level B standards have been tested to reduce organic matter to 25 mg/L cBOD5, total suspended solids to 30 mg/L TSS, and fecal coliform bacteria to 10,000 cfu/100 ml. Higher quality effluents using products that meet Treatment Levels A and B can be dispersed into suitable soils with reduced vertical separation and increased hydraulic loading rates, depending upon soil characteristics. Soil dispersal requirements using treatment products that meet Treatment Levels A and B are specified in Minn. R. ch. 7080.2350, Table XI and Table XII. Higher quality effluents using products that meet Treatment Levels A2 and B2 can be dispersed into suitable soils with increased hydraulic loading rates, but not with a reduction in the vertical separation distance. Treatment levels of registered products can be found at:https://www.pca.state.mn.us/water/registered-treatment-products.

Products can be registered for treating high strength or commercial wastewater (i.e. restaurants, grocery stores).These products have been shown to reduce wastewater from high strength to typical residential strength wastewater. These products are listed as a Treatment Level C product, or products tested to reduce wastewater to 'typical' residential strength (125 mg/L cBOD5, 60 mg/L TSS, and 25 mg/L oil and grease). Treatment levels of registered products can be found at: https://www.pca.state.mn.us/water/registered-treatment-products.

IV. E. 4. Nutrient listing

The list of registered treatment products also identifies products registered for use in Minnesota that have been tested to reduce nitrogen and/or phosphorus. In order to be listed for nitrogen and phosphorus removal, independent third party testing has been completed and shown to meet a total nitrogen concentration of 20 mg/L or less and a total phosphorus concentration of five (5) mg/L or less or listed as to the actual concentration level they can achieve.

Treatment levels of registered products can be found at: https://www.pca.state.mn.us/water/registered-treatment-products.

Treatment levels are used to register treatment and nutrient removal products; they are not intended to be applied as strict, field compliance tools. Their intended use was to establish treatment product performance in the product registration process using established protocols, with testing performed by independent testing entities. Rather, the conditions of an operating permit are used to determine compliance of individual systems; 'template' operating permits have been developed for each of the registered treatment products.

IV. E. 5. Distribution media products

Distribution media are materials used to provide void space through which effluent flows prior to infiltration into the soil. Distribution media includes 1) public domain distribution products like aggregate or drainfield rock and 2) proprietary distribution products like polystyrene aggregates or chambers). Distribution media are required to meet the following four standards:

- be non-decaying and non-deteriorating and does not leach unacceptable chemicals when exposed to sewage and soil
- provides adequate void space for the passage and temporary storage of effluent while maintaining a stable density throughout the life of the system
- supports the distribution network, provides for suitable effluent distribution, and presents an interface with the infiltrative surface - trench bottom and side wall soil - for absorption of the wastewater
- maintains integrity of the excavation, supports soil backfill and cover material, and weight of equipment used in backfilling

For public domain distribution technologies (aggregate or drainfield rock), the MPCA Drainfield *Rock Distribution Media Recommended Standards and Guidance Document* was developed; the document is found at: http://www.pca.state.mn.us/publications/wq-wwists4-40.pdf. The purpose of this document is to identify specifications for drainfield rock used in trenches, beds, at-grades, and mounds. Gravel pit owners are not required to register their drainfield aggregate with the MPCA. However, drainfield rock is required to meet the specifications contained in the MPCA *Drainfield Rock Distribution Media Recommended Standards and Guidance Document*.

For proprietary distribution media products, the Listing provides the name of the company, along with a link to the company website and contact information. The *List of Registered SSTS Proprietary Distribution Media Products* is found on MPCA's website at: https://www.pca.state.mn.us/water/registered-distribution-media. The product name and model is listed, dimensional information regarding the product for sizing, along with information on how the product is to be used in Minnesota.

IV. E. 6. Product information

Manufacturers provide information to the MPCA as part of the registration process. The items listed under the section, 'Important Product Use Information' contains relevant information for each registered product. The following provides a brief overview of the information contained under this section of the product listing:

- Notice of product listing – official notification letter from the MPCA to the manufacturer that the product is registered for use in Minnesota; describes its rated capacity, treatment level, and conditions for product use
- Submitted drawings – drawings that show the layout of treatment or distribution product(s) that were submitted with the initial application for product registration
- Known limitations – manufacturer specified known limitations of their treatment or distribution product
- Installation information – manufacturer prepared installation manual showing how the product is properly installed
- Operation and maintenance – manufacturer explains how the product needs to be properly operated and maintained
- Owners information – prepared by the manufacturer that explains the product, similar to a car owner's manual
- Service Contract – service contract prepared by the manufacturer to ensure the product is properly serviced
- Regulators checklist – various checklists and inspection forms developed by the manufacturer for inspectors (i.e., what to inspect at the time of system installation)
- Operating Permit and Management Plan – operating permit template with suggested permit language and monitoring and maintenance requirements; also the Management Plan developed by the University of Minnesota in consultation with the product manufacturer.

IV. E. 7. Product performance and renewal

Proprietary treatment and distribution products are registered in Minnesota for up to three years, unless a product is recalled, found to be defective, or is no longer available. The product renewal process will include a feedback loop on product performance. Field assessments from local units of governments will be requested as part of product renewal. Operating permits issued at the local level should be able to provide a basis for product performance. An independent, third-party audit of system performance may be needed to fully evaluate product performance 'in the field' as the registration process is fully implemented.

IV. E. 8. Upscaling of registered treatment products; splitting flow to treatment and disinfection devices

The National Sanitation Foundation (NSF) currently certifies proprietary treatment products for domestic strength wastewater with design rated capacities to 1500 gallons per day (gpd). Treatment products are typically tested by NSF at flows between 500 and 600 gallons per day for $cBOD_5$ and TSS removal. NSF typically tests the smallest model (i.e. 500 gpd) and then provides an upscale review of the treatment product to 1500 ppd. The products are then listed on the NSF website and are certified to 1500 gpd.

a. Upscaling

For flows >1500 gpd, NSF can also provide an engineering review for upscaling based on a comparison of larger systems designs with those of the smaller, certified systems. The proportional equivalency evaluation by NSF engineering staff typically includes a review of media volume, tank volumes, hydraulic retention time, sludge storage, and aeration for both oxygen and mixing demands.

The MPCA is in agreement with the approach used by NSF in providing an upscale review of treatment products, based on proportional equivalency for the removal of $cBOD_5$ and TSS. This is a common engineering practice. As part of the product registration process, the MPCA provides engineering 'oversight' of each NSF upscale letter to verify proportional equivalency used in the scale up to the desired flow. At this time, the upscale approach does not work for the UV disinfection device currently being used by manufacturers.

b. Splitting flows

For flows >1500 gpd, where multiple modules or pods would be used (i.e. four (4) modules used, each rated at 500 gpd for a total of 2000 gpd), upscaling does not appear to be an issue. However, flow splitting becomes important when multiple modules are used.

For module treatment and disinfection devices, a review of flow splitting devices will be needed as part of product registration. Flow splitting may be used to: 1) split flow among multiple module treatment devices and 2) split flows among multiple disinfection devices.

Manufacturers will be required to submit technical information when flow splitting is required for wastewater products as part of the product registration process. For treatment systems that require 'multiple' pods for design flows that exceed 500 gallons per day, flow splitting to a treatment device may be required. As part of the product registration review process, MPCA engineering review will include an evaluation of potential flow splitting devices identified by the manufacturer to ensure designs will include proper flow splitting techniques. The manufacturer will need to demonstrate the flow splitting devices are:

- designed specifically and reliability to split wastewater flows
- accessible for ongoing operation and maintenance
- monitored to determine flow rates
- adjustable after construction is complete and settlement occurs and have infinite or continuous adjustment (some older gate-type products do not have continuous adjustment feature)

IV. F. Soil dispersal system design

IV. F. 1. Introduction

Wastewater must meet these limits before discharge to the soil dispersal system.

- Design influent BOD_5 of 170 mg/L or less (for septic tank effluent) (or cBOD of 125 or less for registered treatment products)
- Design influent TSS of 60 mg/L or less
- Design influent O&G of 25 mg/L or less and
- Design Hydraulic Loading of 100-150 gpd/Bedroom based Design Flow Worksheet

For high strength waste design please see Section III C.

IV. F. 2. Performance of soil dispersal systems

Soil dispersal systems distribute sewage effluent over a large natural soil infiltrative surface. Primary treatment components and, if used, wastewater strength reduction components, treat the effluent to reduce the waste strength or nutrients to acceptable levels prior to the soil dispersal component. Final polishing and treatment of the effluent occurs as waste is transported through unsaturated flow in suitable soils. Tables IV C and IV D demonstrate the treatment performance expected when septic tank effluent infiltrates through three feet of natural soil or a combination of three feet of natural soil and mound sand at the loading rates specified in chapter 7080.

Table IV C - Performance of soil treatment

Constituent	Units	When loaded with septic tank effluent
BOD_5	mg/L	2
Total Nitrogen*	mg N/L	18.5
TKN	mg N/L	3.9
Organic Nitrogen	mg N/L	2.3
NH_4-N	mg N/L	1.3
NO_3-N	mg N/L	15
Fecal Coliform	col/100 mL	9

*Can vary dependent on soil textures

Table IV D - Performance of natural soils when loaded* with septic tank effluent

Constituent	Soil water quality at	
	24 inches	48 inches
5-day biological oxygen demand (BOD_5)	<1 mg/L	<1 mg/L
Total Kjeldahl Nitrogen (TKN)	0.77 mg/L	0.77 mg/L
Total Nitrogen (TN)	Varies	Varies available
Nitrites & Nitrates (NO_3-N)	21.6 mg/L	13.0 mg/L
Total Phosphorus	.01 – 3.8 mg/L	.02 – 1.8 mg/L
Fecal Coliform	<1 MPN/100mL MPN/100mL	<1 MPN/100mL

*Loading rate based on Minn. R. ch. 7080

IV. F. 3. Major design parameters for all soil dispersal systems types

This section outlines the requirements that apply to all types of soil dispersal systems (trenches, beds, at-grades and mounds for ISTS and MSTS). The general requirements are found in Minn. R. 7080.2150 as outlined below:

a. All treatment and dispersal methods must be designed to conform to all applicable federal, state, and local regulations. (Type I through Type V)
b. Treatment and dispersal processes must prevent sewage or sewage effluent contact with humans, insects, or vermin. (Type I through Type V)
c. Treatment and dispersal of sewage or sewage effluent must be in a safe manner that adequately protects from physical injury or harm. (Type I through Type V)
d. The soil treatment zone must meet the following:
    1) The distance from the bottom of the media to periodically saturated soils or bedrock for systems receiving septic tank effluent (Types I, II and III) or Treatment Level A2, B2 or C (Type IV) must be at least three (3) feet and for soil systems receiving advanced treatment, the separation distances in Table IV E.

Table IV E

	Texture group		
	All sands and loamy sands	**Sandy loam, loam, silt loam**	**Clay, clay loams**
12 to 17	Treatment level A Uniform distribution Timed dosing	Treatment level A Uniform distribution Timed dosing	Treatment level A Uniform distribution Timed dosing
18 to 35	Treatment level B Uniform distribution Timed dosing	Treatment level B Uniform distribution Timed dosing	Treatment level B Uniform distribution
36+	Treatment level s A-2 , B-2 or C Uniform distribution	Treatment level s A-2 , B-2 or C Uniform distribution	Treatment level s A-2 , B-2 or C Uniform distribution

    2) Soil that are sand or loamy sand texture with 35 to 50 percent rock fragments must be credited at only one-half their thickness as part of the necessary treatment zone. Soil layers, regardless of soil texture, with greater than 50 percent rock fragments must not be credited as part of the necessary treatment zone (Type I – IV)
    3) The entire treatment zone must be within seven (7) feet of final grade (Type I – IV)
    4) This zone cannot be interrupted by zones of periodic saturation. (Type I through IV) This zone must be maintained during operation (i.e., for MSTS this must account for the effects of groundwater mounding)
    5) MSTS requires a minimum of 24 inches of vertical separation distance.

e. The distribution system or media must not place a hydraulic head greater than 30 inches above the bottom of the bottom absorption area. (Type I through IV)
f. Soil treatment and dispersal systems must not be designed in floodways. Soil treatment and dispersal systems installed in flood fringes must meet the requirements in Minn. R. 7080.2270. (Type I through Type V)
g. SSTS components must be set back in accordance with Table VII in Minn. R. ch 7080. (Type I through Type V)
h. Employ components registered under Minn. R. 7083.4070 and 7083.4080 that are installed, used, and operated according to the conditions placed on registration. (Type IV)

i. Employ structural components and joint sealants that meet or exceed the system's expected design life. (Type I and Type IV)

j. The system's absorption area must be original soil. (Type I, II and IV)

l. The system's absorption area must be sized according to Table IX or IXa (Type I – IV)

m. If drainfield rock medium is employed, a durable, non-woven geotextile fabric must be used to cover the distribution rock medium. The fabric must be of sufficient strength to undergo installation without rupture. The fabric must permit passage of water without passage of overlying soil material into the rock medium. (Type I - IV)

n. A minimum of 12 inches of final cover, with six inches of the cover being topsoil borrow, shall be placed over the system. (Type I - IV))

o. A close-growing, vigorous vegetative cover must be established over the soil treatment and dispersal system and other vegetatively disturbed areas. The sodding, seeding, or other vegetation establishment shall begin immediately after the placement of the topsoil borrow. The soil treatment and dispersal system must be protected from erosion and excessive frost until a vegetative cover is established. The vegetative cover established must not interfere with the hydraulic performance of the system and shall provide adequate frost and erosion protection. Trees, shrubs, deep- rooted plants, or hydrophytic plants must not be planted on the system. (Type I - IV)

p. Employ flow measurement if a pump is employed. (Type I - IV)

q. Employ pressure distribution if waste strength is reduced (Type IV)

r. Divert surface water around system (Type I -IV)

IV. F. 4. Design for nitrogen reduction components

a. Nitrogen BMPs

Nitrogen BMPs are required to be employed for systems with a design flow between 2501 and 5000 gallons per day, which discharge above a sensitive aquifer, and MSTS which do not discharge above a sensitive aquifer, to mitigate water quality impacts to ground water.

The methods that qualify as BMPs, along with some design details are as follows:

1) Blackwater separation with only grey water discharge to the system.
If this method is to be employed, the method used for managing toilet waste may need to be approved by the plumbing unit at the Department of Labor and Industry (DOLI). In addition some means (such as installing a two-inch building drain and sewer - subject to DOLI approval) would prohibit future installation of a flush toilet. The management plan would include a periodic inspection that no toilet wastes have been routed into the system.
2) Use of a recirculating media filter
Please refer to Section IV C of the *Recirculating Sand Filter Recommended Standards and Guidance* at: http://www.pca.state.mn.us/publications/wq-wwists4-41.pdf.
3) Placing a mound systems on a loamy or finer topsoil which has medium or high in organic matter content
In a mound system the ammonia nitrogen from the septic tank is nitrified in the aerated sand beneath the media bed. When the effluent hits the natural topsoil which has moderate or high clay and organic matter, the nitrified effluent can be partially reduced to nitrogen gas. In order for this method to qualify as a nitrogen-reducing best management practice, the mound must be placed on a topsoil that has a soil texture of sandy loam or finer, and has a color value of three or less. In addition the dosing frequency cannot be any greater than four (4) doses per day.
4) Use of a registered nitrogen reduction treatment device

Please refer to the registered products listing at: https://www.pca.state.mn.us/water/registered-treatment-products

5) Other BMPs which require a Board geoscientist or engineer with adequate training and experience
   Justification on the appropriateness and effectiveness of their use must be provided to the local unit of government. The following methods can be explored to mitigate the effect of nitrogen on the groundwater:

   § use of natural nitrogen reduction from the groundwater
   § dilution by upgradient groundwater or stormwater basins
   § the use of recovery wells for irrigation
   § denitrification by riparian areas
   § growth and removal of plant materials which will take-up the nitrogen

Generally groundwater flow direction cannot be used to determine groundwater sensitivity as future down gradient areas may be developed with the subsequent use of groundwater. However, groundwater flow direction may be used if restrictions are placed on the down gradient areas to the discharge point. Careful consideration needs to be given on any changes to the native groundwater direction due to the mounding of the groundwater beneath the system and the groundwater drawn-down by nearby wells.

Lastly, a detailed hydrogeological assessment can be conducted to show that the desktop assessment indicating an impact is incorrect and that no nitrogen BMP is necessary.

b. Designing to treat nitrogen to 10 mg/l

   MSTS which will discharge above a sensitive aquifer must treat the sewage (naturally or mechanically) to meet a total nitrogen concentration of 10 mg/l or less at the property boundary or nearest receptor, whichever is closer.

   In many cases, multiple methods may be needed to reduce concentration of nitrogen in the sewage to meet a goal of 10 mg/l at the property boundary or nearest receptor, whichever is closest. Design of a non-registered nitrogen treatment component must be designed by a BP engineer. Any natural nitrogen treatment processes in groundwater, or dilution of nitrogen by upgradient groundwater must be made by a BP geoscientist or engineer with adequate training and experience. In addition, monitoring wells placement and depth shall be determined by a trained and experienced BP.

IV. F. 5. Dispersal component selection

The following section is offered to assist the user of this manual in the decision of which soil component to use based on the soils available and the amount of fecal reduction employed prior to the soil.

Waste treatment devices and soil/site conditions dictate the use of one type of dispersal component over another. Sites with deep permeable soils may be suitable for trench or bed type dispersal components while at-grades and mounds will be more suitable on sites where limiting layers in the soil are located too close to the surface for installation of trench or bed dispersal components.

The following two tables (for ISTS and MSTS) indicate which soil components may be employed based on the depth of the limiting layer from the ground surface to and the degree of fecal reduction prior to the soil system (Level A, A2, Bb, B2 or C treatment see Minn. R. 7083.4030).

The soil dispersal system selection process is as follows:

a. List the depth to the periodically saturated soil or bedrock: _____________ inches

b. List the pretreatment level: Level A, A2, B, B2 or C/Septic Tank Effluent

c. Determine the Suitable Soil Dispersal System for advanced design SSTS from the Tables IV F or IV G:

Table IV F - Suitable soil component for ISTS

Depth from the ground surface to periodically saturated soil or bedrock*	<12"	12 to 17"	18"	19 to 23"	24"	25 to 35"	36 to 42"	43"+
Treatment Level A	N/A**	At-grades, Mounds	At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds
Treatment Level B	N/A**	Mounds	At-grades, Mounds	At-grades, Mounds	At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds
Treatment Level A2, B2 or C or septic tank effluent	N/A**	Mounds	Mounds	Mounds	Mounds	Mounds	At-grades (@36"), Mounds	Trenches, Beds, At-grades, Mounds

**Assuming six (6) inches of media below the distribution pipe with the pipe invert one (1) inch below the original ground surface. This chart is based on no groundwater mounding under the system. If mounding is to be factored, these separation distances will need to be increased by the height of the groundwater mound.*

***Type III system design*

Table IV G - Suitable soil component for MSTS

Depth from the ground surface to periodically saturated soil or bedrock*	<12"	12 to 17"	18"	19 to 23"	24"	25 to 30"	31 to 42"	43"+
Treatment Level A	N/A**	Mounds	Mounds	Mounds	At-grades, Mounds	At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds
Treatment Level B	N/A**	Mounds	Mounds	Mounds	At-grades, Mounds	At-grades, Mounds	Trenches, Beds, At-grades, Mounds	Trenches, Beds, At-grades, Mounds
Treatment LevelA2, B2 or C or septic tank effluent	N/A**	Mounds	Mounds	Mounds	Mounds	Mounds	At-grades (@36"), Mounds	Trenches, Beds, At-grades, Mounds

**Assuming six (6) inches of media below the distribution pipe with the pipe invert one (1) inch below the original ground surface. This chart is based on no groundwater mounding under the system. If mounding is present, these separation distances will need to be increased by the height of the groundwater mound.*

***Type III system design*

IV. F. 6. Determine hydraulic soil loading rates based on organic loading rates

If the sewage is from domestic sources, such as dwellings, the hydraulic soil loading rates can be found in Tables IX or IXa in Minn. R. ch. 7080. The resulting organic loading rate will not exceed the values in Table IV H 1. To determine the absorption area required, divide the design flow by the soil loading rate.

If dealing with high strength waste, sizing will depend on if the waste strength can adequately be reduced to Level C concentrations or less. If so, then use the sizing procedure for dwellings. If the effluent cannot reach Level C concentrations ($cBOD_5$ =<125 mg/l (i.e., BOD_5 of 170 mg/l), TSS =< 60 mg/l or O&G =< 25 mg/l) then the hydraulic loading rate will be based on the organic loading rate. The organic loading rate cannot exceed values in Table IV H 1 and it is recommended that they do not exceed values in Table IV H 2:

Table IV H 1 - Maximum waste strength loading rates based on design flow

Bottom Area Only*

Loading Rate (g/d/ft2)	BOD (170 mg/l)	TSS (60 mg/l)	O&G (25 mg/l)
1.2	0.0017	0.0006	0.0003
0.78	0.0011	0.0004	0.0002
0.68	0.0009	0.0003	0.0001
0.6	0.0009	0.0003	0.0001
0.52	0.0008	0.0003	0.0001
0.5	0.0007	0.0003	0.0001
0.45	0.0006	0.0002	0.0001
0.42	0.0006	0.0002	0.0001

**Based on organic loading to a Type I system. – Design flow, bottom area loading only with six (6) inches of sidewall with concentrations of BOD_5 of 170 mg/l, TSS of 60 mg/l and O&G of 25 mg/l. The actual loading rate delivered to operating systems is about 50% of these values due to actual flow being less than design flow.*

Table IV H 2 - Sustainable waste strength loading rates based on design flow

Bottom Area Only*

Soil Texture	Sustainable BOD Loading ($lbs/ft^2/day$)	Sustainable TSS Loading ($lbs/ft^2/day$)	Sustainable FOG Loading ($lbs/ft^2/day$)
All Sands	0.001191	0.00042	0.000175
Sandy loam	0.000774	0.000273	0.000114
Fine sand, loam	0.000595	0.000210	0.000088
Silt loam	0.000496	0.000175	0.000073
Clay loams	0.000447	0.000158	0.000094

**These values are 70 % of maximum allowable organic loading rates for Type I systems to provide a more representative waste loading versus a peak waste loading.*

The organic loading rate to the absorption area can be calculated as follows:

____________	x ____________	x 0.00000835 =	__________	lbs of contaminant/day
Design Flow (gpd)	Conc. of Contaminant (mg/l)			

Absorption area required is calculated as follows:

________________________	/ ___________________________	=	____________________
lbs of contaminant/day (BOD, TSS, or O&G)	lbs of contaminant ft2/day (from table)		ft2 of absorption area/day

IV. F. 7. Design considerations for groundwater mounding

a. ISTS

A detailed mounding assessment is not required for systems with a flow of 5,000 gallons per day or less. To mitigate mounding for this size of system, a contour loading rate of =< 12 gpd/lineal foot must be employed for above ground ISTS. In addition the ANTM model can be used. However a groundwater mounding assessment as described for MSTS is recommended if site conditions exist which may exacerbate groundwater mounding (high clay soils, restrictive layers, flat slope, and poor surface or internal drainage).

