Carlos Township on Lake Miltona

FINAL Community Assessment Report

Douglas County, Minnesota

Wenck

Prepared for

Carlos Township

March 2011

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Douglas County, Minnesota

Wenck File #2420-01

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March 2011

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Table of Contents

Table of Contents (Cont.)

TABLES

Table of Contents (Cont.)

FIGURES

APPENDICES

1.0 Introduction

1.1 BACKGROUND

The southern tip of Lake Miltona in Carlos Township is located approximately 12 miles north of Alexandria in Douglas County, Minnesota (Figure 1). Residents currently have individual water supply wells. The area is unsewered, resident wastewater needs are met by individual subsurface treatment systems (ISTS)[1] or by holding tanks, which collect and store effluent until it is collected by a pump truck and disposed of off-site. Wenck Associates, Inc. (Wenck) was retained to assess the probable compliance status of existing ISTS, and provide alternatives for viable long term infrastructure to collect, treat, and disperse wastewater within the Carlos Township portion of Lake Miltona shoreline.

The approximate population of the Community Assessment Report (CAR) area is 190, based on the average number of bedrooms per residence as determined by the homeowner surveys. The population is expected to remain steady, based on the set CAR boundaries and the relatively small lot sizes that will prevent future subdivision of lots. The population in the CAR area is largely seasonal, although some residents have plans to convert seasonal residences to permanent residences in the future. The setting is a rural residential area on the southeast corner of Lake Miltona. The lake is larger surrounded by agricultural fields.

This CAR was made possible through a Small Community Wastewater Technical Assistance Grant from the Minnesota Public Facilities Authority. These grants are available to small unsewered communities so they may analyze possible solutions to wastewater problems associated with non-complying septic systems. The Small Community Wastewater Technical Assistance Grants are designed to help communities develop the technical, managerial and

[1] ISTS (a.k.a. septic system) is defined in Minnesota Rule Chapter 7080 as a type of Subsurface Sewage Treatment System (SSTS) that treats and disperses wastewater with an average daily flow less than 5,000 gallons per day.

financial capacity necessary to build, operate, and maintain new subsurface sewage treatment systems (SSTS).

1.2 PREVIOUS INVESTIGATIONS

In 2008, Wenck completed an Unsewered Area Needs Documentation (UAND) for the CAR area. Using Douglas County permit records, soil survey data, and a visual survey of the CAR area, Wenck determined that 39 of the parcels in the CAR area were likely non-compliant failing to protect groundwater and that an additional 7 parcels likely did not meet at least one of the required setbacks. Based upon these preliminary numbers, a Technical Assistance Grant was applied for and received from the Minnesota Public Facilities Authority to complete a CAR.

1.3 REPORT PURPOSE

This report is to be viewed as a planning document for possible long term solutions for wastewater collection and treatment within the Carlos Township portion of Lake Miltona shoreline. Within this report are developed concepts and a framework to provide sanitary sewer service to the existing residences in this area. Alternatives are given for long-term wastewater treatment.

1.4 WORK PERFORMED

To determine the baseline for the analysis, a field investigation and county file review was completed in July and August