General design considerations to mitigate groundwater mounding are found in Section III G.

b. MSTS

The design of a MSTS soil dispersal system must account for groundwater mounding as determined by an assessment provided in this document or conducted by a BP geoscientist or engineer with adequate training and experience. The system design needs to be modified by the advanced designer if groundwater mounding indicates that the needed vertical separation distance will not be met. The groundwater mounding mitigation techniques found in Section III G. may be applied, and the design and the mounding re-examined on the new design.

The advanced designer must design a monitoring scheme to measure the separation distance during the lifetime of the operating system. The monitoring location and frequency shall be such to capture the peak seasonal saturation level at or near the center of the system. It is recommended that the advanced designer develop a mitigation plan in the event the system is found to be in violation of the designed vertical separation distance. Please refer to Section VI C.

IV. F. 8. Design of trenches

The following chart describes the design requirements for ISTS and MSTS which require advanced design trench systems:

<table>
<tr><td>Maximum. Waste Strength</td><td>Type I = BOD_5 =<170 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l
Type IV =
Level A and A2 = $cBOD_5$ =<15 mg/l, TSS =<15 mg/l
Level B and B2 = $cBOD_5$ =<25 mg/l, TSS =<30 mg/l
Level C = $cBOD_5$ =<125 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l</td></tr>
<tr><td>Design Flow</td><td>2,500 to 10,000 gpd</td></tr>
<tr><td>Flow Measurement</td><td>ISTS – Systems with a pump
MSTS – All</td></tr>
<tr><td>Slope</td><td>No slope restriction</td></tr>
<tr><td>Soil</td><td>Native soil. Soil must have loading rate listed in Tables Table IX or IXa</td></tr>
<tr><td>Bottom Area Sizing</td><td>Flow / Soil Loading Rate (Flow Determined by Flow Worksheet, Soil Loading Rate determined by Table IX or IXa</td></tr>
<tr><td>Bottom Area Sizing
(Reduction for sidewall)</td><td>
<table>
<tr><td colspan="2">Type I - III</td><td rowspan="6">Type IV – No sidewall reduction</td></tr>
<tr><td>Sidewall Depth (inches)</td><td>Percent Bottom Area Reduction</td></tr>
<tr><td>6 to 12</td><td>no reduction</td></tr>
<tr><td>12 to 17</td><td>20%</td></tr>
<tr><td>18 to 23</td><td>34%</td></tr>
<tr><td>24</td><td>40%</td></tr>
</table>
</td></tr>
<tr><td>Unit Width</td><td>=< 36 inches</td></tr>
<tr><td>Unit Spacing</td><td>Natural undisturbed soil between units</td></tr>
<tr><td>Contour Loading Rate/Ground water mounding</td><td>MSTS – must conduct mounding assessment</td></tr>
<tr><td>Inspection Pipes</td><td>4” minimum in every unit, opposite end of distribution point</td></tr>
<tr><td>Level/Contour</td><td>The top and bottom of the distribution medium level along the contour</td></tr>
<tr><td>Depth</td><td>Minimum soil cover of 12” (same soil texture as native soil), entire soil treatment zone must be within 7 feet of final grade</td></tr>
<tr><td>Distribution</td><td>Pressure distribution is required for:
· All Type IV systems
· All MSTS
· One option for sandy soil conditions</td></tr>
</table>

IV. F. 9. Design of seepage beds

The following chart describes the design requirements for ISTS and MSTS which require advanced design seepage bed systems:

Effluent Treatment Level	Type I = BOD_5 =<170 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l Type IV = Level A and A2 = $cBOD_5$ =<15 mg/l, TSS =<15 mg/l Level B and B2 = $cBOD_5$ =<25 mg/l, TSS =<30 mg/l Level C = $cBOD_5$ =<125 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l
Design Flow	2,500 to 10,000 gpd
Flow Measurement	ISTS – Systems with a pump MSTS – All
Slope	< 6%
Soil	Native soil - Soil must have loading rate listed in Tables Table IX or IXa
Bottom Area Sizing	Flow/Soil Loading Rate (Flow Determined by Flow Worksheet, Soil Loading Rate determined by Table IX or IXa System sized increased by 50 percent if gravity distribution.
Bottom Area Sizing (Reduction for sidewall)	No bottom area reduction for sidewall area
Unit Width	Greater than 3' and 25' or less
Unit Spacing	One-half the bed width
Contour Loading Rate/Ground water mounding	MSTS – must conduct mounding assessment
Inspection Pipes	4" minimum in every unit,
Level/Contour	The top and bottom of the distribution medium level along the contour
Depth	Minimum soil cover of 12" - same soil texture as native soil, entire soil treatment zone must be within 7 feet of final grade
Floodplain	No beds in floodplains
Distribution System	Pressure distribution is required for: · All at-grades and mounds · All Type IV systems · All MSTS · All beds over 12' wide · One option for sandy soil conditions

IV. F. 10. Design of at-grade systems

The following chart describes the design requirements for ISTS and MSTS which require advanced design at-grade systems:

Effluent Treatment Level	Type I BOD_5 =<170 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l Type IV = Level A and A2 = $cBOD_5$ =<15 mg/l, TSS =<15 mg/l Level B and B2 = $cBOD_5$ =<25 mg/l, TSS =<30 mg/l Level C = $cBOD_5$ =<125 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l
Design Flow	2,500 to 10,000 gpd
Flow Measurement	Flow measurement required
Site Slope	Less than 25 percent
Soil	Native soil. Upper 12 inches of soil must have loading rate of 0.45 gpd or greater in Table IX or IXa, in chapter 7080. Three feet of suitable soil for systems w/o pretreatment.
Bottom Area Sizing	Flow / Soil Loading Rate (Flow Determined by Flow Worksheet, Soil Loading Rate determined by Table IX or IXa (Type I - IV)
Contour Loading Rate/Ground water mounding/System width	ISTS =< 12 gallons/lineal foot (ISTS). MSTS – must conduct mounding assessment Bed must not exceed =< 15 feet (does not include upslope width)
Inspection Pipes	4" minimum along downslope portion
Level/Contour	Upslope edge of the distribution medium level along the contour
Cover	Six inches of loamy or sandy cover material. Cover must extend at least five feet from the ends of the rock bed. Side slopes must not be steeper than four horizontal units to one vertical unit. Six inches of topsoil borrow must be placed on the cover material
Distribution System	Pressure distribution required

IV. F. 11. Design of mound system

The following chart describes the design requirements for ISTS and MSTS which require advanced design mound systems:

Effluent Treatment Level	Type I = BOD_5 =<170 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l Type IV = o Level A and A2 = $cBOD_5$ =<15 mg/l, TSS =<15 mg/l o Level B and B2 = $cBOD_5$ =<25 mg/l, TSS =<30 mg/l o Level C = $cBOD_5$ =<125 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l
Design Flow	2,500 to 10,000 gpd
Flow Measurement	Flow measurement required
Site Slope	No maximum rule value, but if natural slope is 33 percent or greater the maximum 3:1 berm slope will not "catch-up" with the hill slope.
Soil	Native soil - Upper 12" w/o periodically saturated soil or bedrock. Soil must have mound absorption ratio listed in Table IX or IXa in chapter 7080 -
Media Bed Sizing	Flow / 1.2 gpd/ft_2 for Septic tank effluent or Treatment Level C Flow x 1.6 gpd/ft_2 for Level A, A2, B or B2 treatment
Native Soil Area Sizing	Multiple the media bed width by the mound absorption ratio in Tables IX or IXa, of upper 12" of soil
Native Soil Area Geometry	On slopes from zero to one percent must be centered under the mound distribution media bed width. On slopes greater than one percent must be measured downslope from the upslope edge of the mound distribution media bed width and measured in the direction of the original land slope and perpendicular to the original contours (Type I rule, Type IV recommendation).
Contour Loading Rate/Ground water mounding, Bed width	ISTS =< 12 gallons/lineal foot (ISTS). MSTS – must conduct mounding assessment ISTS and MSTS – Maximum bed width of 10 feet.
Side Slopes	3:1 Maximum, no Minimum
Inspection Pipes	4" minimum, any location in media
Level/Contour	Upslope edge of the distribution medium level along the contour. Not in swales. Media bottom and top level in all directions
Fill Sand	**Sieve Size** — **Percent Passing** No. 4 — 95-100 No. 8 — 80-100 No. 10 — 0-100 No. 40 — 0-100 No. 60 — 0-40 No. 200 — 0-5 Contain less than three percent deleterious substances and be free of organic impurities Minimum depth of 12" on upslope edge final height dependent on required separation distance **Sieve Size** — **Percent Passing** No. 200 — 0-5

Effluent Treatment Level	Type I = BOD_5=<170 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l Type IV = o Level A and A2 = $cBOD_5$=<15 mg/l, TSS =<15 mg/l o Level B and B2 = $cBOD_5$=<25 mg/l, TSS =<30 mg/l o Level C = $cBOD_5$=<125 mg/l, TSS =<60 mg/l, O&G =< 25 mg/l
	Contain less than three percent deleterious substances and be free of organic impurities Minimum depth of 12" on upslope edge final height dependent on required separation distance
Cover	Six inches of loamy or sandy cover material at edges of the media and must be sloped upward toward the middle at 10:1 slope. Six inches of topsoil borrow must be placed on the cover material.
Distribution System	Pressure distribution required

IV. G. Design worksheets

The step-by-step method to design systems can be accomplished by using the University of Minnesota's design forms (worksheets). They can be found at: https://septic.umn.edu/ssts-professionals/forms-worksheets.

V. Collection system design

V.A. Overview

This section of the design manual will describe collection system design. Collection systems are set up to transport wastewater from a number of connection points to a central treatment location. The following sections will describe detailed design guidance for two broad types of collection sewer systems, gravity and pressure. The purpose of this overview is to describe some basic items for the advanced designer to consider with both types of collection systems in mind, as the decision is considered for which type of collection system to select for a specific project location.

Four basic items or local site conditions should be considered as the advanced designer is determining the type of collection system to design for a project or site specific location. These four items are not in any specific order.

- Density or distance separation of the buildings with sewer connections to be served by a collection system
- Topography of the area with buildings to be served by a collection system, along with the relative elevation of the proposed treatment site
- Soil conditions and possible presence or absence of bedrock in the soils along the collection system routing
- Depth to groundwater on the collection system routing

Recognition of these four basic local site conditions will assist the advanced designer in determining if a gravity or pressure collection system could be used at a site, and will also assist the advanced designer in determining if one type of collection system will have design advantages over the other for an individual project.

Two brief examples may be helpful to describe collection systems choices.

Example one is a small rural area at an intersection of two county roads. There are 10 dwellings with small lots, with sandy loam soils and the regional groundwater table is 20 feet below grade. The area topography has a gentle slope toward the treatment site. This may be a good location to consider a gravity collection system.

Example two is eight (8) dwellings on large lots spread out along a lake front area with bedrock at 9 feet. The topography is relatively flat along the home sites, dropping off toward the lake. The treatment site is located on higher ground further away from the lake. This may be a better location to consider a pressure type collection system.

The advanced designer can also consider the overall costs when making the collection system choice. This would include the construction costs, and the long term operation and maintenance costs of the collection system. Gravity collection systems will likely have higher construction costs due to deeper sewer burial, but will have advantages with reduced long term operation costs because less electricity will likely be used for pumping. Pressure systems will likely have lower construction costs due to a more consistent depth of burial for the pressure sewer, but will have a disadvantage on costs due to the long term use of electricity for pumping to create the pressure and a schedule for replacement of pumps that wear out over time. Collection systems with individual septic tanks (see STEG and STEP in gravity and pressure collection system design sections) at each service connection will have different construction and maintenance costs versus using common septic tanks at the treatment site.

It is recommended the advanced designer consider all of the potential local site conditions and both the possible construction and long-term maintenance costs when selecting a type of collection system for a specific location. A cost effective analysis of the long-term annualized costs of construction and the operation and maintenance costs is the preferred method to assist the advanced designer to select the type of collection system for a project.

V. B. Gravity collection system design

V. B. 1. Introduction

There are two types of gravity collections systems that will be described within this design guidance document, conventional collection systems and Septic Tank Effluent Gravity (STEG) systems. Conventional gravity collection systems have the individual gravity building sewer directly connected to the common gravity collection sewer system that transports the wastewater from a number of buildings to the treatment site. A STEG gravity collection system includes individual gravity building sewers that are connected to individual septic tanks at each building site, with the gravity outlet pipe from the septic tank connected to the common gravity collection sewer system that transports the wastewater to the treatment site (see section IV. B. for stilling tank design).

This set of gravity collection design concepts is for residential or domestic strength wastewater. Residential or domestic strength wastewater concentrations are considered to be equivalent to a five - day Biochemical Oxygen Demand (BOD_5) in the range of 110 to 400 mg/L, Total Suspended Solids (TSS) in the range of 100 to 350 mg/L, and Oil and Grease of 70 to 105 mg/L. Non- residential strength wastewater must have pretreatment to reduce the pollutant concentrations to less than or equal to the range of residential wastewater concentrations, and then gravity collection may be used for this wastewater. An example of non-residential strength wastewater would be restaurants or any locations with food preparation. The number of residential service connections can be from approximately five (5) to 30 dwellings (Example Class I, two (2) bedroom dwellings). The number of non-residential service connections is limited by the design flow of 10,000 gpd. The ISTS or MSTS gravity collection system cannot be extended to additional service connections beyond the total of 30 residential connections.

V. B. 2. Definitions

Gravity collection sewer means the collector sewer pipe that is the sewer pipe located in the public right of way or is located on private parcels of land and is transporting the wastewater from five (5) or more service connections to a treatment and dispersal site.

Service connection means the pipe from the residential, the non-residential unit or from the septic tank for a residential or non-residential unit that transports wastewater to the gravity collection sewer.

V. B. 3. Design flow

The design flow for the gravity collection system shall be calculated using the design flow from Table IV (Minn. R. 7080.1860) for Class I dwellings and number of bedrooms for each residence. Non-residential design flows shall be calculated based on Table I (Minn. R. 7081.0130). The design flow shall be equal to the sum of all residential and non-residential design flows plus the calculated infiltration rate for the collection system at 200 gallons per inch diameter per mile length of collection pipe. In general design flow, in gravity collection systems, is used to assist the advanced designer to determine septic tank sizing, whether individual STEG tanks are used at connection points or to size common septic tanks at the treatment site. The design flow should also be considered for the number of on and off cycle times if a lift station is used in the collection system.

The design flow for the gravity collection system shall be three (3) times the total sum of the design flow from the residential and non-residential service connections plus the calculated infiltration rate of the collection system. The design flow **for gravity collection** shall be used to determine if the gravity collection system piping has adequate capacity to transport this flow. As systems get smaller the potential for a larger peak is part of the design procedure. For lift station design another value to evaluate is 50 percent of the design flow in one hour. The greater of these values should be incorporated into any lift station designed for a gravity collection system must be capable of pumping the greater of these two flows to the remaining collection system components or to the treatment site.

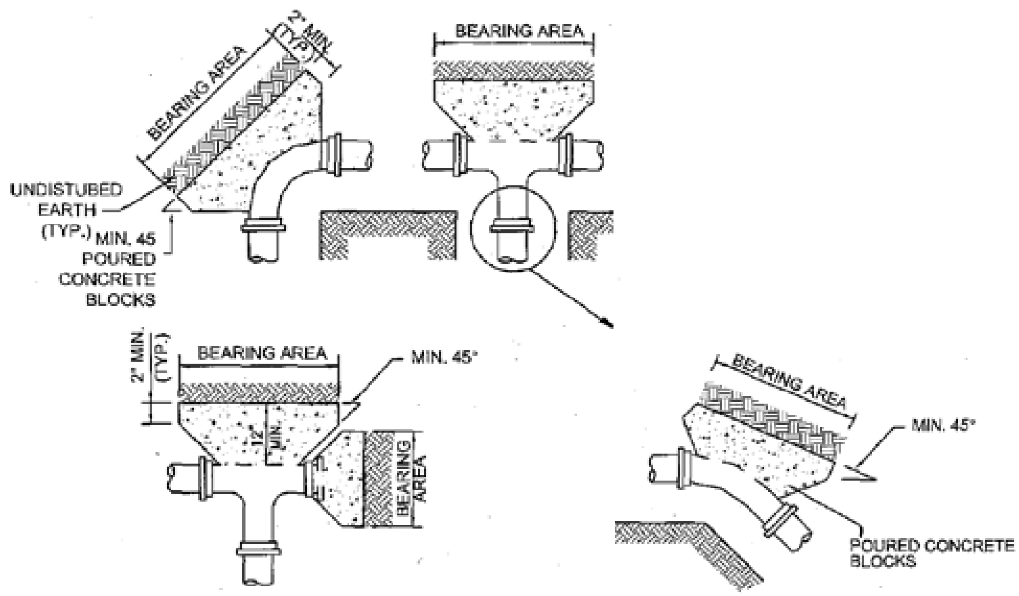
V. B. 4. Design pipe diameter, materials and slope

The allowable minimum diameter for the gravity collection sewer will be 4-inch Standard Dimension Ratio (SDR) 35 pipe or SDR 26 pipe for road crossings for gravity collection systems that use an individual septic tank(s) with an effluent screen at each home (also called Septic Tank Effluent Gravity (or STEG)) system.

The allowable minimum diameter for the gravity collection sewer will be 6-inch SDR 35 pipe, or SDR 26 pipe for road crossings, for gravity collection systems that connect each individual residential service connection directly to gravity collection sewer main.

The minimum slope for a 4-inch or 6-inch diameter gravity collection sewer shall be 1/8 inch per foot to maintain a minimum cleansing velocity of 2 feet per second (ft/sec) assuming full pipe flow. The maximum slope gravity collection sewer slope should be 0.2 feet per foot (or 20 percent) for 4-inch or 6-inch diameter sewer to maintain a maximum velocity below 15 ft/sec. If sewer slopes greater than 0.2 feet per foot are designed, the pipe must be secured with concrete anchors. Anchors shall be spaced at 36 feet for slopes from 0.2 to 0.35 feet per foot, at 24 feet for slopes from 0.35 to 0.5 feet per foot, and at 16 feet for slopes over 0.5 feet per foot. Thrust blocks shall be used at the lower end of the pipe slope to prevent damage or movement of pipe sections, and must be placed against undisturbed soil. Thrust block minimum bearing areas, size and shapes are shown in Figure V.A and Table V.A.:

Figure V.A. Thrust block details



Notes

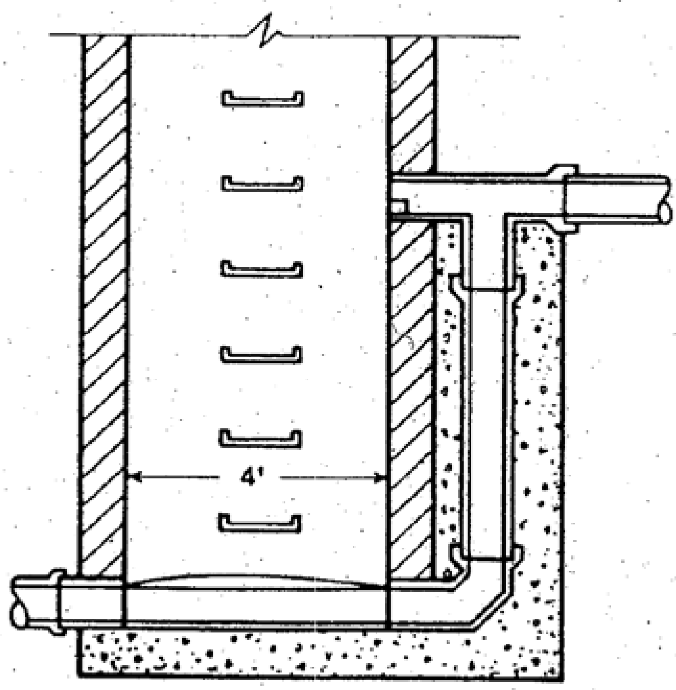
a. Prefabricated thrust blocks are not permissible.
b. Minimum concrete strength is 3000 psi at 28 days.
c. Place 4 mil. Polyethylene between concrete and fitting (Concrete shall not interfere with joint).
d. Minimum concrete thickness shall be 12 inches.
e. The horizontal dimensions of the bearing area shall be between 0.8 and 1.25 times the vertical dimension.
f. Thrust block orientation shall be such that the center of the fitting corresponds with the center of the thrust block.
g. The minimum allowable angle (either vertical or horizontal) shall be 45 degrees.

Table V.A.: Bearing area of thrust block in square feet (ft²)

Pipe Size (inches)	Tee & End	90º Bend	45º Bend	22 ½º Bend	11 ¼º Bend
4 or less	2.0	2.0	2.0	2.0	2.0
6	2.0	2.0	2.0	2.0	2.0
8	2.5	3.0	2.0	2.0	2.0

Drop cleanouts or manholes should be used at the lower end of these steep slope sewer sections to allow entrained air in these pipe sections to dissipate. Figure V.B. shows an example of a drop manhole.

Figure V.B.: Drop manhole



Eight (8) inch diameter gravity collection SDR 35 pipe, or SDR 26 pipe for road crossings, may also be used for gravity collection systems that connect each individual residential service connection directly to gravity collection sewer main. The minimum slope for 8inch diameter pipe is 0.004 feet per foot (or 0.4 feet per 100 feet).

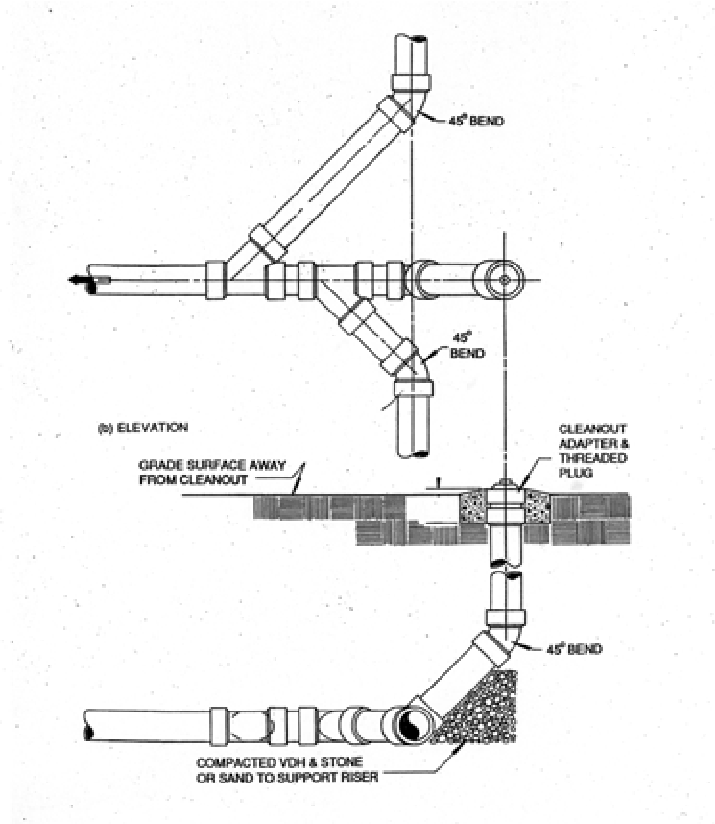
V. B. 5. Design sewer setback, alignment, and depth

Gravity collection sewer shall be laid at least 10 feet horizontally from any existing or proposed water main. Gravity collection sewer crossing water mains shall be laid to provide a minimum vertical distance of 18 inches from the outside of each pipe. Gravity collection sewer main shall be located at least 50 feet from a private well or public water supply well.

Gravity collection sewer shall be laid straight between cleanouts (or manholes). The grade or slope of the gravity sewer shall remain uniform between cleanouts (or manholes if used). Alignment and slope shall be checked by using a laser level or equivalent method

At a minimum, a cleanout must be placed at the upstream terminal end of the gravity collection sewer main, at the intersection of each sanitary main connection, at any change in sanitary main diameter, at any change in sanitary main slope or alignment, or every 100 feet of pipe length, whichever is less (See Figure V.C.). Manholes may be used as an alternative to cleanouts.

Figure V.C. Cleanout detail example



Manholes may be used as an alternative to cleanouts. Manholes shall be spaced no more than 400 feet apart or installed where the main changes in diameter, slope or alignment, and at major junctions. A combination of cleanouts and manholes may be allowed. Cleanouts or manholes must be brought to the ground surface, and the ground surface shall be sloped away from the cleanout cover or manhole cover to prevent the entrance of surface water.

Gravity collection sewer shall be laid at a minimum depth of seven (7) feet to prevent freezing. This 7-foot minimum depth is for the southern part of Minnesota as shown on Figure V.D. (or Table V.D. lists minimum frost depth by county name). This figure also shows that the minimum depth increases as the location of the sewer main moves farther north in the State. Gravity sewer depths designed at less than the minimum depth shown on Figure V.D. shall only be allowed with insulation used to prevent freezing. Insulation shall also be used for sewer mains crossing under paved roads, driveways or parking lot areas, and under unpaved traffic areas.

Figure V.D. Minimum sewer depth for frost protection

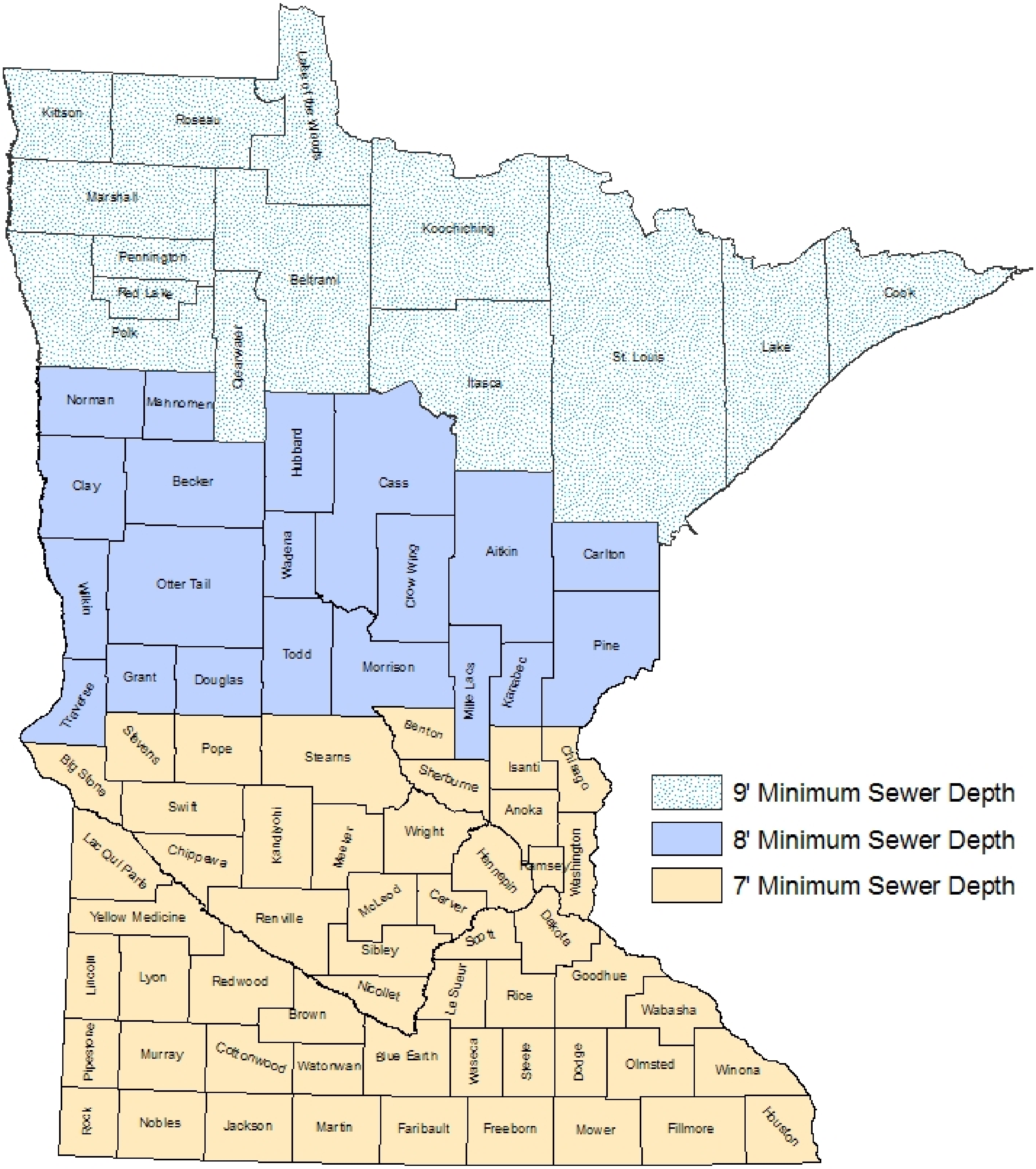


Table V.D. Minimum sewer frost depth for frost protection

Listed by Minimum Frost Depth and County Name (87 Counties Alphabetical by Depth Zone)
7’ Minimum Depth (53 Southern and Central Counties)
Anoka, Benton, Big Stone, Blue Earth, Brown, Carver, Chippewa, Chisago, Cottonwood, Dakota, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Hennepin, Houston, Isanti, Jackson, Kandiyohi, Lac Qui Parle, Le Sueur, Lincoln, Lyon, Martin, Mc Leod, Meeker, Mower, Murray, Nicollet, Nobles, Olmsted, Pipestone, Pope, Ramsey, Redwood, Renville, Rice, Rock, Scott, Sherburne, Sibley, Stearns, Steele, Stevens, Swift, Wabasha, Waseca, Washington, Watonwan, Winona, Wright, and. Yellow Medicine
8’ Minimum Depth (20 North Central Counties)
Aitkin, Becker, Carlton, Cass, Clay, Crow Wing, Douglas, Grant, Hubbard, Kanabec, Mahnomen, Mille Lacs, Morrison, Norman, Ottertail, Pine, Todd, Traverse, Wadena, and Wilkin
9’ Minimum Depth (14 Northern Counties)
Beltrami, Clearwater, Cook, Itasca, Kittson, Koochiching, Lake, Lake of the Woods, Marshall, Pennington, Polk, Red Lake, Roseau and St. Louis
If insulation is used, it shall be extruded polystyrene foam insulation that meets Mn/DOT Specification 3760 and has a minimum density (kg/m^3) of R-21. The insulation shall be centered on the sewer, and shall be installed at a depth of at least 18 inches below finished grade with 6 inches of sand cover, and at least 6 inches above the sewer with 3 inches of sand directly below the insulation. The minimum insulation thickness shall be equivalent to 1 inch per foot of soil cover over the sewer that is reduced. The insulation width shall be a minimum of 4 feet, and the length 8 feet.
Insulated SDR 35 or SDR 26 (for road crossings) sewer pipe may be used as a substitute for separate sewer pipe and insulation. If insulated pipe is used, the insulation around the pipe shall meet the minimum density (kg/m^3) of R-21.

V. B. 6. Design sewer main trench, trench bedding and backfill material

Gravity collection sewer main shall be installed according to the American Society of Testing and Materials (ASTM), Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, ASTM D2321 (2005). This design reference will highlight particular points of emphasis from ASTM D2321, the advanced designer is expected to know and understand the entire ASTM D2321 standard.

The minimum width of the trench excavation for 4 inch diameter sewer main shall be equal to 20 inches, and the minimum width of the trench excavation for 6 inch sewer main shall be 22 inches. These minimum trench widths are specified to allow room for proper preparation of the trench for the pipe foundation, bedding, haunching and initial backfill (also known as pipe embedment) and final backfill. See Figure 1. from ASTM D2321 to show these areas of the trench.

In general, it is preferable to use native soil as the pipe foundation, if the native soils are Class I, II or III according to ASTM D2321. Minimize excavation depth to allow supporting the pipe on the native material for the foundation. If the native material is a Class IV or V according to ASTM D2321, it shall be removed and Class I, II or III material shall be placed in the trench as foundation material and compacted to 95 percent maximum density. The trench foundation shall be dry during construction of the sewer.

Bedding shall be placed in the trench on the foundation below the pipe, and shall be Class I, II or III material compacted to 95 percent maximum density. The pipe shall be placed on the bedding, and the haunching material shall be placed to provide a cradle for the pipe to approximately the centerline of the pipe. Haunching shall be Class I, II or III material compacted to 95 percent maximum density. Initial backfill shall be placed above the haunching and shall extend from the centerline of the pipe to from 6 to 12 inches above the crown of the pipe. Initial backfill shall be Class I, II or III material compacted to 95 percent maximum density. Bedding, haunching, and initial backfill shall be free of large stones or sharp angular stones that may cause damage to the pipe, and frozen material shall not be used in these areas around the pipe. Final backfill shall be placed above the initial backfill, and may be Class I through Class V material compacted to 95 percent maximum density. Bedding, haunching, initial backfill and final backfill shall all be placed in 6 inch lifts.

V. B. 7. Air, hydrostatic and deflection testing

The advanced designer shall specify that the construction contractor shall perform either the air or the hydrostatic testing, and the deflection testing for the collection sewer. The construction contractor shall submit the results of the air or hydrostatic testing and the deflection testing to the advanced designer in writing and the advanced designer shall submit the testing results to the permitting authority.

V. B. 8. Air testing

The air test shall be performed on each section of the gravity collection sewer pipe by attaching an air compressor or testing apparatus to any suitable opening and closing all other inlets and outlets to the sewer system by means of proper testing plugs. Air shall be forced into the sewer system until there is a uniform pressure of 5 pounds per square inch (psi) on the portion of the sewer system being tested. The pressure shall remain constant for 15 minutes without the addition of air.

V. B. 9. Hydrostatic testing

The hydrostatic test shall be performed on all the pipe sections in the sewer system. The pipe section to be tested shall be bulkheaded, and shall be subjected to a hydrostatic pressure by a head elevation of water 3 feet above the invert (crown) elevation of the sewer at the cleanout or manhole of the test section. In areas where groundwater exists, this head elevation shall be 3 feet above the existing water table.

The water head elevation shall be maintained for a period of one (1) hour during which time it is presumed that full absorption of the pipe has taken place. The test shall be extended for one additional hour, and the water head elevation must be maintained during this test period. During the one hour test period, the measured water loss within the test section shall not exceed the maximum allowable loss (in gallons per hour per 100 feet of pipe) as shown in Table V.E.:

Table V.E.: Hydrostatic testing maximum allowable water loss

Sewer Main Diameter (in inches)	Maximum Allowable Loss[A] (in gallons per hour per 100 feet)
4	0.3
6	0.5
8	0.6

[A] Based on 100 gallons per day per pipe diameter inch per mile.

V. B. 10. Deflection testing

Deflection tests shall be performed on all gravity collection sewer pipes. The deflection test shall be conducted after the sewer trench has been backfilled to the desired finished grade and has been in place for a minimum of 30 days.

The deflection test shall be performed by pulling a rigid ball or mandrel through the pipe without the aid of mechanical pulling devices. The ball or mandrel shall have a minimum diameter equal to 95 percent of the actual inside diameter of the pipe. The maximum allowable deflection shall not exceed five (5) percent of the pipe's internal diameter. The pipe will be considered acceptable if the mandrel can progress through the pipe without binding.

V. B. 11. References

American Society of Testing and Materials (ASTM) D2321 (2005), Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

City Engineers Association of Minnesota, Standard Specifications, 1999 Edition. http://www.ceam.org/index.asp?Type=B_BASIC&SEC={E75F3FAC-E612-4185-85CD-34B0372189B1}

Great Lakes Upper Minnesota River Board (GLUMRB) Recommended Standards for Wastewater Facilities, 2004, Sections 33.5, 34, and 38.3. http://10statesstandards.com/wastewaterstandards.html

Metcalf & Eddy, Wastewater Engineering Treatment, Disposal and Reuse, Third Edition, 1991, Table 3-16.

Minnesota Department of Transportation, Standard Specifications for Construction, 2005 Edition, Specifications 2105 (Excavation and Embankment), 3760 (Insulation Board – Polystyrene).

Minnesota Rules 4715.1010, 4715.2400, 4715.2820

Minnesota Rules 4725.4450, subp. 1(E)(12).

Minnesota Rules 7080.1860, 7080.2050, subp. 2(C), 7080.2050, subp. 2(B)(6),(7) and (8), and 7081.0140.

University of Minnesota Extension Onsite Sewage Treatment Program (OSTP) and Minnesota Pollution Control Agency Large Systems Workshop Handouts and Homework #2, 2008 Edition.

US Environmental Protection Agency, Alternative Wastewater Collection Systems Manual (EPA/625/1-91/024), October 1991, Chapter 4.

US Environmental Protection Agency, Onsite Wastewater Treatment Systems Manual (EPA/625/R-00/008), February 2002, Page 3-11

Washington State Department of Ecology, Criteria for Sewage Works Design, December 1998, Chapter C1, Section C1-4.1.

Wisconsin Administrative Code, Department of Commerce, Subchapter III, Chapter Comm. 82.30 (11).

V. C. Pressure sewer collection system design

V. C. 1. Introduction

The pressure collection system design guidance section will describe design issues related to two types of pressure collection systems, septic tank effluent pump (STEP) pressure collection systems and grinder pump pressure collection systems. STEP systems include a gravity building sewer connected to a septic tank with pumping chambers that use the pumps (the pumps develop the pressure) and discharge through pressure lines connected to the common pressure collection system that transports the wastewater from a number of buildings to the treatment site. Grinder pump pressure collection systems include a gravity building sewer connected to a grinder pump chamber with pumps designed with chopper blades that reduce the size of any solids that discharge through pressure lines that connect to the common pressure system sewers. Most of the pump design information included in this section applies to both styles of pumps, and any design differences for the two types of pumps are called out within the section. Finally, this section also covers pump design issues for lift stations in a gravity collection system. Most of the pump design concepts are the same for the lift station pumps as they are for STEP or grinder pump pressure systems. Where there are differences, those differences are identified in the lift station section (see section IV.B. for stilling tank design).

This set of pressure sewer collection design concepts is strictly for residential or domestic wastewater flows and commercial flows of domestic strength wastewater between 2,500 and 10,000 gallons per day. Residential or domestic strength wastewater concentrations are considered to be equivalent to a BOD5 in the range of 110 to 400 mg/l, TSS in the range of 100 to 350 mg/l, and Oil and Grease of 70 to 105 mg/l. Non-residential strength wastewater must have pretreatment to reduce the pollutant concentrations to less than or equal to the range of residential wastewater concentrations in order to be discharged into a pressure sewer collection system as described in this guidance document. An example of non-residential strength wastewater would be the wastewater from a restaurant or other food or meat preparation facility. The number of residential connections can be from approximately five (5) to 30 dwellings. (Example: Class I, two (2) bedroom dwellings.) The ISTS or MSTS pressure sewer collection system should not be extended to additional connections beyond 30 connections. This set of pressure sewer collection design concepts is not required to and generally does not conform to, Greater Lakes Upper Mississippi River Board (GLUMRB) “Recommended Standards for Wastewater Facilities” (2004), Chapter 30.

V. C. 2. Definitions

Pressure sewer collection means the collector sewer pumps and piping that is located in the public right of way or is located on private parcels of land and is transporting the wastewater from five (5) or more service connections under pressure to a wastewater treatment and disposal site.

Service connection means the pipe on private parcels of land from a residence, a non-residential unit, or from a septic tank for a residence or non-residential unit that transports wastewater to the pressure sewer collection system.

V. C. 3. Design flows and minimum velocity

Design flow for the pressure sewer collection system shall include the design flows from Table IV in Minn. R. 7080.1860 for the classification and number of bedrooms for each residence, plus I/I (Infiltration and Inflow) according to Minn. R. 7081.0140, (200 gallon per inch diameter per mile length of collection pipe). The design flow for non-residential establishments shall be based on Table I, Minn. R. 7081.0130, “Flow and Waste Concentration Determination For Other Establishments” plus I/I (Infiltration and Inflow) of 200 gallons per inch diameter per mile length of collection pipe. The design flow for large pressure sewer collection systems shall be based on a peaking factor of 3.0 times the design flow based on the number of pumps operating at one time. The individual pump requirements for the individual lift stations would be based on the flow required to pump 50 percent of the design flow in one hour.

At the average daily pumping rate, a minimum cleansing velocity of 1 foot/second shall be maintained in pressure sewers from a STEP (Septic Tank Effluent Pump) system and a minimum cleansing velocity of 2 feet/second shall be maintained from a pressure grinder system.

V. C. 4. Pump selection

Pumps with a nearly vertical head-discharge pump curve, such as submersible lightweight multiple-stage turbine pumps or semi-positive displacement pumps for grinder pump stations are the preferred choice for STEP system pumps. For pumps operating in parallel when connected to the pressure sewer collection system, the discharge from any individual onsite pump is determined by adding the discharge at a constant head. The maximum discharge volume for each segment of the pressure collection system must be determined.

For a pressure collection segment with a number of pumps connected, only a certain number will be operating at the same time. Table V.F. shows the maximum number of pumps operating for the total number of pumps connected to the pressure collection system.

Table V.F.: Number of pumps in operation

Number of System Pumps	Maximum Number of Pumps Operating
2 to 3	2
4 to 9	3
10 to 18	4
19 to 30	5

Flow controllers shall be placed in the pump discharge line to limit the individual flows to approximately 10 gallon per minute and a trapped air release hole drilled in the discharge line should be used. The trapped air release hole also allows for the recirculation of sewage back to the pump chamber when the collection system mainline pressure is too high to accept the full discharge. Pumps and piping segments must be designed so that at peak flows the maximum velocity does not exceed 6.0 feet per second to avoid excessive friction loss in small diameter pipes. Total dynamic head in each collection system segment must not exceed 140 feet.

The total head on any pump in the collection system is determined by the sum of the accumulated friction loss in the collection system up to that pump as determined by the Hazen-Williams Equation. The total head calculation includes the friction loss for the type, size and length of collection pipe used; the friction loss of bends, tees, valves, etc., and the static head difference between the pump elevation and the maximum piping elevation in the total system.

The Hazen-Williams equation is written as follows:

$$V = 1.318CR^{0.63}S^{0.54}$$

where: V = velocity of flow, ft/s
C = Hazen-Williams coefficient
R = hydraulic radius (flow area divided by wetted perimeter), ft
S = slope of the energy grade line, ft/ft

Assuming that round pipes are flowing full, then:

$$R = D/4$$
$$S = h_f/L$$

where: D = diameter of pipe, ft
h_f = headloss due to friction, ft
L = length of pipeline, ft

The Hazen-Williams equation can be rearranged and written in terms of flowrate expressed as gal/min and pipe diameter expressed in inches:

$$h_f = \frac{10.5}{D^{4.87}} * (Q \div C)^{1.85} * L$$

where: h_f = headloss through the collection pipe, ft
L = length of pipe, ft
Q = flowrate, gal/min
C = Hazen-Williams coefficient
D = diameter of pipe, inch

A “C” value of 130 shall be used for plastic pipe. The “C” value used for design shall be noted on the project plans. When initially installed, force mains may have a significantly higher “C” values.

Appendix H, titled Pressure Collection System and Lift Station Pump Design Worksheet, is included in the back of this guidance document. This worksheet may be used to calculate the total head required for the pumps selected for use in either a pressure collection system design or the pumps in a lift station designed for use in a gravity collection system

V. C. 5. Other construction requirements

a. Air relief valves

An automatic air relief valve shall be placed at high points in the force main to prevent air locking. Water filled air relief valves will not be allowed due to freezing in cold conditions.

b. Thrust anchors

The pressure sewer collection piping, thrust blocking, and lift station piping must be designed to withstand water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of individual system and wastewater lift stations pumps. Anchorage of pressure sewer pipes and appurtenances should be placed at bends greater than 22 ½ degrees, tees, stops, valves or changes in sizes. The anchorages consist of thrust blocks, restrained joints or tie rods depending on pipe material used and trench conditions. Thrust blocks should be concrete and placed on and against undisturbed soil. Thrust block minimum bearing areas, size and shapes are shown in Figure V.A. in Section V. B. 4.

c. Leakage testing

Leakage tests shall be conducted after installation of the piping. Leakage testing should be conducted using the air test procedure described below or in ASTM F 1417 for plastic pipe, or a hydrostatic test procedure as described below. The construction contractor shall submit the results of the air or hydrostatic testing to the advanced designer for the project and the advanced designer shall submit the testing results to the permitting authority. Results also shall be recorded and maintained with the drawings for the project.

d. Air testing

The air test shall be performed on each section of the pressure collection sewer pipe by attaching an air compressor or testing apparatus to any suitable opening and closing all other inlets and outlets to the sewer system by means of proper testing plugs. Air shall be forced into the sewer system until there is a uniform pressure of 150 pounds per square inch (psi) on the portion of the sewer system being tested. The pressure shall remain constant for one (1) hour without the addition of air.

e. Hydrostatic testing

The hydrostatic test shall be performed on all the pipe sections in the sewer system. The pipe section to be tested shall be bulk headed, and shall be subjected to a hydrostatic pressure by a head elevation of water 3 feet above the invert (crown) elevation of the sewer at the cleanout of the test section. In areas where groundwater exists, this head elevation shall be 3 feet above the existing water table.

The water head elevation shall be maintained for a period of one (1) hour during which time it is presumed that full absorption of the pipe has taken place. The test shall be extended for one (1) additional hour, and the water head elevation must be maintained during this test period. During the one hour test period, the measured water loss within the test section shall not exceed the maximum allowable loss (in gallons per hour per 100 feet of pipe) as shown in Table V.E. in Section V. B. 9.

If measurements indicate water losses within the test pipe section is less than the maximum allowable loss, that pipe section shall be accepted as passing the test.

f. Effluent screens

An effluent screen is required to be installed prior to the wastewater being pumped into the pressure collection system, except when a grinder pump system which grinds the solids to a small size is utilized.

g. Installation

Collection system pipe shall be installed according to "American Society of Testing and Materials," "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers," and "Other Gravity-Flow Applications," ASTM D2321 (2005).

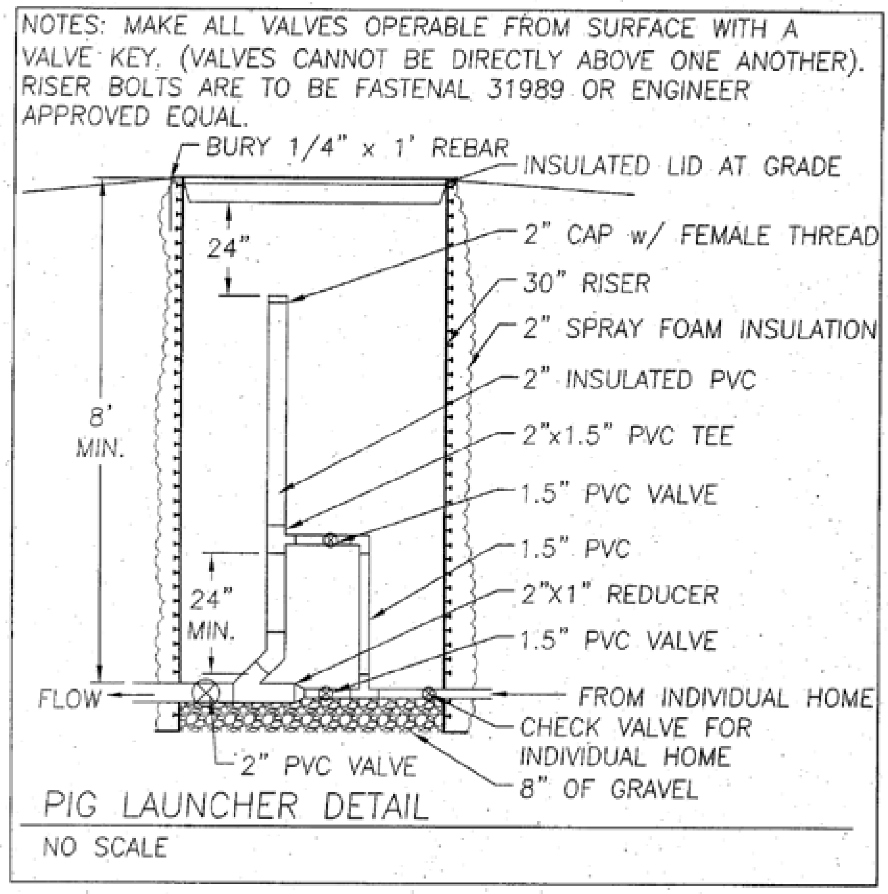
h. Routing

Pressure collection sewer pipe shall be laid basically straight or the pipe bent in a long radius. If possible, the grade or slope of the sewer pipe shall remain uniform between manholes, cleanouts, and air relief valves. However, because of the flexibility of small diameter PVC and HDPE pipe and because the pressurized flow regime is not very sensitive to horizontal alignment, line changes and grade changes can be made as long as the pipe is still going up or down. An air relief valve shall be placed at all peaks or high points in the pressure sewer.

i. Cleanouts

At a minimum, a cleanout must be placed at the upstream terminal end of the pressure collection pipe, at any minor junctions on the mainline, at the intersection of each sanitary main connection, at any change in sanitary main diameter, or every 500 feet of pipe length, whichever is less. Cleanouts must be brought to the ground surface, and the ground surface shall be sloped away from the cleanout cover to prevent the entrance of surface water. Cleanouts at low points should also be considered. Pig in Ports such as shown in Figure V.G. may be used in place of a cleanout.

Figure V.G.



j. Isolation valves

Management and cleaning of the collection system is critical for long-term operation. Being able to work on the system is the purpose of isolation valves. Isolation valves should be considered each 2,500 to 5,000 feet of uninterrupted pressure sewer, at water crossings, and at areas of unstable soil. Two (2) isolation valves should be used at an intersection of two mains.

k. Separation distance

The system should meet the requirements in the plumbing code. It is recommended that pipes and lift stations shall be laid at least ten (10) feet horizontally from any existing or proposed water main. If the separation is less updating materials to the current plumbing code may be necessary in the project area. Sanitary force mains crossing water mains shall be laid to provide a minimum vertical distance of 18 inches from the outside of each pipe. Sanitary force mains and lift stations must be located at least 50 feet from a private or public water supply well.

l. Bedding

Bottom of trench must be maintained in a stable and water free condition during period of installation. No installation shall be allowed on mucky or unstable trench bottoms except when the unstable material is removed down to a depth of 24 inches below grade, (bottom of sewer pipe), or to solid material and the unstable material replaced with acceptable bedding material.

Where sand is encountered, or the trench bottom is stable and does not contain stones larger than 1 inch in size or is not at bedrock, the trench may be excavated only to grade. For other conditions, the trench bottom shall be excavated to a depth of at least 3 inches below grade elevation and brought back to grade with sand, pea gravel, or graded stone bedding. The bedding material shall pass a ¾ inch sieve. The bedding shall be hand or mechanically compacted to 95 percent maximum density and the bedding shaped to accommodate pipe bells or couplings.

The initial backfill material to a depth of 3 inches above the pipe on property other than street right of way shall be sand, gravel, graded stone, or excavated material of non-organic nature that passes a 1 inch sieve. The backfill material to a depth of 12 inches around and over the pipe on street right of way shall be sand, gravel or graded stone of a size that passes a 1 inch sieve. Initial backfill material shall be placed in layers not exceeding 6 inches and shall be well compacted.

Pipe zone bedding is not required if the pipe is installed with the use of directional drilling.

m. Cover and insulation

Collection sewers shall be laid at a minimum depth of 7 feet soil cover to prevent freezing. This 7-foot minimum depth is for the southern part of Minnesota as shown in Figure V.D. in Section V. B. 5 (or Table V.D. lists minimum frost depth by county name.) This figure also shows that the minimum depth increases as the location of the sewer piping moves further north in the State. Sewer pipe depths of less than 7 feet or the depth shown on Figure 3 will only be allowed with insulation use or insulated pipe to prevent freezing. Insulation should also be used for sewer lines crossing under paved roads, driveways, parking lot areas, and under unpaved traffic areas. If insulation is used, it shall be extruded polystyrene foam insulation that meets Mn/DOT Specification 3760 and has a minimum density (kg/m^3) of R21. For sheet insulation, extruded polystyrene foam insulation shall be centered on the sewer pipe, and shall be installed at a depth of at least 18 inches below finished grade, and at least 6 inches above the sewer pipe. The insulation minimum dimensions shall be 2 inches thick and 4 feet wide. The minimum insulation thickness shall be equivalent to 1 inch per foot of soil cover over the sewer that is reduced. If insulated pipe is used, the insulation around the pipe shall meet the minimum density (kg/m^3) value of R-21.

n. Check valve

A check valve shall be installed after the residential or commercial system pump when a pressure building sewer discharges into a pressure collection system. The use of a manual isolation valve to allow the servicing of the check valves is recommended.

V. C. 6. Material specifications

- For collection systems that use individual septic tanks with effluent filters at each home, this can be in the front of a pump vault (also called Septic Tank Effluent Pump [or STEP]), the minimum diameter for pressure sewer collection pipe shall be 1.5 inch and the maximum diameter shall be 2.0 inch.
- Polyvinyl chloride pipe and joints shall meet the requirements of ASTM D2239, D-3033, or D-3034 (1980) (minimum class 160), SDR 21, and Schedule 40. Solvent weld (primer and glue) or elastomeric (rubber ring) joints will be acceptable.
- ABS pipe and joints shall meet the requirements of ASTM D22892 (1977) (Minimum class 160). Solvent weld or elastomeric joints will be acceptable.
- SDR 11 HDPE pipe must conform to ASTM D2239, ASTM D 3055, or ASTM F 714 and have a minimum working pressure of 160 pounds per square inch at 73 degrees F.

V. C. 7. Wastewater lift station requirements when installed in the main collection system

a. General

These requirements apply only to a pumping station with a capacity greater than 2,500 gallons per day, and do not apply to individual STEP system pumping stations.

b. Flooding

Wastewater pumping station structures and electrical and mechanical equipment shall be protected from physical damage and remain fully operational during a 25-year flood event. Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structure shall be considered and provisions made for protection.

c. Accessibility

The pumping station shall be readily accessible by maintenance vehicles and have access hatches with locking capability.

d. Equipment removal

Provisions shall be made to facilitate removal of pumps, motors, and other electrical equipment. Rail systems shall be provided for pumps.

e. Design capacity

Pumping rates (average and peak) for lift stations integral to collection systems shall be designed in the same manner as flows for all the collection sewers contributory to the lift station.

f. Ventilation

All lift stations shall be vented to the atmosphere.

g. Duplicate units

At least two (2) pumps or pneumatic ejectors shall be provided in each lift station. Each pump or ejector shall be capable of pumping the peak design pumping rate as determined by an advanced Designer or Registered Engineer.

h. Electrical equipment

Electrical systems and components (e.g. motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw wastewater wet wells, or in partially enclosed spaces where hazardous concentrations of flammable gasses or vapors may be present, shall comply with the National Electrical Code requirements for Class I, Division 1, Group D locations.

i. Submersible pumps

Submersible pumps shall be designed for total submergence during operation and for the appropriate type of use.

k. Emergency power

All lift stations shall have provisions made for hookup of portable generation equipment unless the lift station capacity is increased to one-day holding capacity at the design flow for the residential connections and commercial establishments. If all the water supplies to the residential and commercial sources of wastewater to the collection system are on the same power supply as the lift station so that no new wastewater can be generated to the collection system, then no provision for emergency power is required. However, due to the more prevalent use of individual dwelling emergency generators to power households and their raw water pumps, such hookups are still recommended.

k. Flow meters

Flow monitoring and recording equipment must be installed. Acceptable flow monitoring methods are either running time meters or a flow meter. With the use of time meters, there must be a minimum of three (3) run time meters (one for each pump and one for the time when both pumps are pumping) for each lift station.

l. Alarm system

The pumping station must employ an alarm device to warn of failure.

V. C. 8. References

GLUMRB Recommended Standards for Wastewater Facilities (2004) Chapter 30

Alternative Wastewater Collection Systems Manual (EPA/625/1-91/024) October 1991, Chapter 2

Washington State Department of Ecology, Criteria for Sewage Works Design, December 1998, Chapter C1, Section C1-4.1

Minn. R. 7080.2050, subp. 2(B)(6)

Small and Decentralized Wastewater Management Systems (1998) McGraw-Hill, Crities and Tchobanoglous, Chapter 6

U of M Onsite Sewage Treatment Program (OSTP) and MPCA Large Systems Workshop Handouts and Homework #2 (2008 Edition).

GLUMRB Recommended Standards for Wastewater Facilities (2004) Section 38.31

Minn R. 7080.2050, subp. 2(B) (7) and (8)

Wisconsin Administrative Code, Department of Commerce, Subchapter III, Chapter Comm. 82.30 (11)

Metcalf & Eddy, Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, 1991, Table 3-16

Minnesota Rules 4715.1010, 4715.2400, and 4715.2820

Minnesota Department of Transportation, Standard Specifications for Construction, 2005 Edition, Specifications 2105 (Excavation and Embankment), 3760 (Insulation Board-Polystyrene).

American Society of Testing and Materials (ASTM) D2321 (2005), Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

Wisconsin Administrative Code, Department of Commerce, Subchapter III, Chapter Comm. 82.30 (11)

VI. Operation and maintenance

VI. A. Management plans

VI A. 1. Introduction

Minn. R. ch. 7080.1100 subp. 46 states:

"The Advanced Designer must develop a management plan in consultation with the local unit of government. A Management plan is a plan that contains the requirements for periodic examination, adjustment, testing, and other operational requirements to meet system performance expectations, including a planned course of action in the event a system does not meet performance expectations"

The management plan is a very valuable tool in the operation and maintenance of every SSTS. At a minimum from Minn. R. 7082.0600 the management plans must include:

- Maintenance requirements, including frequency
- Operational requirements, including which tasks the owner can perform and which tasks a licensed service provider or maintainer must perform
- Monitoring requirements
- Requirements that the owner notifies the local unit of government when management plan requirements are not met
- Disclosure of the location and condition of the additional soil treatment and dispersal area on the lot or serving that residence
- Other requirements as determined by the local unit of government

The University of Minnesota (U of M) has developed over 20 management plans for different types of systems and for various system components (i.e. external grease interceptor). Management plans are available on the U of M's website at the following location: https://septic.umn.edu/ssts-professionals/forms-worksheets#mgmt.

The following management plans have been developed, as of September 2011:

- Below Grade Systems (trenches and beds)
- Above Grade Systems (mounds and at-grades)
- Holding Tank System

High strength wastes, treatment products:

- Amphidrome Sequencing Batch Reactor ATU
- Anua Puraflo Fixed Film Treatment System
- Anua PuraSys Sequencing Batch Reactor
- AquaPoint Bioclere
- AquaTest Nibbler Fixed Film Aerobic Treatment Unit
- Bio Microbics Fixed Film ATU
- Clarus Fusion Suspended Growth ATU
- Clearstream Model G
- Consolidated Treatment Systems Enviro-Guard, Nayadic, and Multi-Flow ATU

- Delta Environmental Ecopod Fixed Film ATU
- Eljen Corporation Geotextile Sand Filter
- External Grease Interceptor
- E-Z Treat Re-Circulation Synthetic Sand Filter
- FujiClean CE and CEN Aerobic Treatment Unit
- Hoot Systems Suspended Growth ATU
- Hydro-Action Industries Extended Aeration Unit
- Norweco Fixed Film Aerobic Treatment Unit
- Orenco Systems AdvanTex System
- Premier Tech Ecoflo Biofilter
- Single Pass or Recirculating Sand Filter
- SludgeHammer Fixed Film Aerobic Treatment Unit
- Smart-Treat MBBR
- Waterloo Biofilter Systems Wire Mesh Basket Series, Model 440

VI A. 2. General system considerations

a. Use education

To ensure proper functioning of the collection and treatment system it is important to educate the users of the system. 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 management plan typically includes a discussion of the proper use of the system: this portion of the manual should be provided to builders and homeowners. The backwash water from home water softeners and other drinking water treatment systems should be restricted in the plan. Discharges from swimming pools or spas should also be restricted.

b. Seasonal and start-up issues

If there are any seasonal operational changes they should be addressed in the manual as temperature changes affect the performance of many systems and seasonal operation changes may be necessary to maintain temperature and allow for access to equipment. Also change in flow over the season can affect system operation.

The management plan should address any start-up operational issues. Some new systems may require “seeding” with microorganisms from a similar facility with established biology to ensure proper initial operation. Also, some new SSTS 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.

d. Flow determination

All management plans must include a provision of determining the actual flow to the system. Automated systems with telemetry are preferred as they provide daily up-to-date flow information for the system’s service provider and user. If this is not available flows must be calculated from running time clocks and event counters at the system at the time of grease trap and/or septic tank evaluation (see number 3). If bi-annual readings are taken it is advisable to note if the average flow over this time is greater than 60 percent of the design flow. If flows are greater than 60 percent of design, flow measurement frequencies shall be increased to determine if the system is being over used.

VI A. 3. Collection system

The management plan should cover all aspects of the collection system. If STEP tanks, grinder pump stations, or individual septic tanks at each user's location are utilized in the design, operation and maintenance for those tanks should be specified in the plan. If the collection system is proprietary in nature, the manufacturer must be consulted to determine the required management of the system; including pump replacement, screen cleaning and tank/sump cleaning frequencies. The plan should include provisions in the case of line blockage such as location of cleanouts and cleaning with a jetter. At a frequency of no less than annually any sewer manholes or lift stations should be evaluated to assure proper operation and no infiltration into the system. At this time all alarm systems and electrical components should be tested.

Maintenance schedules developed for the above sewer main and lift station activities should clearly note when and/or how often each activity will take place.

VI A. 4. Grease interceptors

As part of the collection system and overall system operation, grease interceptors shall be evaluated quarterly at a minimum to determine if cleaning/pumping is needed.

VI A. 5. Septic tanks

a. Domestic waste

   Sludge and scum levels in septic tanks must be measured at a minimum bi-annually (two [2] times per year) for flows from 2,500 – 5,000 gpd.

   Therefore, a sludge core sampler, or tank sampler, is a necessary piece of equipment. **Note**: The larger diameter (1.5"+) core samplers are recommended as they perform better in septic tanks and do not clog as easily as those with small diameter (1").

b. Non-domestic waste

   For design flows of 2,500 – 5,000 gpd, due to the potential for high strength waste, these septic tanks shall be evaluated quarterly for build-up of sludge and scum.

   If an effluent screen is present in the septic or pump tank, the screen should be evaluated and cleaned based on the manufacture's recommendations and adjusted based on the flow and usage from the facility.

VI A. 6. Advanced pretreatment units

The manufacturer of registered products in Minnesota is required to submit an Operations and Maintenance manual as part of the registration process. The designer shall include operations and maintenance requirements in the management plan along with any additional requirements due to special site constraints or user features. The plan should include all needed equipment and control adjustments. For example, the recirculation rates for recirculating filters should be identified and how and when changes should be made based on operating data. The operating permit may require effluent sampling, and if so, the plan should indicate where the sample will be collected.

SSTS systems incorporate, among other things, biological processes that rely on microorganisms to consume the waste. The microorganisms need proper environmental conditions to survive and propagate. The most basic parameters which are commonly monitored to evaluate "environmental conditions" in a treatment system include dissolved oxygen (DO), pH, and temperature. Equipment to measure DO, pH, and temperature are necessary to ensure the success of the SSTS system.

a. Aerobic Treatment Unit (ATU)

Regardless of the manufacture of the ATU, several items should be specified in the management plan by the advanced designer. They include:

1) Unit type: The type of aerobic treatment unit needs to be specified.
2) System appearance: Check for soil settling, damage or erosion, depressions, or possibility of surface water collection around the modules.
3) Lids: Access points must be functional allowing access to components for providing evaluation of operation and maintenance.
4) Odors: Aerobic microbial treatment processes can have a mild aerobic smell. However, the odor should not be a strong anaerobic odor.
5) Foaming: Excessive foaming may be caused by constituent treatment or excessive soap in the wastewater.
6) Aeration: Aeration chamber is evaluated to verify mixing of the wastewater. The dissolved oxygen concentration should be maintained at 2 mg/l or above. Evaluate the type of air supply system providing air into the aerobic treatment unit. The air supply system must have an electrical supply and be running. Make sure the air access to the air supply is free of obstructions.
7) Settling: A clear zone is needed below the outlet to assist in preventing solids overflow during flow events. Settleability rate is performed to evaluate the density of mixed liquor in the aeration chamber. The settled solids should be between 40 and 60 percent. The ATU should be cleaned if these values are higher.
8) Media appearance: Aerobic treatment units utilizing attached growth media may plug with biomass. The media should be evaluated for proper mixing or water flow through the media. Media may float as the biomass accumulates on the media. This accumulation means the ATU should be cleaned.
9) Effluent screen: An effluent screen or tertiary filter may need to be cleaned to remove solids attached to the screens.
10) Alarms: Presence of alarms should be noted and operation should be checked.
11) Additional requirements: Manufacturers of specific units may recommend additional maintenance for their products. These activities should be performed and the completion of these activities should be documented in the comments section.
12) Sampling to satisfy regulatory, operation and maintenance requirements, the location and method of collect, transport and storage of samples must be addressed. Use an authorized laboratory for sample analysis and report information to the proper entities.

b. Media filters

Regardless of the manufacturer, several items should be specified in the management plan by the Advanced Designer for media filters. They include:

1) Sand filters:
    a. System appearance: Check for soil settling, damage or erosion, depressions, or possibility of surface water collection around the filters and tanks.
    b. Ponding: Check surface of filter for settling, damage or erosion, depressions, or possibility of surface water collection.
    c. Effluent quality: Check effluent clarity, transparency and odor.
    d. Sewage Treatment Area (STA) Pump: Check effluent level in center sump area or discharge basin (within the filter) that houses the STA pump. Level should be below the elevation of the base of the sand media.

e. Pumping system:
   - Check the function of each float in the sump.
   - Check pump operation in automatic and manual modes.
   - Check electrical junction box for damage or moisture.
   - Verify proper operation of all alarms.

f. Distribution system:
   - Measure distal head pressure on the lateral end before and after cleaning.
   - Clean distribution laterals by flushing, snaking with a bottle brush (or pressure washing), and flushing again.

2) Peat filters:

a. System appearance: Check for soil settling, damage or erosion, depressions, or possibility of surface water collection around the modules.

b. Peat Media: Check for media settling, damage or erosion, depressions, or possibility of surface water collection around the modules.
   - Check for excessive odors or ponding at the surface of the filter.
   - Check for settling and decomposition of peat media and replace it as necessary.
   - Check for wastewater bypassing the peat media. Pest damage (from ants, mice, and snakes) and frozen media can divert wastewater flow.
   - Rake the peat media yearly to fluff it up.
   - Check to see if additional peat material is needed to cover distribution laterals (this will keep odor risks low).

c. Effluent quality: Check the clarity of the peat filter effluent. The effluent color may vary from a dark tea to a light amber color from the tannins leaching from the media. Color is darker at the time of start-up and lightens with time.

d. Odors: Check the odor of the peat filter effluent. Effluent may smell musty, but it should not smell septic.

e. Landscaping: Makes sure no heavy objects are placed over the peat filter.

f. Alarms: Verify proper operation of all alarms.

3) Foam-type filters:

a. System appearance: Check for soil settling, damage or erosion, depressions, or possibility of surface water collection around the modules.

b. Media appearance:
   - Inspect overall condition of the media.
   - Verify media depth for treatment.
   - Inspect filter for odors and surface ponding.

c. Effluent quality: Check clarity, odor and transparency of treated effluent.

d. Pump tank levels: Check with manufacturer concerning acceptable effluent ponding levels at base of foam filter because some technologies use this zone as a sump area for a STA dosing pump.

e. Distribution:
   - Remove and clean spray nozzles yearly and check for equal spray distribution.

- Verify proper operation of all alarms.

4) Textile filters:
   a. System appearance: Check for soil settling, damage or erosion, depressions, or possibility of surface water collection around the modules.
   b. Media appearance:
      - Inspect overall condition of the media.
      - Verify media depth for treatment.
      - Inspect filter for odors and surface ponding.
   c. Effluent quality: Check textile filter effluent clarity and odor
   d. Distribution: Check function and position of manifold
      - Check for uniform spraying out of orifices (view underside of filter lid for distribution pattern).
   e. Flush, snake, and flush laterals.

VI A. 7. Soil treatment systems

During the routine evaluation of the tanks and advanced treatment units the soil treatment area should also be evaluated. The management plan should include the location of all inspection ports and cleanouts with a frequency of assessment and cleaning as appropriate. At a minimum, the soil treatment area should be evaluated at the time of evaluation of grease traps and/or septic tanks (See number 3). The management plan must include a schedule for mowing, planting, weeding, and other landscape care and maintenance of site restriction methods.

VI. B. Operating permits

Operating permits are issued to the owner by the Local Unit of Government (LUG). The owner is responsible for the operation and performance of their sewage treatment system. The purpose of an operating permit is to ensure each system functions as intended and is being properly operated and maintained. The owner is responsible for meeting all requirements contained in their operating permit.

All Type IV systems need maintenance on a regular schedule as specified in the Operating Permit. Maintenance requirements vary by treatment product. If the required maintenance is not done, the system will not work properly in the long run. For example, if the system has an ultraviolet light (UV) disinfection unit, the bulb needs to be cleaned regularly and replaced on a prescribed schedule. If this maintenance is not done, the unit will not properly disinfect the wastewater before dispersed to the soil.

Monitoring is necessary to determine relative performance of the system. Both field tests and lab tests may be used. Field test should be routinely employed to monitor performance at the time of system maintenance. Grab or composite wastewater samples may be used to collect representative samples. Specific laboratory tests are performed to measure parameters of interest to determine if compliance limits contained in the operating permit are met.

Operating permits for a Type IV system would initially be issued for a period of one (1) year. The purpose of issuing a short-term operating permit is to: (1) insure the owner operates the system within operational requirements, (2) correct issues that impact system performance, (3) make sure the required maintenance is done, and (4) make sure the required monitoring occurs. If the system is operating within design parameters/performance, then a longer term operating permit could be issued by the (LGU).

The operating permit could be re-issued for a second term, for duration of one (1) to five (5) years depending on operational requirements, risk, and owner responsibility for doing the required operation, maintenance and monitoring. If the operating permit conditions were met, and the owner did everything as required, the second operating permit would typically be issued for a longer term, between three (3) and five (5) years, depending on system complexity and environmental risk.

Simple field tests should be used to the greatest extent practical to monitor system performance. Field tests could include dissolved oxygen, turbidity, temperature and pH. Laboratory tests for cBOD5, TSS, fecal coliform bacteria, and nitrogen may be needed.

An *Operating Permit Template* was developed for use by local units of government. The operating permit template, along with instructions to consider for developing an operating permit for a system, is found on the next page of this document and on MPCA's website in both word and PDF formats at the following location: https://www.pca.state.mn.us/water/operating-permit-examples and https://www.pca.state.mn.us/sites/default/files/wq-wwists5-15.doc.

A list of operating permits 'examples' is contained in the MPCA document *List of Operating Permit Examples*. This list of operating permits is found at: http://www.pca.state.mn.us/publications/wq-wwists5-16a.pdf. The following are the operating permits found on the SSTS product registration website:

- List of operating permit examples
- Operating permit example: AK/HA Manufacturing/Hydro-Action Industries (Hydro-Action)
- Operating permit example: ANUA - formerly Bord Na Mona (Puraflo Peat Fiber Biofilter)
- Operating permit example: AquaTest (The Nibbler for high strength waste)
- Operating permit example: Bio-Microbics (MicroFAST)
- Operating permit example: (Enviro-Guard) (wq-wwists5-16n)
- Bio-Microbics (MicroFAST 3.0, 4.5, and 9.0) (wq-wwists5-16w)
- Bio-Microbics (RetroFAST) (wq-wwists5-16e)
- Bio-Microbics (HighStrength FAST) (wq-wwists5-16k)
- Clarus Environmental (Fusion) (wq-wwists5-16l)
- Consolidated Treatment Systems (Nayadic) (wq-wwists5-16o)
- Consolidated Treatment Systems (Multi-Flo) (wq-wwists5-16m)
- Hoot Systems (Hoot H-Series) (wq-wwists5-16h)
- Norweco (Singular 960 and TNT) (wq-wwists16x)
- Orenco Systems (AdvanTex) (wq-wwists5-16c)
- Single Pass Sand Filter (wq-wwists5-16i)
- Recirculating Sand Filter (wq-wwists5-16u)
- Holding Tanks (wq-wwists5-16j)
- System Remediation (wq-wwists5-16v)

Operating Permit Template
https://www.pca.state.mn.us/sites/default/files/wq-wwists5-15.doc

Operating Permit Examples:
https://www.pca.state.mn.us/water/operating-permit-examples

VI. C. Groundwater mounding monitoring

This section describes specifications and installation of Water Table Monitoring Devices (WTMD) to be used to determine the presence or extent of groundwater mounding under an MSTS. This document also describes methods for the collecting, reporting and interpreting water table elevation data.

VI. C. 1. Introduction

All MSTS must measure the height of the free water surface beneath the operating soil dispersal system. ISTS (i.e., flow of 5,000 gpd or less) do not require measurement for groundwater mounding. The outcome of the monitoring is to determine if the designed vertical separation distance is being met. This section explains:

- Applicable rules
- Suitable devices
- Monitoring location
- Monitoring depth and screen depth
- Testing and Maintenance
- Taking Water-Level Measurements
- Timing, Frequency, and Duration of Readings
- Interpreting results
- Reporting results
- Device removal

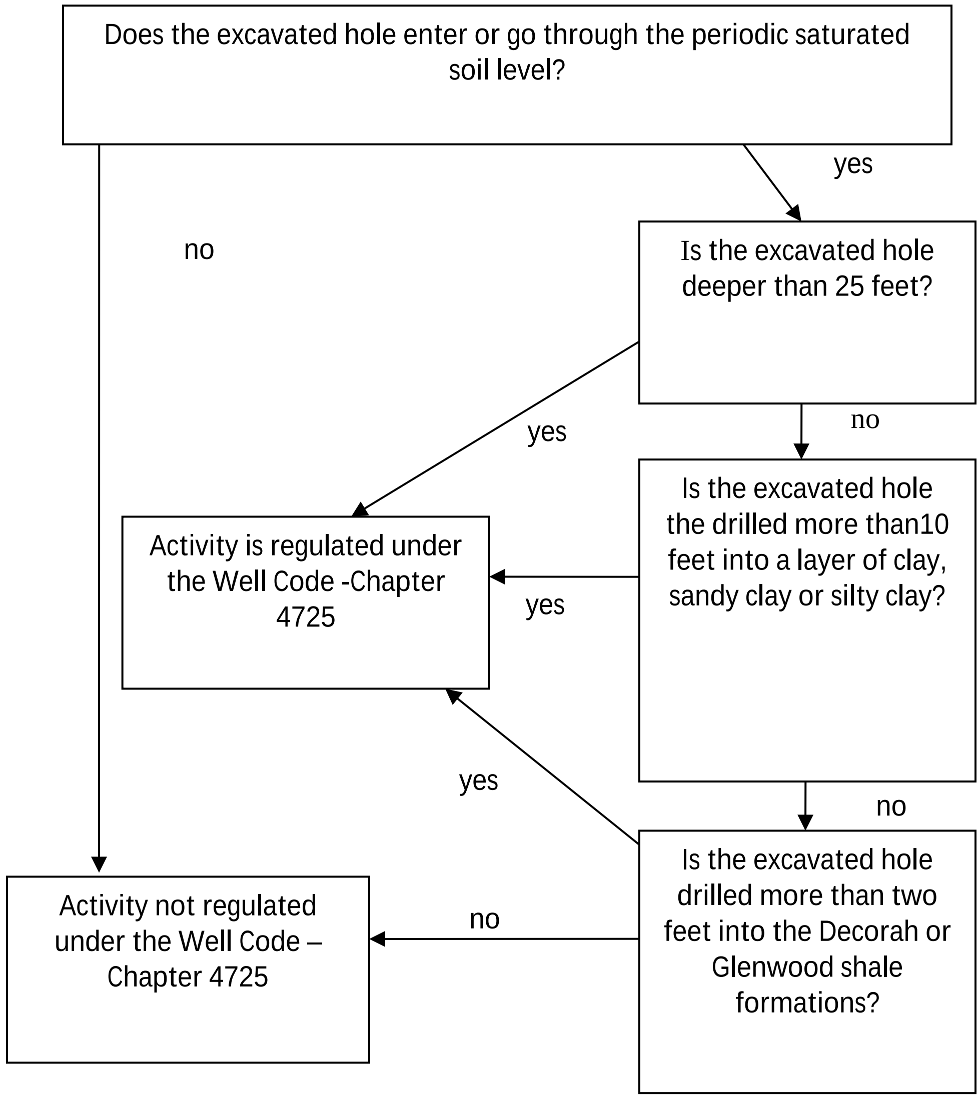
This section also contains possible mitigation methods if the mounding is encroaching upon the required vertical separation distance. The work described in this section can be performed by an SSTS advanced design business or advanced designer qualified employee if these prescriptive methods and guidance are followed. Interpretation of monitoring results can be performed by an SSTS service provider business or service provider qualified employee.

VI. C. 2. Applicable rules – Minn. R. ch. 4725 – Wells and Borings

Careful attention needs to be given to the installation of groundwater mounding monitoring devices in conjunction with the requirements of Minnesota Rules, Chapter 4725 (Wells and Borings). It is anticipated that many of the groundwater mounding monitoring devices will be exempt from Chapter 4725. However if Chapter 4725 does apply, please consult with a Minnesota licensed well contractor. The requirements of Chapter 4725 pertaining to Environmental Boreholes apply if the following conditions are true:

- The excavated hole enters or goes through the periodic saturated soil level, **and**
- The excavated hole is deeper than 25 feet, or
- The excavated hole is drilled into more than 10 feet of clay, sandy clay, or silty clay (USDA texture classification), or
- The excavated hole is drilled into more than two feet of Decorah or Glenwood shale formations

The above requirements are depicted in the flow chart below:



Chapter 4725 regulations do apply if the monitoring device is used at any time to extract liquids (as opposed to just measuring the elevation of the liquid). Devices used to extract liquids are considered groundwater monitoring wells. Groundwater monitoring wells may be needed to determine groundwater quality impacts from the system as determined in Section II F.

VI. C. 3. Suitable devices

A device is needed to measure the depth to free water beneath a MSTS. That is the intended purpose of this device. Therefore for MSTS groundwater mounding monitoring purposes, this device is to be termed "Water Table Monitoring Device (WTMD)

VI. C. 4. Monitoring location

The location of the WTMD should be as follows:

a. For trench systems, the WTMD should be in the center of the system, centered both in respect to the system length and width.

b. For bed type systems (pressure seepage beds, at-grades and mound systems) the WTMD should be placed between 1 and 5 feet of the downslope absorption area at the mid-point distance along the system length.

c. If the system is zoned for long-term dosing and resting or if the system is divided into multiple soil dispersal systems with intermittent dosing, each zone or system should be monitored for groundwater mounding.

VI. C. 5. Device depth and screen depth

a. Device depth

The depth of the device is dependent on the designed vertical separation distance and the soil/watertable conditions. The following must be applied:

1) The bottom of the WTMD must be at least one foot deeper than the top of the redoximorphic features. Therefore the possible depths of the WTMD will range from two feet below the ground surface (for mound systems) to eight feet below the ground surface for deeper trench and bed systems. Screened depths will be provided in item b. below.

2) In addition to the WTMD described in item 1 above, another WTMD must be employed if any hydraulically restrictive layer is within the designed vertical separation distance below the bottom of the media. The bottom of this shallow WTMD must be placed above any restricting layer. This second WTMD must be placed four to five feet away from the deeper WTMD.

Therefore, to determine the number and depths of WTMDs, the soil profile must be described at least to one foot deeper than the top of the redoximorphic features. Of critical importance is the identification of soil strata that can restrict downward water movement. Soil strata that can restrict downward water movement include changes in soil texture, structure, consistence, density, saturated zones, etc. If a restrictive soil layer is identified, care must be taken during the installation of a shallow WTMD (as described in item 2) above) to ensure that the restrictive layer is not penetrated and the device should be finished above the restrictive layer. Penetration of the restrictive layer may result in misleading shallow free water surface readings. If necessary, a deeper WTMD may penetrate this shallow restrictive condition.

b. Screens

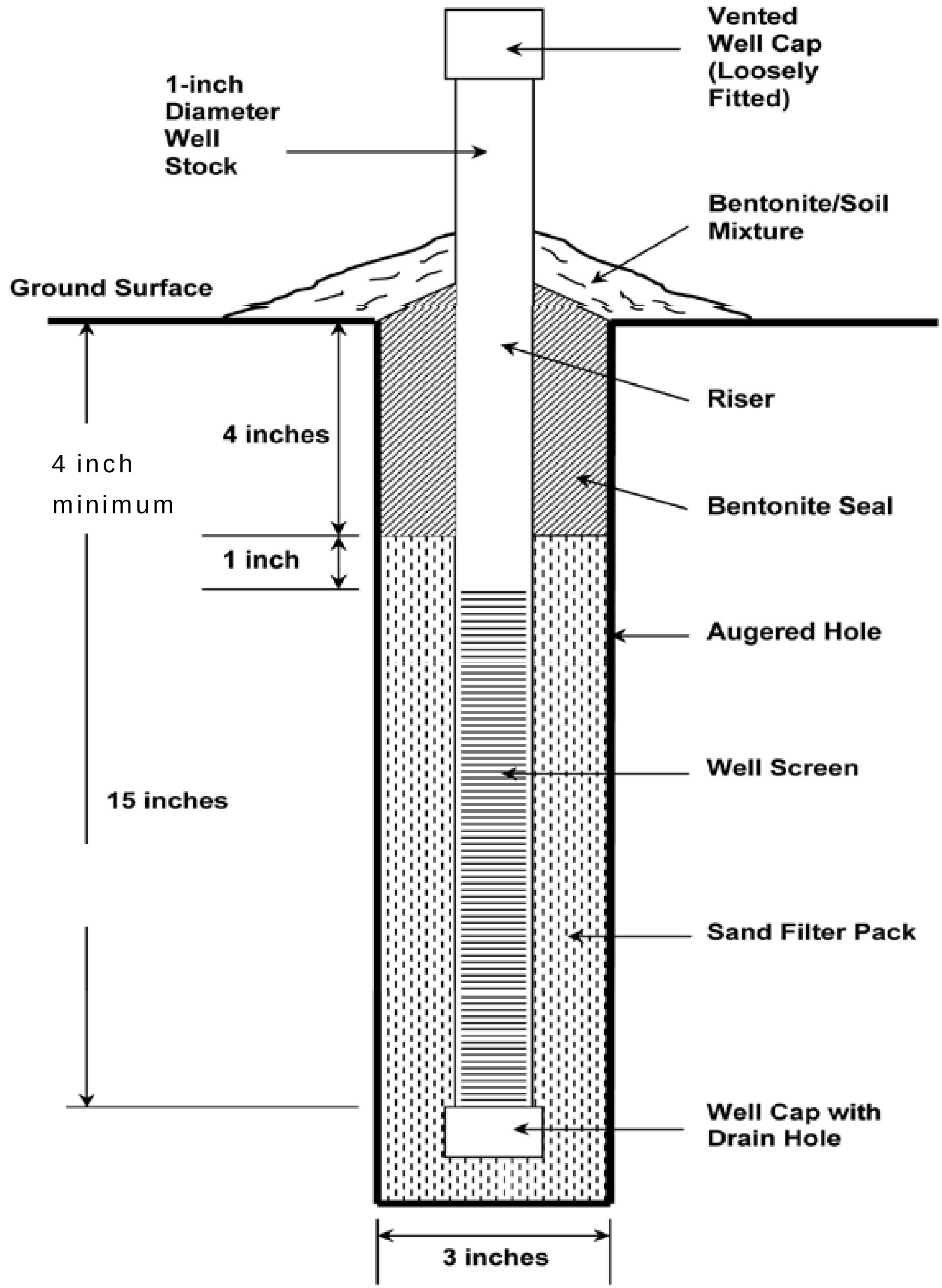
Well screens are slots or perforations in the well casing so water can enter the well for measurement. Screens must be used to accurately measure the free water surface and not a pressure head (as with an open bottom non- screened casing – i.e., "piezometer"). The screen placement for WTMD should be the bottom one foot of the casing.

c. Design and installation

Careful design and construction of the WTMD is necessary to ensure proper measurement of the height of the water table. Much of the following information was summarized from the U.S. Army Corps of Engineer's Publication – Technical Standards for Water-Table Monitoring of Potential Wetland Sites (ERCD TN-WRAP-05-2) – June 2005. If additional detail is required, this source of information can be found at:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_020656.pdf

1) Augered WTMD
A standard monitoring device installed by excavating the hole with an auger. The main components of the WTMD are: screen, riser, caps, sand filter pack, and bentonite sealant. Specifications for each of these components are given below the diagram.

Figure VI-A


Vented
Well Cap
(Loosely
Fitted)
1-inch
Diameter
Well
Stock
Bentonite/Soil
Mixture
Ground Surface
Riser
4 inches
4 inch
minimum
Bentonite Seal
1 inch
Augered Hole
Well Screen
15 inches
Sand Filter Pack
Well Cap with
Drain Hole
3 inches

a) Stock/riser

The stock/riser is the unslotted PVC pipe that extends from the top of the screen to above the ground surface. The stock/riser should extend far enough above the ground to allow easy access but not so high that the leverage of normal handling will crack below-ground seals. In locations that do not pond or flood, 9 to 12 inches above the ground surface is usually sufficient.

The stock/riser should be made from commercially manufactured well stock. Schedule 40, 1-inch inside diameter PVC pipe is recommended. The diameter of the pipe allows sufficient room for hand measurement of water levels while minimizing volume and maximizing responsiveness to water-table changes. The small diameter also minimizes auger hole diameter, volume of the filter pack, and the quantity of bentonite needed to seal the bore hole.

The riser or cap should be distinguishable from the soil dispersal systems inspection pipes used to check for ponding levels in the media.

b) Screen and bottom cap

Recommended screen dimensions are slot openings (0.010 inch) and slot spacing (0.125 inch). Commercial well screen should be used and cut 12 inches in length within the slotted portion of the pipe. The commercial well screen should be glued to the non-slotted casing with a coupling. Hand-slotted or drilled screens should not be used. A PVC cap should be glued at the bottom of the screen and a small drain hole should be drilled in the bottom cap. Screen depths are described in Section VI. C. 5. b.

c) Top cap

A top cap is required to protect the top of the device from contamination and rainfall. Top caps should be attached loosely so they can be removed easily without jarring or dislodging the device, or cracking the bentonite seal. It is recommended to use a threaded, compression seal, or “J” plug cap to prevent vandalism, damage, and flooding. The cap should be vented with a small horizontal hole to allow equilibration of air pressure inside and outside of the device.

d) Filter pack

A filter pack is placed around the screen prevent fine particles from entering the monitoring device and to provide a zone of high hydraulic conductivity that allows water movement into the WTMD. Filter packs can be classified into two major categories, natural and artificial. Natural packs are created by manually repacking any excavated soil around the screen, ensuring that large voids are absent. Natural packs are recommended in coarse-textured, sandy soils. In fine-textured soils, an artificial pack of silica sand must be used. See Table VI-1 for recommendations on the use of filter packs for soils of different textures.

Table VI-1 USDA soil texture classes and recommendations for sand filter packs

Native Soil	Silica Sand Pack
Coarse Sand	None
Medium Sand	None
All other soil textures	Required

e) Bentonite seal

Bentonite is available from well drilling supply companies in powder, chip, granular or pellet form. Chips are easiest to use in the field. They can be dropped directly down the annular space above the sand filter pack. If chips are used, it is recommended that smaller chips be used and pour slowly to avoid bridging. If this zone is already saturated with water, the chips will absorb water in place, swell tight, and seal off the sand filter from above. If the bentonite chips are dropped into a dry annular space, they should be packed dry and then water should be added down the annular space so the clay can swell shut.

f) WTMD installation

Recommended equipment includes a bucket auger which is 2 inches larger than the diameter of the device being installed, a tamping tool (e.g., wooden or metal rod), bentonite, silica sand, scarification tool, tape measure, soil boring log, water level checking device, water bottle, permanent marker, small scoop to pour bentonite and sand and the constructed monitoring device. The following (simplified) procedure is used to install the device:

- Auger a hole in the ground to a depth approximately 2 inches deeper than the bottom of the device. Be sure the hole is vertical.
- Scarify the sides of the hole if it was smeared during augering. Remove scarification spoil from bottom of hole.
- Place 2 to 3 inches of silica sand in the bottom of the hole.
- Insert the device into the hole to the proper depth. Do not insert through the sand.
- Pour and gently tamp more of the silica sand in the annular space around the screen and a minimum of eight inches above the screen. It is important that the sand is properly compacted to minimize future settling.
- Pour and gently tamp bentonite chips above the sand to the ground surface. If necessary, add water to cause the bentonite sealant to expand.
- Form a low mound of a soil/bentonite mixture on the ground surface around the base of the riser to prevent surface water from puddling around the pipe.

2) Establishing riser height

Water-level measurements are typically recorded as the "depth to water" from the top of the riser. The depth of the water table below the ground surface is determined by subtracting the riser height from the "depth to water" measurement. Therefore, after installing the device, measure and permanently record the height of the riser above the ground surface. This can be done using survey equipment, laser level and benchmark or simply determined relative to ground height. To determine if adequate separation distance is maintained, the depth of the soil dispersal system must also be determined.

VI. C. 6. Testing and maintenance

Typically WTMD need little testing and maintenance. Things to periodically check for include clogged screens. Clogging can be determined by (1) emptying the device by and monitoring how quickly the water level returns to the initial level, or (2) if the device is dry, filling it with water and monitoring the rate of outflow.

In addition, check for vertical displacement of the device after spring thaw and periodically during sampling by re-measuring the height of the riser above the ground surface and adjusting water-table measurements or resetting the device, as needed.

VI. C. 7. Taking water-level measurements

Water levels in WTMD should be measured with an accuracy of one (1) inch. Measurements may be made manually or with automated equipment.

a. Automated readings

   The use of automated water-level recorders is recommended unless an uninterrupted schedule of frequent site visits can be maintained. Automated recorders are also recommended in areas with highly variable or flashy hydrology. Whichever method is selected, it should be used consistently throughout the duration of the monitoring study.

b. Manual readings

   Water-level measurements can be made easily with a steel measuring tape marked with chalk or a water-soluble marker. Another approach is to use an electric device that sounds or flashes when the sensor, attached to the end of a measurement tape, makes contact with the water. A third method is to run a tape measure down the device until the hook of the tape hits the water and liquid contact is heard. Measurement devices that displace large amounts of water (e.g., dowel rods) should not be used.

VI. C. 8. Timing, frequency, and duration of readings

Groundwater mounding is a long-term phenomenon but can be very dynamic for perched conditions. Suggested times to read the WTMD for water elevations is in January, March, April, May, June, September, and November for the first five (5) years of system operation. If these readings indicate vertical separation distance compliance then the readings can be reduced to quarterly. If non-compliance issues are discovered then bi-monthly reading should be taken.

Readings must be taken for the entire life of the operating soil dispersal system. Readings should continue to be taken even if the zone or system is being rested.

VI. C. 9. Interpreting results

In measuring how the vertical separation distance is affected by groundwater mounding, compliance is determined if the vertical separation distance is being met 90 percent of the time. If the readings are compliant, then no interpretation is needed. However if reading are non-compliant, then a higher frequency of readings should be required until enough evidence is gathered to determine if it is possible for the system to meet the compliance goals.

VI. C. 10. Reporting results

a. Device locations and logs

   A report should be prepared showing the location of the WELs along with a log of the design and as-built information. A sample installation data form can be found at the publication: Technical Standards for Water-Table Monitoring of Potential Wetland Sites by the Army Corps of Engineers (ERDC TN-WRAP-05-2) which can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_020656.pdf .

   The location of each device should be recorded and identified on a map. Site maps should include a north arrow and landmarks such as roads, buildings, property boundaries, possible hydrologic disturbances such as ditches or levees, and any other information that would help someone who has not been to the site before to find the location of any monitoring device. Devices do not need to be surveyed or tied into a benchmark. However, large, complex, or problematic systems, or systems with multiple WELs, measurements establishing a location tied to an established benchmark might be advisable.

b. Monitoring reports

Monitoring reports should indicate the depth of the standing water (if any) as compared to the ground surface and the depth of the bottom of the soil dispersals system.

The report should also include the date of measurement, the date of the last precipitation and a general description of the current climate cycle (drought, normal, or wet). A conclusion should be made to whether the system is meeting the intended vertical separation distance.

The report should also indicate the condition of the device, height of riser above the ground surface and any testing or maintenance conducted on the device. A suggested recording form is provided below:

Project name ____________________ Monitoring device id _______________

Depth/elevation of system bottom

Monitoring date	General climate condition (drought, normal, wet)	Date and amount of last precipitation	Depth of liquid surface to top of casing	Height/elevation of casing above ground surface	Depth/elevation of liquid surface

VI. C. 11. Device removal

When the MSTS is no longer in service and is to be abandoned the WTMD should be completely removed and the holes filled with natural soil material.

VI. C. 12. References

U.S. Army Corps of Engineers (2005) “Technical Standard for Water-Table Monitoring of Potential Wetland Sites”, WRAP Technical Notes Collection (ERDC TN-WRAP-05-2 June 2005), .S. Army Engineer Research and Development Center, Vicksburg, MS.
www.oregon.gov/DSL/docs/techstan_watertable_mes.pdf

Noble, C. V. (2006). “Water table monitoring project design,” WRAP Technical Notes Collection (ERDC TN-WRAP-06-2), U.S. Army Engineer Research and Development Center, Vicksburg, MS.
http://el.erdc.usace.army.mil/wrap/

Minnesota Department of Health (2009). Minn. R. Chapter 4725 – Wells and Borings
www.revisor.leg.state.mn.us/rules/?id=4725

University of Minnesota OSTP – Advanced Designer Workshop - 2009

NRCS/Iowa State University – Field methods for water table monitoring employed in the Taylor and Ringgold County Soil Surveys – Iowa, 1983 to 1987.

VII. Appendices

Appendix A

State system classification and permit worksheet

Step 1 – Surface or subsurface discharge

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

Yes – The system requires a National Pollution Discharge Elimination System (NPDES) permit. This is a federal permit issued by the Minnesota Pollution Control Agency.
No – Go to Step 2.

Step 2 – 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 permit. This is a State permit issued by the Minnesota Pollution Control Agency.
No – Go to Step 3.

Step 3 – Types of subsurface sewage treatment systems

Systems which do not qualify under Steps 1 or 2 are defined as a Subsurface Sewage Treatment System (SSTS) which discharges below final grade and into the soil (e.g., trenches, beds, at-grade, and drip dispersal and mound systems). Regulatory jurisdiction is dependent on the system size.

Step 3-1: Does the waste contain sewage or other wastes mixed with sewage (See Minn. R. 7080.1100 subp. 73 for the definition of sewage)?

Yes – System is an SSTS: go to step 3-2.
No – Please contact the Minnesota Pollution Control Agency for the correct regulatory authority for systems receiving solely non-sewage wastes.

Step 3-2: Will a single SSTS or a group of SSTS under common ownership, with all or part of proposed or existing soil dispersal components within one-half mile of each other and the combined flow from all proposed and existing SSTS be greater than 10,000 gallons per day as determined in Flow Determination Method in Section II C *(use higher of estimated or measured flow).*

Yes – System requires SDS permit from the Agency. Please see https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-01.pdf
No – Go to Step 3-3

Step 3-3: Will the SSTS or group of SSTS cause adverse public health or environmental impacts if not regulated under a State permit as determined by the commissioner of the MPCA (such as systems in environmentally sensitive areas, unsubstantiated or unexpected flow volumes, or systems requiring exceptional operation, monitoring, and management)?

Yes – The system ***may*** need a State permit. This is a State permit issued by the Minnesota Pollution Control Agency. Please see:https://www.pca.state.mn.us/sites/default/files/wq-wwprm1-01.pdf

No – System regulated under a local permit. Please contact the local permitting authority (either county environmental health or planning and zoning office, or township office or city building inspector). Go to Step 3-4.

Step 3-4: Is the system designed to receive 5,000 gpd or less? (see flow worksheet to calculate flow)?

Yes – System is an Individual Sewage Treatment System (ISTS).

No – The system qualifies as a Mid-sized Subsurface Sewage Treatment System.

Important note: All multiple family dwellings, cluster of dwellings, or establishments that have the capacity to serve over 20 people that have subsurface discharges, must register for a Class V injection well with EPA. The following link provides information and requirements for registration: https://www.epa.gov/uic/underground-injection-control-epa-region-5-il-mi-mn-oh-and-wi

Appendix A-2

Federal system classification and permit worksheet suitable waste for subsurface sewage treatment systems worksheet

This appendix addresses non-domestic waste sources that may be harmful to the groundwater as a source of drinking water (e.g., solvents, industrial compounds, etc…). This section is not meant to assess high strength waste (e.g. generally food wastes), which is not a threat to the groundwater, but a threat to the system's operation and longevity. High strength waste will be determined in the high strength waste assessment in Section II B and Appendix B.

1. Dwellings

A. Is there a home business that will discharge a waste that is non-domestic in nature?

Yes _______ No _______

If so, list the business type: _________________________________

B. List the non-domestic waste that will be discharged:

____
____
____
____
____

C. Is more than one dwelling connected to the system?

Yes ______ No ____

2. Other establishments (non-dwellings)

A. List the business type: _________________________________

B. Will the establishment discharge waste that is non-domestic in nature? Yes___ No____

List the non-domestic waste that will be discharged:

____
____
____
____
____

C. Is it anticipated that any domestic type wastes will be discharged into the system in a greater percentage than what would be expected in a dwelling (e.g. increased use of cleaners)?

Yes____ No_____

List the non-domestic waste that is expected to be in higher concentrations:

____
____
____
____
____
____

D. How many persons will the establishment serve per day? _________________________

3. Class V Assessment Worksheet – Complete **ALL** of the following steps to determine the regulatory requirements of the system. It should be understood that the system may fall under multiple regulations. For UIC Injection Well determination, this worksheet method is limited to Class IV or Class V criteria for fluids discharged into soil dispersal systems. This worksheet will not make a determination for all classes of injection wells (e.g., inject brines for oil and gas production, solution mining, etc...). For assistance on completing this worksheet, please refer to the instruction sheet and overview discussion.

Step 1. Determine if the system is a Subsurface Sewage Treatment System (SSTS)

The system is considered an SSTS if **both** of the following are met:

Criteria
1. The system discharges below final grade, and
2. The system receives sewage or sewage mixed with other wastes.

Check here if the system is an SSTS: ____________. Go to Step 2.

Step 2. Determine if the system is an Underground Injection Control (UIC) injection well

The system is considered an UIC injection well if Criteria 1 is met and then either Criteria 2 or 3 are met:

Criteria
1. A fluid is discharged to a well, and
2. One or more of the fluids discharged to the well are non-domestic waste, or
3. The system receives domestic waste (sewage) from more than one dwelling or an establishment which has the capacity to serve more than 20 people per day.

Check here if the system is an UIC Well: ____________. If yes, go to Step 3. If no system is not a UIC well go to Step 4.

Step 3. Determine the type of UIC injection well

Step 3A. The system is considered a Class IV (4) injection well if the following is met

Criteria
One or more of the fluids discharged to the well is a hazardous waste.

Check here if the system is a Class IV Well: ____________. If yes, go to Step 4. If no go to Step 3B.

Step 3B. The system is considered a Class V (5) Injection Well if the following are met

Criteria
One or more of the fluids discharged to the well are non-hazardous and non-domestic waste, or
The system receives only domestic waste from more than one dwelling or another establishment which has the capacity to serve more than 20 people per day.

Step 4. Summary and suitable waste stream

Based on the above steps, the system is classified as (check all that apply)

Subsurface Sewage Treatment System (SSTS) _____

Class IV Injection Well _____ (Prohibited)

Class V Injection Well _____

Appendix B

High Strength Waste Worksheet

This worksheet aids in identifying high strength which is a threat to the system's operation and longevity (e.g., generally food preparation wastes). This section is not meant to assess waste sources that may be harmful to the ground water as a source of drinking water. That determination was made in Section II A and Appendix A.

1. **High strength waste estimates**

   The following chart from the EPA and the U of M provides waste strength estimates:

Organic loading from individual residential plumbing fixtures

Parameter		Garbage disposal (lbs/person/day)	Toilet (lbs/person/day)	Bathing, sinks, appliances (lbs/person/day)	Approximate total (lbs/person/day)
BOD_5	mean range	0.039 0.024 -0.068	0.037 0.015-0.052	0.063 0.055-0.086	0.14
Total suspended solids	mean range	0.06 0.035-0.097	0.06 0.029-0.018	0.037 0.024-0.05	0.157

[a]Adapted from USEPA, 1992.

[b]Means and ranges for BOD5, TSS, and TN are results reported in Bennett and Linstedt, 1975; Laak, 1975; Ligman et al., 1974; Olsson et al., 1968; and Siegrist et al., 1976.

Estimate of Waste Strengths from Other Establishments		
Type of Facility	**BOD (mg/L)**	**BOD (lbs/unit/day)**
Airports		
Per passenger	400 - 500	0.2
Per employee	400 - 500	0.5
Apartment houses	240 - 400	0.175/multiple family
Assembly hall (no kitchen)	240 - 400	0.01/seat
Boarding school	240 - 400	0.15/student
Bowling alley (no kitchen)	240 - 400	0.15/lane
Camps		
Construction (Semi-permantent)	400 - 500	0.140
Counntry club (member)	400 - 500	0.052/member
Country club (resident)	240 - 400	0.208/resident
Day (no meals)	400 - 500	0.031
Luxury	400 - 500	0.208
Church (no kitchen)	240 - 400	0.01/seat
Country club	400 - 800	0.17/member
Personnel addition	240 - 400	0.04/employee
Day school	240 - 400	0.03/student
Add for showers	240 - 400	0.01/student
Add for cafeteria	500 - 700	0.03/meal
Add for employees	240 - 400	0.03/employee
Factory		
No showers	240 - 400	0.04/employee
With showers	240 - 400	0.07/employee
Food service		
Ordinary restaurant	600 - 1500	0.35/seat
24-Hour restaurant	600 - 1500	0.50/seat
Freeway restaurant	600 - 1500	0.70/seat
Tavern (limited food)	400 - 800	0.10/seat
Carry-out (single service)	600 - 800	0.70/100 sqft
Carry-out	200 - 600	0.04/employee
Fast food chain	1000 - 2000	0.80/seat
Hospital (not including personnel)	400 - 600	0.70/bed
Personnel addition	240 - 400	0.04/employee
Laundromat	600 - 800	2.0/machine
Mobile home park	240 - 400	0.40/space
Motel, Hotel	240 - 400	0.30/room
Nursing home (not including kitchen or laundry)	400 - 600	0.30/bed
Personnel addition	240 - 400	0.04/employee
Office building (per 8 hour shift)	240 - 400	0.04/employee
Resort hotel, cottage	240 - 400	0.15/room
Add for self-service laundry	600 - 800	2.0/machine
Service station	240 - 400	0.50/toilet or urinal
Swimming pool	300 - 500	0.21
Shopping center (no food service or laundry)	400 - 600	0.30/1000 sqft
Theaters		
Drive-in	400 - 500	0.010/car space
Indoor	240 - 400	0.010/seat
Travel trailer or RV park		
No water/sewer hook up	400 - 800	0.25/space

Appendix C

Flow determination for Individual Dwellings Worksheet

The following table provides the flow for individual dwellings

Table I. Design flow dwellings *(gallons per day)*

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

Notes for Table I

Flows for Classification IV dwellings are 60 percent of the values as determined for Classification I, II, or III systems. For more than six bedrooms, the design flow is determined by the following formulas:

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 design 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 design 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 design 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.

Classification IV Classification IV dwellings are dwellings designed under Minn. R. 7080.2240.

Other notes

Each family unit in a multi-family residence is considered one (1) dwelling. For example, a duplex would be considered two (2) dwellings. One (1) bedroom units must be considered as two-bedroom units (already incorporated into the Table I).

Appendix D

Flow worksheet for multiple dwellings

Minnesota Pollution Control Agency

OSTP Flow Estimation: Existing Dwellings

University of Minnesota

Dwelling #	# of Bedrooms (minimum = 2)	Dwelling Classification (see Table IV)	7080.1860 Design Flow (gpd) (See Table 1)	Reduction Factor - 0.45 (if applicable*)	LISTS Flow per Dwelling (gpd)
1	4	I	600	1.00	600
2	4	I	600	1.00	600
3	4	I	600	1.00	600
4	4	I	600	1.00	600
5	4	I	600	1.00	600
6	5	I	750	1.00	750
7	3	I	450	0.45	203
8	3	I	450	0.45	203
9	3	II	300	0.45	135
10	3	I	450	0.45	203
11	3	I	450	0.45	203
12	4	I	600	1.00	600
13	5	I	750	1.00	750
14	4	I	600	1.00	600
15	5	I	750	1.00	750
16	3	I	450	0.45	203
17	3	I	450	0.45	203
18	3	I	450	0.45	203
19	4	I	600	0.45	270
20	3	I	450	0.45	203
21	3	I	450	0.45	203
22	3	I	450	0.45	203
23	3	I	450	0.45	203
24					
25					
26					
27					
28					
29					
30					
				Total Dwelling Flow Estimate	9083

* Use 1.0 for the flow from the ten hightest flow dwellings and 0.45 for remaining dwellings

Appendix E

Flow estimation for other establishments

Table I. Estimated design sewage flow from other establishments

(1) Dwelling units (also see outdoor recreation)		**Unit**	**Design flow (gal/ day/unit)**
	(a) Hotel or luxury hotel	Guest	55
		square foot	0.28
	(b) Motel	Guest	38
		square foot	0.33
	(c) Rooming house	Resident	45
		add for each nonresident meal	3.3
	Apartment Building	Bedroom	150
	(d) Daycare (no meals)	Child	19
	(e) Daycare (with meals)	Child	23
	(f) Dormitory	Person	43
	(g) Labor camp	Person	18
	(h) Labor camp, semi-permanent	Employee	50
(2) Commercial/Industrial			
	(a) Retail store	square foot	0.13
		Customer	3.8
		Toilet	590
	(b) Shopping center	Employee	11.5
		square foot	0.15
		parking space	2.5
	(c) Office	employee/8-hour shift	18
		square foot	0.18
	(d) Medical office*	square foot	1.1
		Practitioner	275
		Patient	8
	(e) Industrial building*	employee/8-hour shift	17.5
		employee/8-hour shift with showers	25
	(f) Laundromat	Machine	635
		Load	52.5
		square foot	2.6
	(g) Barber shop*	Chair	68
	(h) Beauty salon*	Station	285
	(i) Flea market	nonfood vendor/space	15
		limited food vendor/space	25
		with food vendor/space	50

(3) Eating and drinking establishments			
	(a) Restaurant (does not include bar or lounge)	meal without alcoholic drinks	3.5
		meal with alcoholic drinks	8
		seat (open 16 hours or less)	30
		seat (open more than 16 hours)	50
		seat (open 16 hours or less, single service articles)	20
		seat (open more than 16 hours, single service articles)	35
	(b) Restaurant (short order)	Customer	7
	(c) Restaurant (drive-in)	car space	30
	(d) Restaurant (carry out, including caterers)	square foot	0.5
	(e) Institutional meals	Meal	5.0
	(f) Food outlet	square foot	0.2
	(g) Dining hall	Meal	8.5
	(h) Coffee shop	Customer	7
	(i) Cafeteria	Customer	2.5
	(j) Bar or lounge (no meals)	Customer	4.5
		Seat	36
(4) Entertainment establishments			
	(a) Drive-in theater	car stall	5
	(b) Theater/auditorium	Seat	4.5
	(c) Bowling alley	Alley	185
	(d) Country club	member (no meals)	22
		member (with meals and showers)	118
		member (resident)	86
	(e) Fairground and other similar gatherings	Visitor	1.5
	(f) Stadium	Seat	5
	(g) Dance hall	Person	6
	(h) Health club/gym	Member	35
(5) Outdoor recreation and related lodging facilities			
	(a) Campground	campsite with sewer hook-up (per person)	32
		campsite with sewer hook-up (per site/space)	100
		campsite without sewer hook-up, with central toilet or shower facility (per site)	50
		campsite without sewer hook-up, with central toilet or shower facility, served by central dump station (per site)	63
	(b) Permanent mobile home	mobile home	225
	(c) Camp, day without meals	Person	20
	(d) Camp, day with meals	Person	25
	(e) Camp, day and night with meals	Person	45
	(f) Resort/lodge hotel	Person	62
	(g) Cabin, resort	Person	50

	(h) Retail resort store	Customer	4
	(i) Park or swimming pool	Guest	10
	(j) Visitor center	Visitor	13
	(k) Marina (no bathhouse)	Slip	10
	(l) Marina (with bathhouse)	Slip	30
(6) Transportation			
	(a) Gas station/convenience store	Customer	3.5
	(b) Service station*	Customer	11
		service bay	50
		Toilet	250
		square foot	0.25
	(c) Car wash* (does not include car wash water)	square foot	5
	(d) Airport, bus station, rail depot	Passenger	5
		square foot	5
		Restroom	565
(7) Institutional			
	(a) Hospital*	Bed	220
	(b) Mental health hospital*	Bed	147
	(c) Prison or jail	Inmate	140
	(d) Nursing home, other adult congregate living	Resident	125
	(e) Other public institution	Person	105
	(f) School (no gym, no cafeteria, and no showers)	Student	14
	(g) School (with cafeteria, no gym and no showers)	Student	18
	(h) School (with cafeteria, gym, and showers)	Student	27.5
	(i) School (boarding)	Student	95
	(j) Church	Seat	4
		add for each meal prepared	5
	(k) Assembly hall	Seat	4
(8) Miscellaneous			
	(a) Public lavatory	User	5
	(b) Public shower	shower taken	11

** Waste other than sewage is only allowed to be discharged into the system if the waste is suitable to be discharged to groundwater.*

Unless otherwise noted in Table I, the flow values do not include flows generated by employees. A flow value of 15 gallons per employee per eight-hour shift must be added to the flow amount. Design flow determination for establishments not listed in Table I shall be determined by the best available information and approved by the local unit of government.

Notes for flow estimates for other establishments

Waste other than sewage may only be discharged into the system if the waste is allowed to be discharged to a subsurface soil treatment and dispersal system. This additional flow must be added to the flow values in this chart.

Unless otherwise noted in the preceding table, the flow values do not include flows generated by employees. A flow value of 15 gallons per employee per eight-hour shift must be added to the flow amount.

The design flow determination for establishments not listed in the preceding table shall be determined by the best available information and approved by the local unit of government.

Definitions for other establishments

Dwelling unit or living unit

This means one room or rooms connected together, constituting a separate independent housekeeping establishment for owner occupancy, for rent or lease, and physically separated from any other rooms or dwelling units which may be in the same structure and containing independent cooking and sleeping facilities

Hotel

A commercial establishment offering lodging to travelers and sometimes to permanent residents, and often having restaurants, meeting rooms, stores, etc., that are available to the general public

Motel

Provides travelers with lodging and free parking facilities; typically a roadside hotel having rooms adjacent to an outside parking area or an urban hotel offering parking within the building

Rooming house

A house with furnished rooms to rent; lodging house

Daycare

Of, pertaining to, or providing daycare

Dormitory

- A building, as at a college, containing a number of private or semiprivate rooms for residents, usually along with common bathroom facilities and recreation areas.
- A room containing a number of beds and serving as communal sleeping quarters, as in an institution, fraternity house, or passenger ship.

Labor camp

A prison camp where forced labor is performed

Commercial/industrial

Retail store

A place of business for retailing goods

Shopping center

A group of stores within a single architectural plan, supplying most of the basic shopping needs especially in suburban areas

Office

A room, set of rooms, or building where the business of a commercial or industrial organization or of a professional person is conducted

Medical office

Office and laboratory facilities constructed for the use of physicians and other health personnel.

Industrial building

A factory or collection of buildings relating to industrial production

Laundromat

A self-service laundry having coin-operated washers, driers, etc...

Barber shop

The place of business of a barber

Beauty salon

An establishment for the hairdressing, manicuring, or other cosmetic treatment of women

Flea market

A market, often outdoors, consisting of a number of individual stalls selling old or used articles, curios and antiques, cut-rate merchandise, etc.

Eating and drinking establishments

Restaurant

An establishment, other than a hotel, under the control of a single proprietor or manager, where meals are regularly prepared on the premises and served at tables to the general public, and having a minimum seating capacity for guests as prescribed by the appropriate license issuing authority.

Institutional meals

Meals served at a place that cares for persons who are destitute, disabled, or mentally ill.

Food outlets

A large, self-service store that sells groceries and, usually, medications, household goods, and/or clothing

Dining hall

A large room at a college or university, used especially for dining

Coffee shop

A place where coffee is sold and consumed.

Cafeteria

A restaurant in which the customers serve themselves or are served at a counter and take the food to tables to eat

Bar or lounge

A business that serves drinks; especially alcoholic beverages such as beer, liquor, and mixed drinks, for consumption on the premises

Entertainment establishments

Drive-in theater

A form of cinema structure consisting of a large outdoor screen, a projection booth, a concession stand and a large parking area for automobiles

Theater

A building, part of a building, or outdoor area for housing dramatic presentations, stage entertainments, or motion-picture shows

Bowling alley

A game/sport in which players attempt to score points by rolling a bowling ball along a flat surface either into objects called pins or to get close to a target ball.

Country club

A club, usually in a suburban district, with a clubhouse and grounds, offering various social activities and generally having facilities for tennis, golf, swimming, etc…

Fairgrounds

A place where fairs, horse races, etc., are held; in the United States usually an area set aside by a city, county, or state for an annual fair and often containing exhibition buildings.

Stadium

A sports arena, usually oval or horseshoe-shaped, with tiers of seats for spectators

Dance hall

A public establishment that, for an admission fee, provides its patrons with music and space for dancing and, sometimes, dancing partners and refreshments.

Health club/gym

A usually private club that offers its members facilities for exercising and physical conditioning

Outdoor recreation and related lodging facilities

Campground

A place for a camp or for a camp meeting

Permanent mobile home

A large house trailer, designed for year-round living in one place.

Camp

A place where an army or other group of persons or an individual is lodged in a tent or tents or other temporary means of shelter

Resort

A place to which people frequently or generally go for relaxation or pleasure, especially one providing rest and recreation facilities for vacationers.

Cabin

A small house or cottage, usually of simple design and construction

Retail resort store

The sale of goods in small quantities to consumers in a vacation or recreation area

Park

An area of land, usually in a largely natural state, for the enjoyment of the public, having facilities for rest and recreation, often owned, set apart, and managed by a city, state, or nation

Swimming pool

A tank or large artificial basin, as of concrete, for filling with water for swimming

Visitor center

A specific attraction or place of interest, such as a landmark, national park, national forest, or State park, providing information.

Transportation

Gas station

A place equipped for servicing automobiles, as by selling gasoline and oil, making repairs, etc.

Convenience store

A retail store that carries a limited selection of basic items, as packaged foods and drugstore items, and is open long hours for the convenience of shoppers

Service station

A place that provides some service, as the repair of equipment, or where parts and supplies are sold, provided, dispensed, etc.

Car wash

A place or structure having special equipment for washing automobiles

Airport

A tract of land or water with facilities for the landing, takeoff, shelter, supply, and repair of aircraft, especially one used for receiving or discharging passengers and cargo at regularly scheduled times.

Bus station

A terminal that serves bus passengers

Rail depot

Terminal where trains load or unload passengers or goods

Institutional

Hospital

An institution in which sick or injured persons are given medical or surgical treatment

Mental health hospital

A hospital specializing in the treatment of serious mental illness, usually for relatively long-term inpatients

Prison/jail

A building for the confinement of persons held while awaiting trial, persons sentenced after conviction, etc.

Nursing home

A private residential institution equipped to care for persons unable to look after themselves, as the aged or chronically ill

Other public institutes

School

An institution where instruction is given, especially to persons under college age

Boarding school

A school at which the pupils receive board and lodging during the school term.

Church

A building for public worship

Assembly hall

A hall where many people can congregate

Miscellaneous

Public lavatory

A toilet that is available to the public

Public shower

A shower that is available to the public

Appendix F

Minnesota Pollution Control Agency

OSTP Flow Estimation: Existing Dwellings

University of Minnesota

v 06.12.13

Dwelling #	# of Bedrooms (minimum = 2)	Dwelling Classification (see Table IV)	7080.1860 Design Flow (gpd) (See Table 1)	Reduction Factor - 0.45 (if applicable*)	LISTS Flow per Dwelling (gpd)
1	4	I	600	1.00	600
2	4	I	600	1.00	600
3	4	I	600	1.00	600
4	4	I	600	1.00	600
5	4	I	600	1.00	600
6	4	I	600	1.00	600
7	4	I	600	1.00	600
8	4	I	600	1.00	600
9	4	I	600	1.00	600
10	4	I	600	1.00	600
11	4	I	600	0.45	270
12	3	I	450	0.45	203
13	3	I	450	0.45	203
14	3	I	450	0.45	203
15	3	I	450	0.45	203
16	3	II	300	0.45	135
17	2	II	225	0.45	101
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
				Total Dwelling Flow Estimate	7316

* Use 1.0 for the flow from the ten highest flow dwellings and 0.45 for remaining dwellings

Appendix G

Final Flow Worksheet

Minnesota Pollution Control Agency	OSTP Final Permitting Flow Worksheet			University of Minnesota
				v 06.12.13
1. Flow from Dwellings	Flow from Dwellings	7316	gpd	From either existing and new development worksheet
2. Flow from Other Establishments	Permitting Flow from Other Establishments	0	gpd	From either Measured or Estimated-OE worksheet
3. Flow from Collection System	a) Total Length of Collection Pipe:	1000	feet	Design flow must include 200 gallons of infiltration and inflow per inch of collection pipe diameter per mile per day with a minimum pipe diameter of two inches. Flow values can be further increased if the system employs treatment devices that will infiltrate precipitation.
	b) Diameter of Pipe (Minimum of 2 in):	6.00	inches	
	c) Flow from I& I in Collection System:	227	gpd	
4. Final Permitting Flow		7543	gpd	Sum of 1, 2 and 3c.

Appendix H

Pump Selection Worksheet

Minnesota Pollution Control Agency

OSTP Basic Pump Selection Design Worksheet

University of Minnesota

1. PUMP CAPACITY Project ID: v 06.12.13

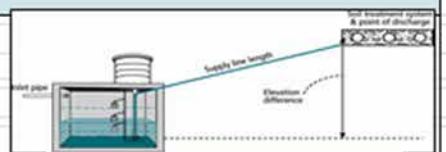
Pumping to Gravity or Pressure Distribution: ○ Gravity ○ Pressure Selection required

1. If pumping to gravity enter the gallon per minute of the pump: ______ GPM *(10 - 45 gpm)*

2. If pumping to a pressurized distribution system: ______ GPM

3. Enter pump description: ______

2. HEAD REQUIREMENTS



A. Elevation Difference between pump and point of discharge: ______ ft

B. Distribution Head Loss: ______ ft

C. Additional Head Loss: ______ ft (due to special equipment, etc.)

Distribution Head Loss	
Gravity Distribution = 0ft	
Pressure Distribution based on Minimum Average Head Value on Pressure Distribution Worksheet:	
Minimum Average Head	**Distribution Head Loss**
1ft	5ft
2ft	6ft
5ft	10ft

Table I. Friction Loss in Plastic Pipe per 100ft

Flow Rate (GPM)	Pipe Diameter (inches) 1	1.25	1.5	2
10	9.1	3.1	1.3	0.3
12	12.8	4.3	1.8	0.4
14	17.0	5.7	2.4	0.6
16	21.8	7.3	3.0	0.7
18		9.1	3.8	0.9
20		11.1	4.6	1.1
25		16.8	6.9	1.7
30		23.5	9.7	2.4
35			12.9	3.2
40			16.5	4.1
45			20.5	5.0
50				6.1
55				7.3
60				8.6
65				10.0
70				11.4
75				13.0
85				16.4
95				20.1

D. 1. Supply Pipe Diameter: ______ in

2. Supply Pipe Length: ______ ft

E. Friction Loss in Plastic Pipe per 100ft from Table I:

Friction Loss = ______ ft per 100ft of pipe

F. Determine *Equivalent Pipe Length* from pump discharge to soil dispersal area discharge point. Estimate by adding 25% to supply pipe length for fitting loss. *Supply Pipe Length (D.2)* X 1.25 = *Equivalent Pipe Length*

______ ft X 1.25 = ______ ft

G. Calculate *Supply Friction Loss* by multiplying *Friction Loss Per 100ft* (Line E) by the *Equivalent Pipe Length* (Line F) and divide by 100.

Supply Friction Loss =

______ ft per 100ft X ______ ft ÷ 100 = ______ ft

H. *Total Head* requirement is the sum of the *Elevation Difference* (Line A), the Distribution Head Loss (Line B), Additional Head Loss (Line C), and the Supply Friction Loss (Line G)

______ ft + ______ ft + ______ ft + ______ ft = ______ ft

3. PUMP SELECTION

A pump must be selected to deliver at least ______ GPM (Line 1 or Line 2) with at least ______ feet of total head.

Comments:

Appendix I

Nitrogen impacts to aquifers assessment for advanced designers

The first part of the appendix is the instruction sheet, followed by the actual worksheet.

Assistance for Step 1

Definitions

Public water supply

Community public water supplies serve at least 25 persons or 15 service connections year-round, which include municipalities, manufactured mobile home parks, etc.

Non-community public water systems serve facilities such as schools, factories, restaurants, resorts, and churches that are served by their own supply of water (usually a well).

"Public water supply well" means a well, that serves a public water supply and is not a dewatering well or a monitoring well serving a public water supply.

Information and assistance

The following information is required to complete Step 1:

- if any nearby wells are public water supply wells (need community name or facility name)

Tool needed

The tool needed to make these determinations is found at the following Web address: https://mdh.maps.arcgis.com/apps/View/index.html?appid=5051b7d910234421b0728c40a1433baa

Procedure

1. Enter the name of the county in the data box on the webpage; a list of public water supply wells will be generated, or enter the name of the nearest establishment that has a water supply well.
2. Determine if any public water supply well is within 200 feet (the inner wellhead management zone boundary) of the proposed system.

Assistance for Step 2

Definitions:

"Private well" means a non-public water supply, such as water supply wells that serve single family dwellings.

Assistance for Step 3

Definitions

"Property boundary" is defined as the land area which is owned and controlled by the SSTS owner(s).

"Other restrictions" is defined as any legal control prohibition placed on property for placement of a water supply well.

Information and assistance

To answer the question in Step 3 you need to determine the property boundary of the proposed system, or if any prohibition exists or will exist on the placement of water supply wells.

Assistance for Step 4

Definitions

"Drinking water supply management area" means the wellhead protection area as delineated by geographic features.

"Wellhead Protection Area" means the ten-year recharge zone for community public water supply well.

Appendix I (cont.)

Information and assistance

To answer the questions in Step 4 you need to know:

- if any nearby wells are a public water supply well (need community or facility name);
- whether a Drinking Water Supply Management Area (DWSMA) has been designated and its boundaries
- whether the water supply well is sensitive

Tool needed

The tool needed to make this determination is found at the following Web address: https://mdh.maps.arcgis.com/apps/View/index.html?appid=5051b7d910234421b0728c40a1433baa

Procedure

1. Enter the name of the county; a list of public water supply wells will be generated.
2. Click on the Surface/Ground Water Assessment hypertext corresponding to the well in question. A Source Water Assessment page will appear.
3. Determine from the Source Water Assessment page:
   - the aquifer sensitivity
   - if a Source Water Assessment has been conducted; if so, click on "map" to determine the boundaries of the drinking water supply management area

Assistance for Step 5

Definitions

"Sensitive" means a soil condition that has either a "sand texture" in the lowest horizon indicated on the soil survey; or has bedrock conditions in the upper five (5) feet of the soil profile; or has organic soil textures in the lowest horizon indicated in the soil survey.

"Majority" means greater than 50 percent as determined by visual examination of the soil map or other means of measurement. This majority criteria better reflects the dominate groundwater conditions.

Information and assistance

To answer the question in Step 5 you need to know if the Web Soil Survey lists the area as sensitive for impacts from SSTS.

Tool needed

The tools needed to make these determinations are found at the following Web address: https://websoilsurvey.nrcs.usda.gov/app/

Procedure

1. Click "Start" button
2. Find site using the "Quick Navigation" feature
3. Zoom in or out to get a 1/4 mile radius of the proposed ISTS site
4. Click the "soil map" tab
5. Click the "Soil Data Explorer" tab
6. Click on the "Sanitary Facilities" hyper text
7. Click on "Aquifer Assessment – 7081 (MN)"
8. Under "View Options", click "Map", "Table", "Component Breakdown and Rating Reason", "Rating Value", and "Description of Rating"
9. Click "View Rating"

Appendix I (cont.)

10. View the map. A percentage of each unit is provided in a table. High sensitivity areas are depicted (red color) and those which are low sensitivity (non-red color). If a simple visual determination is difficult, percentages of each area are provided.
11. If the area is clearly one sensitivity type, then use that in Step 3. If the sensitivity is evenly split (approximately 40 to 60 percent); then a professional geoscientist should be employed to complete the assessment.

Assistance for Step 6

Definition

"Majority" means greater than 50 percent as determined by visual examination of the soil map or other means of measurement. This majority criteria better reflects the dominate groundwater conditions.

Information and assistance

To answer the question in Step 6 you need to know the sensitivity classification for the proposed site.

Tool needed

Some areas of the State have been mapped for aquifer sensitivity. Please refer to the following website to determine if sensitivity mapping is available:
http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html

Procedure

1. Go to: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html
2. Determine if area has been mapped. If not then go to Step 7
3. Click on the Plate map that show sensitivity to pollution
4. Determine if the sensitivity is Very High or High

Assistance for Step 7

Definition

"Sandy soil texture" means the USDA soil textures of Coarse Sand, Sand, Fine Sand, Very Fine Sand and any modifiers to those terms (e.g., loamy fine sand, gravelly coarse sand, etc.).

Information and assistance

To answer the question in Step 7 you need to conduct onsite soil borings.

Tools needed

The tools needed to make these determinations are a soil boring tool, boring log, and map preparation tools.

Procedure

1. Dig a minimum of two (2) soil borings to a depth of six feet below the proposed bottom of the soil dispersal system somewhere in the proposed soil treatment area
2. Determine the soil texture per the USDA classification system
3. Record your boring log with depths and textures
4. Prepare a map showing the location of the boring(s)
5. Provide an interpretation/determination if a "sandy" soil texture exists in the 6 foot zone below the bottom of the soil dispersal system

Nitrogen impacts to aquifers from SSTS

Worksheet

The Nitrogen Impacts to Aquifer Worksheet is a basic approach to determine if there is a significant potential for an SSTS to unacceptably impact an aquifer with nitrate nitrogen. This sheet is designed to be completed by a trained and licensed Advanced SSTS Designer.

This assessment is accompanied by an instruction sheet which contains suggested protocols, location of the necessary information, and definitions. Please refer to the instruction sheet for more information.

Before beginning this assessment, it may be beneficial to contact the local unit of government to see if any sensitive groundwater areas have been locally designated.

Step 1 – Public water supply wells

Are there any public water supply wells within 200 feet of the proposed soil dispersal system?

Yes – Site not suitable for large or have a hydrological assessment conducted by an AELSLAGID BP.
No – Go to Step 2

Step 2 – Private water supply wells

Are there any private water supply wells within 200 feet of the proposed soil dispersal system?

Yes – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.
No – Go to Step 3

Step 3 –Water supply wells – future location

Are the property boundaries for the site or other restrictions in place that would prohibit the installation of a private water supply well within 200 feet of the proposed system?

Yes – Go to Step 4
No – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.

Step 4 – Public water supply wells - Drinking Water Supply Management Area

Is the site for the proposed system located in a Drinking Water Supply Management Area with a high or very high sensitivity rating?

Yes – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.
No – Go to Step 5.

Step 5 – Protective layer determination – Web Soil Survey

What is the "Aquifer Assessment – 7080 (MN)" rating for the majority of the land area, within a 1/4 mile radius of the proposed system as determined by the Web Soil Survey?

Yes – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.
No – Go to Step 6.

Step 6 – Protective layer determination – DNR sensitivity map

If the map is available, is the sensitivity to pollution high or very high for the majority of the land area, within a 1/4 mile radius of the proposed system as determined by DNR sensitivity maps?

Yes – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.

No, or no mapping available – Go to Step 7.

Step7 – Protective layer determination – field borings

According to multiple onsite field borings, is the soil texture 6 feet below the bottom of the proposed soil dispersal system a sandy soil (soil texture group 1 – 4)?

Yes – A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process), or have a hydrological assessment conducted by an AELSLAGID BP.

No - Not Sensitive, no BMP necessary. Done with assessment

Final conclusion

Based on Step _____ (fill in the step #), the following has been concluded (check box):

- ☐ A nitrogen BMP must be employed (go to: Nitrogen Reduction Best Management Practice Selection Process)
- ☐ A detailed hydrological assessment for impacts has been elected to be conducted.
- ☐ No nitrogen requirement applies.

Appendix J

Setbacks

(Derived from Minn. R. 7080.2150 subp. 3 item F)

TABLE VII MINIMUM SETBACK DISTANCES (FEET)			
Feature	**Sewage tank, holding tank, or sealed privy**	**Absorption area or unsealed privy**	**Building sewer or supply pipes**
Water supply wells	*	*	*
Buried water lines	*	*	*
Buildings**	10	20	
Property lines***	10	10	
Ordinary high water level of public waters	****	****	

** Setbacks from buried water lines and water supply wells are governed by Minn. R. chs. 4715 and 4725, respectively.*

*** For structures other than buildings, these setbacks are allowed to be reduced if necessary due to site conditions, but no component of an ISTS is allowed to be located under or within the structure or other impermeable surface.*
**** Infringement on property line setbacks must be made through accepted local procedures.*

***** Setbacks from lakes, rivers, and streams are governed by Minn. R. chs. 6105 and 6120.*

Appendix K

Acronyms and abbreviations

ASTM – American Society of Testing and Materials

ATU – Aerobic Treatment Unit

BMP – Best Management Practice

BOD_5 – Five Day Biochemical Oxygen Demand

CFR – Code of Federal Regulations

DWSMA – Drinking Water Supply Management Area

EPA – United States Environmental Protection Agency

GLUMRB – Great Lakes Upper Minnesota River Board

HDPE - High Density Polyethylene

HRSA – High Rate Soil Absorption System

ISTS – Individual Subsurface Sewage Treatment System

LCSS – Large Capacity Septic System

LGU – Local Government Unit

LIST – Product Listing

MN Board of AELSLAGID – Minnesota Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience and Interior Design Board Professional

MnTAP – Minnesota Technical Assistance Program

MPCA – Minnesota Pollution Control Agency

NSF – National Sanitation Foundation

O&G – Oil and Grease

OSTP – University of Minnesota Onsite Sewage Treatment Program

PE – AELSLAGID Professional Engineer

PG – AELSLAGID Professional Geologist

POTW – Publicly Owned Treatment Works

PSS – AELSLAGID Professional Soil Scientist

RI – Rapid Infiltration

RS&G's – Recommended Standards and Guidance for Registered Products

SDR – Standard Dimension Ratio

SDS – State Disposal System

SPSF – Single Pass Sand Filter

SSTS – Subsurface Sewage Treatment System

STEG – Septic Tank Effluent Gravity

STEP – Septic Tank Effluent Pump

SWDA – Safe Water Drinking Act

TN – Total Nitrogen

TP – Total Phosphorus

TSS – Total Suspended Solids

UIC – Underground Injection Control

USDA – United States Department of Agriculture

USDW – Underground Source of Drinking Water

Appendix L

Interpretation of site evaluation

A. Does the soil description and other field information substantiate the soil survey report? *(Minn. R. 7080.1730 item I)*

Yes_____ No_____

If no, explain the possible reasons why and which data was chosen for design:

____
____
____
____

B. What is the limiting layer?

Seasonally saturated soil *(7080.1720 subpart 5)* ______________________________

Bedrock *(7080.1100 subpart 10)*____

Did not encounter the limiting layer ____

What is the depth of the limiting layer for design?_________________________________

C. How uniform is the soil over the proposed soil dispersal area?

____
____
____

D. Are there any site or soil conditions affecting construction (slope, clay textures, boulders, tree stumps, etc.)? If so, please explain:

____
____
____
____

Reporting - (All of the evaluation information must be reported, plus the information below)

Provide a map of the proposed soil treatment and dispersal area, drawn to scale, showing:

1) features with a setback within 150 feet of the system___________________________
2) easements within 50 feet of the system______________________________________
3) floodplains, wetlands, and surface waters within 100 feet of the system______________
4) location and elevation of all soil pits, borings, and hydraulic tests___________________
5) two-foot contour lines, unless use of the contours are not warranted as determined by the local unit of government__________________

Site Protection *(Minn. R. 7080.1720 subpart 7)*

The proposed soil treatment and dispersal area must be protected from disturbance, compaction, or other damage by staking, fencing, posting, or other effective method.

Appendix M

Effluent mounding on an unsaturated restrictive layer

Step 1 – Soil Dispersal Size (choose either A. Trenches or B. Beds)

A. Trenches:

Step 1a

__________ - 1 = __________ Step 1a
# of trenches

Step 1b

__________ x __________ = __________ Step 1b (ft)
Step 1a *trench spacing O. C. (ft)*

Step 1c

__________ + __________ = __________ Step 1c - System width (ft)
Step 1b *trench width (ft)*

Step 1d

__________ x __________ = __________ Step 1d - System size (ft^2)
Step 1c *trench length (ft)*

B. Systems with Beds

Step 1e. - Beds/At-grades/Mounds:

= __________ Step 1e - Absorption area (ft^2)
bottom area size(area in contact with native soil for mounds)

Step 2 – Soil Dispersal Half Width

A. Trenches:

Step 2a

__________ x 0.5 = __________ Step 2a – Soil dispersal system half width (ft)
Step 1c

B. Beds/At-grades/Mounds:

Step 2b

__________ x 0.5 = _____ Step 2b – Soil dispersal system half width (ft)
Bottom area width

Step 3 – Flow Amount – gallons/day

__________ x 0.5 = __________ Step 3 - Ave. flow for mounding cal (gpd)
Design Flow (gpd)

Step 4 – Loading Rate feet/day

__________ / __________ / 7.5 = __________ Step 4 - Loading Rate (ft/d)
Ave. flow for mounding cal. (gpd) Step 3 *Soil system size Step 1d or 1e*

Step 5 - Kahn Perched Mounding Equation
Step 5a ____________ / ______________________ = __________ Step 5a *Loading Rate Step 4* — *Ksat of upper permeable layer ft/day*
Step 5b ___________ / ___________________________ = _________Step 5b *Loading Rate Step 4* — *Ksat of lower less permeable layer ft/day* **NOTE: if the value in Step 5b is less than 1, no perched mounding will occur, you may stop the calculation here.**
Step 5c ___________ - 1 = ________ Step 5c *Step 5b*
Step 5d ____________ x __________ = ________ Step 5d *Step 5a* — *Step 5c*
Step 5e Take the square root of Step 5d = _________ Step 5e
Step 5f ____________ x ___________________________ = ________ Step 5 f - maximum mound height of perched effluent (ft) Step 5e — 1/2 width of the soil dispersal system Step 2a or 2b
Step 6 – Add Mounding height to Limiting Layer ______________________ - _________________ = _______ Step 6 - Depth to limiting layer based on mounding (ft) Depth to restrictive layer — Max mound height Step 5f

Appendix N – Check of Hantush spreadsheet

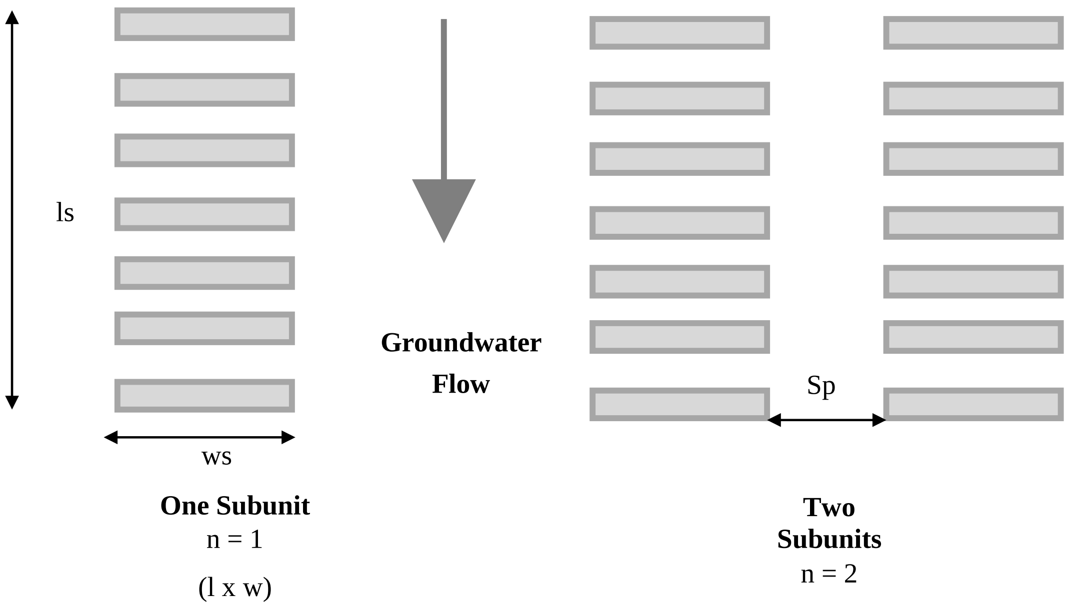
Below is an example calculation into the Hantush spreadsheet. This is provided to check if the values are correctly being placed into the spread sheet.

Zmax Beneath Center of Entire Drain Field (L*W)								
Feet and Days	Length of Drain Field Subunit	Width of Drain Field Subunit		Separation between Drain Field Subunits	Fraction of Drain Field Subunit that is Trench Area	Horizontal Hydraulic Conductivity	Specific Yield use 0.001 to approximate steady state at 10 years	time use 10 years to approximate steady state
	l_s	w_s		Sp	f	Kh	Sy	time
	ft	ft		ft		ft/days	none	days
	98.4	49.2		4.9	0.5	16.4	0.001	3650
	L	W	q effective in subunit ls x ws	q in trenches	q' effective on LxW	Q	Zmax 12 iterations	Initial Saturated Thickness
Number of subunits, n	ft	ft	ft/day	ft/day	ft/day	gallons/day	ft	ft
1	98.4	49.2	0.2187	0.4374	0.2187	7920	4.382	13.
2	103.3	98.4	0.1094	0.2083	0.1042	7920	4.237	13.
4	211.5	98.4	0.0547	0.1018	0.0509	7920	4.025	13.
8	427.9	98.4	0.0273	0.0503	0.0251	7920	3.754	13.

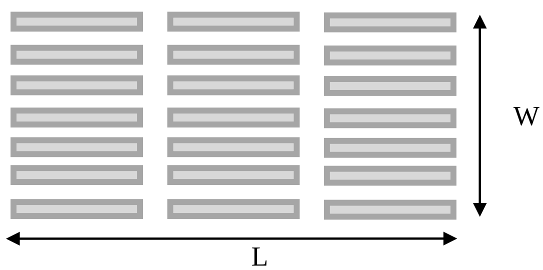
Water Table Rise on Side Slope										
Uses Subunit Geometry and Material Properties from Zmax Table										
	L	W	q effective in subunit ls x ws	q in trenches	q' effective on LxW	Q l/day	Zsx 12 iterations	Distance from Center of Drain Field in Long Dimension (x in figure)	Distance from Center of Drain Field in Wide Dimension (y in figure)	Initial Saturated Thickness
Number of subunits, n	ft	ft	ft/day	ft/day	ft/day	gallons/ day	ft	ft	ft	ft
1	98.4	49.2	0.2187	0.4374	0.2187	7920	3.236	54.1	200	13.
2	103.3	98.4	0.1094	0.2083	0.1042	7920	3.221	78.7	200	13.
4	211.5	98.4	0.0547	0.1018	0.0509	7920	3.118	78.7	200	13.
8	427.9	98.4	0.0273	0.0503	0.0251	7920	2.950	78.7	200	13.

Instructions for Hantush spreadsheet

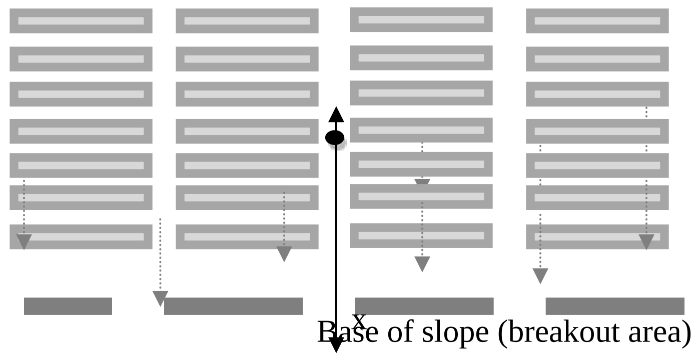
1. Diagrams of input variables:



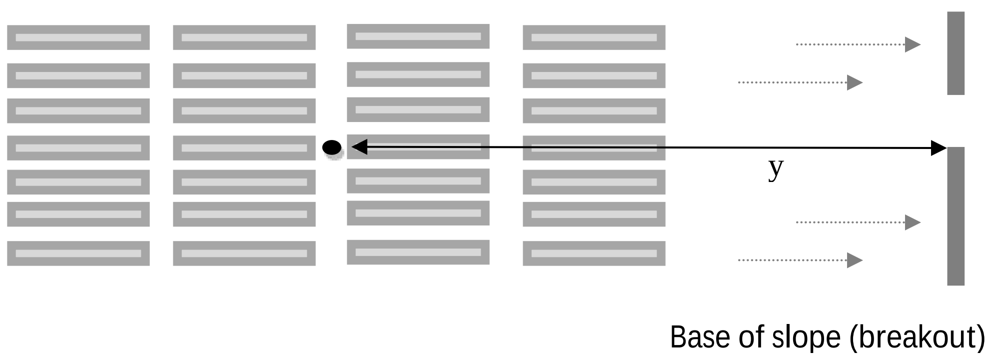
f = fraction of area that is trench (bottom absorption area divided by lawn area)
The factors "L" and "W" will be automatically calculated in the spreadsheet when entering the values "ls", "ws" and "sp".



Distance from Center of Drain Field in Long Dimension (x)



Distance from Center of Drain Field in Wide Dimension (y)



2. Fraction of drainfield subunit that is trench area (aka "absorption area"):

Step 1. - Lawn area calculation –

A. Trenches –

[__________ x (___________ + ___________)] = ______ Lawn Area (ft2)

total trench length (ft) — *trench spacing (O.C.) (ft)* — *trench width (ft)*

B. At-grades and seepage beds –

Absorption area = Lawn area

C. Mounds –

Native soil absorption area = Lawn area

Step 2. – Calculate fraction of drainfield that is absorption area:

_________ / ____________ = __________ Fraction of drainfield which is absorption area

Absorption area (ft2) — *Lawn area (ft2)*

3. Horizontal Hydraulic Conductivity = Use Table IIB or measure
4. Specific Yield = Use Table II C
5. Time = Use 3,650 day
6. Q - Gallons = Use ½ of the design flow
7. Initial Saturated Thickness = Use five (5) feet, measure from borings, or estimate from well logs.

Appendix O

Aquifer impacts determination for MSTS for advanced designers

I. Determine Well Impacts
Step A. Is a proposed soil dispersal system within 200 feet of any drinking water supply well? Yes – Site is not suitable or has a hydrological assessment conducted by an AELSLAGID Board Professional. No – Go to Step B.
Step B. Are constraints in place to prohibit future drinking water supply wells to be within 200 feet of the soil dispersal system? No – Site is not suitable or have a hydrological assessment conducted by an AELSLAGID Board Professional. Yes – Go to Step C.
Step C. Is the proposed soil dispersal system placed in a Drinking Water Supply Management Area with a high or very high sensitivity rating? Yes – Site is not suitable or has a hydrological assessment conducted by an AELSLAGID Board Professional. No – Go to Calculate Treatment Below – Step 1
II. Calculate Treatment
Step 1. Determine the concentration of total N from the last treatment device before the soil dispersal system __________. For a determination see the Instruction Sheet for Step 1.
Step 2. Determine the concentration level once the effluent has passed through the soil treatment zone from the following charts. See the instruction sheet for assistance.

Table 1. System Located South of St. Cloud - Receiving Septic Tank Effluent			
	Total N concentration remaining at the depths below the system (in decimal percent)		
	3 feet	**4 feet**	**6 feet**
Coarse sand, sand	1.00	1.00	1.00
Fine sands	1.00	1.00	0.98
Loamy sand	1.00	0.90	0.84
Sandy loams	1.00	0.90	0.46
Loam	1.00	0.90	0.46
Silt loam	1.00	0.88	0.40
Clay loams	1.00	0.78	0.00

Table 2. System Located St. Cloud and North - Receiving Septic Tank Effluent			
	Total N concentration remaining at the depths below the system (in decimal percent)		
	3 feet	**4 feet**	**6 feet**
Coarse sand, sand	1.00	1.00	1.00
Fine sands	1.00	1.00	1.00
Loamy sand	1.00	1.00	0.94
Sandy loams	1.00	1.00	0.84
Loam	1.00	1.00	0.82
Silt loam	1.00	1.00	0.80
Clay loams	1.00	0.96	0.58

Table 3. System Located South of St. Cloud - Receiving Nitrified and N Reduced Effluent				
	Total N concentration remaining at the depths below the system (in decimal percent)			
	2 feet	3 feet	4 feet	6 feet
Coarse sand, sand	1.00	1.00	0.98	0.98
Fine sands	1.00	0.98	0.98	0.98
Loamy sand	0.90	0.88	0.80	0.64
Sandy loams	0.84	0.56	0.50	0.04
Loam	0.84	0.56	0.50	0.04
Silt loam	0.82	0.52	0.48	0.02
Clay loams	0.76	0.40	0.30	0.00

Table 4. System Located St. Cloud and North - Receiving Nitrified and N Reduced Effluent				
	Total N concentration remaining at the depths below the system (in decimal percent)			
	2 feet	3 feet	4 feet	6 feet
Coarse sand, sand	1.00	1.00	1.00	1.00
Fine sands	1.00	1.00	1.00	1.00
Loamy sand	1.00	0.98	0.90	0.86
Sandy loams	0.96	0.84	0.82	0.58
Loam	0.94	0.82	0.82	0.58
Silt loam	0.92	0.80	0.80	0.58
Clay loams	0.90	0.72	0.50	0.16

Step 3.

Determine the concentration of total nitrogen after passing the soil treatment zone:

________ conc. of total N mg/l x ________ N reduction = _________ Cs (Step 3)
ep 1 Step 2

Step 4.

Calculate the quantity of effluent – Qs

______________ x 0.5 = ____________ Qs (gallons/day) (Step 4)
Design Flow (gpd)

Step 5.

Assume concentration of N in the infiltration recharge is <u>1 mg/l</u> Ci (Step 5)

Step 6.

Determine the aquifer infiltration recharge

Select the infiltration recharge from the map for Step 6 in the Instruction Sheet.

____________ in/year / 4380 = ___________ Infiltration recharge (ft/day) (Step 6)
Infiltration recharge

Step 7.

Determine the aquifer infiltration recharge over the system and to the nearest property boundary. For multiple systems/zones, calculate each one separately in Step 7 and add together.

<u>Step 7a -</u>

___________ x ___________ = __________ft2 (Step 7a)
*Length of system** *Width of system**

**See instructions for explanation*

<u>Step 7b -</u>

(__________ + __________) x 0.5 = _______ ft (Step 7b)
*Length of system** *Width of system**
**See instructions for explanation*

<u>Step 7c -</u>

___________ x _____________ = __________ ft2 (Step 7c)
Step 7b *distance to the nearest property boundary from edge of soil absorption area (ft)*

Step 7d -

__________ + __________ = _________ ft2 (Step 7d)

Step 7a *Step 7c*

Step 7e -

__________ x __________ x 7.5 = _________ (Step 7e) Infiltration Recharge – Qi (gal/day)

Step 7d *Step 6*

Step 8 – Calculate the final concentration of total N entering the groundwater

Step 8a -

__________ x __________ = __________ (Step 8a)

Cs (Step 3) *Qs (Step 4)*

Step 8b-

__________ x __________ = __________ (Step 8b)

Step 5 *Step 7e*

Step 8c-

__________ + __________ = __________ (Step 8c)

Step 8a *Step 8b*

Step 8d-

__________ + __________ = __________ (Step 8d)

Step 4 *Step 7e*

Step 8e-

__________ / __________ = __________ (Step 8e) Concentration of total N to the groundwater (mg/l)

Step 8c *Step 8d*

Step 8f

If the concentration is 10mg/l or greater, then the aquifer is consider as being sensitive and the system must be designed to meet a 10 mg/l total N concentration at the property boundary or the nearest well, whichever is closets.

Instruction sheet for aquifer impacts determination

I. Determine well impacts

To answer the questions in Step C you need to know:

- if any nearby wells are a public water supply well (need community or facility name);
- whether a Drinking Water Supply Management Area (DWSMA) has been designated and its boundaries
- whether the water supply well is sensitive

Tool needed

The tool needed to make this determination is found at the following Web address: https://mdh.maps.arcgis.com/apps/View/index.html?appid=5051b7d910234421b0728c40a1433baa

Procedure

1. Enter the name of the county; a list of public water supply wells will be generated.
2. Click on the Surface/Ground Water Assessment hypertext corresponding to the well in question. A Source Water Assessment page will appear.
3. Determine from the Source Water Assessment page:
    - the aquifer sensitivity
    - if a Source Water Assessment has been conducted; if so, click on "map" to determine the boundaries of the drinking water supply management area

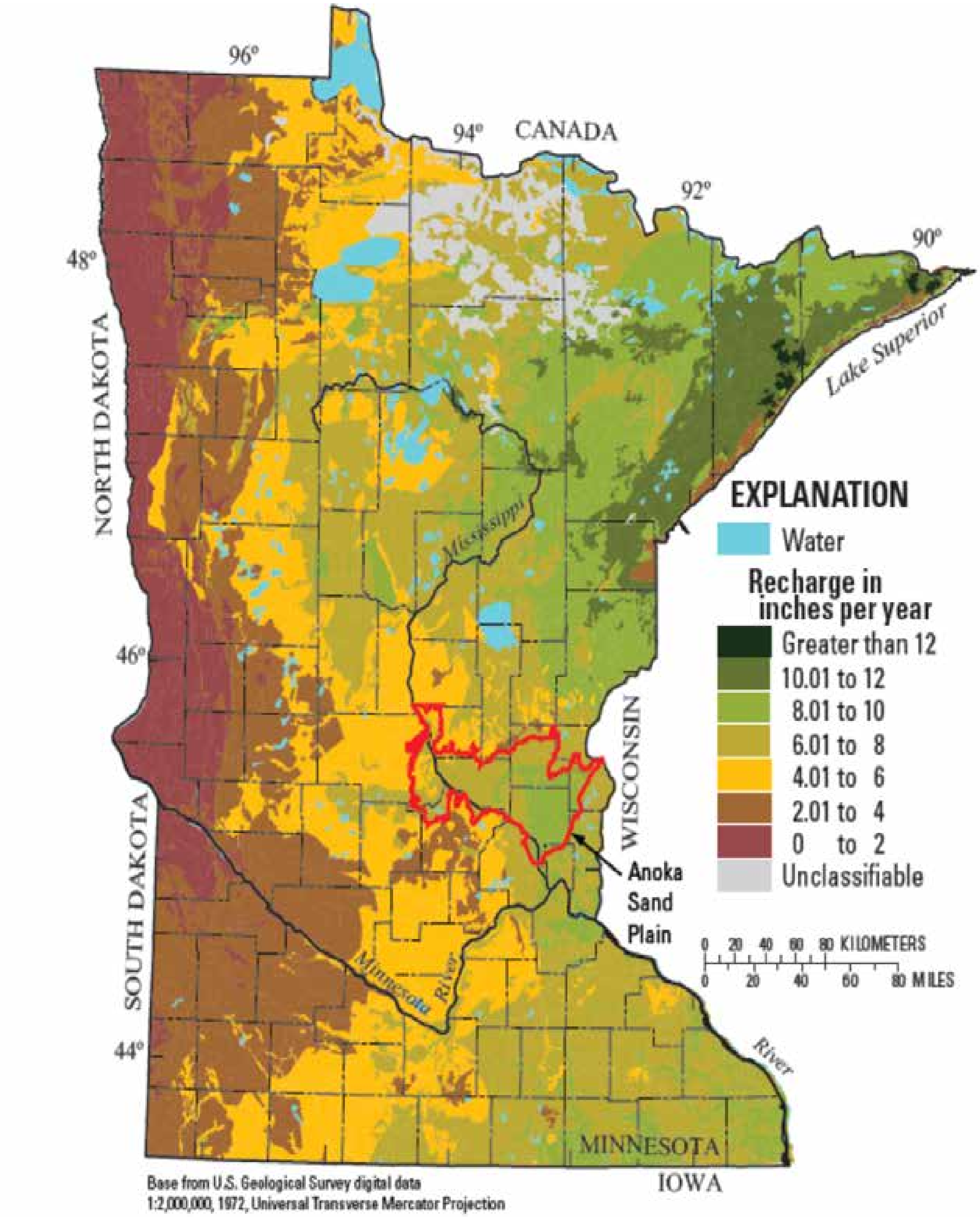
II. Calculate treatment

Step 1 -

- If septic tank effluent is from dwellings use 50 mg/l total nitrogen.
- Effluent total nitrogen concentrations from non-dwellings the will need to be estimated or measured.
- If an N reducing treatment device is used, use the concentration provided by its MPCA registration at https://www.pca.state.mn.us/water/registered-treatment-products.

Step 2 - The chart is based on either a Type I or Type IV hydraulic loading rates. Please note which type of effluent discharged into the soil and the location of the system in the State (northern or southern Minnesota). The soil depth is the designed vertical separation distance from the bottom of the distribution media to the periodically saturated soil or bedrock. The percent remaining is what can be expected 75 percent of the time.

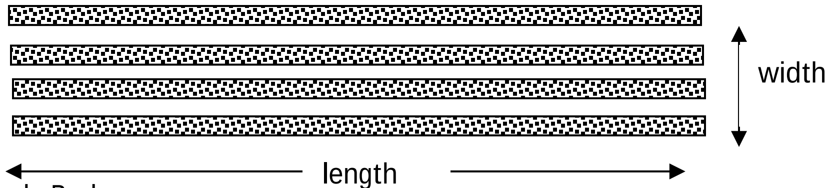
Step 6 – Select the infiltration recharge from the following map:



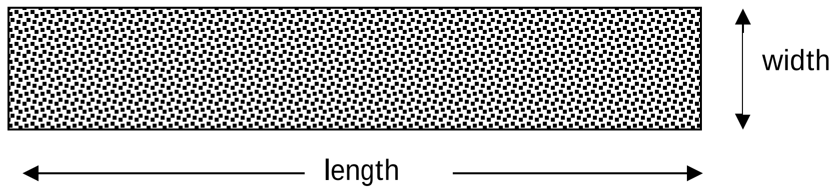
Steps 7a and 7b

The following diagram indicates how to determine the length and width of a system (plain view):

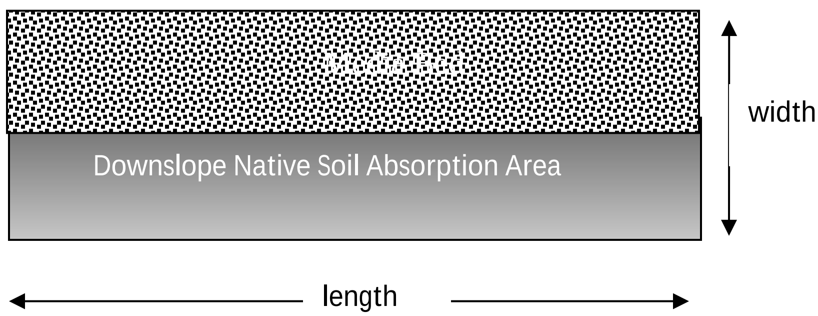
Trenches:



Seepage Beds and At-Grade Beds:

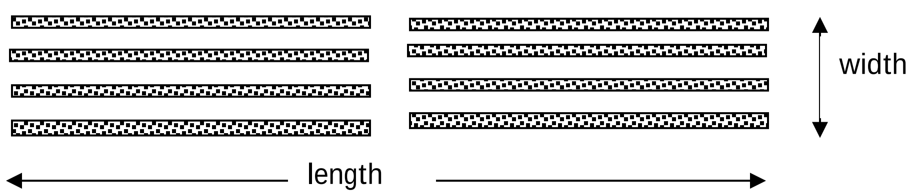


Mounds:



Multiple Zones/Systems:

If systems are adjacent, then consider it as one unit



If systems are not adjacent, then calculate each unit separately as a single system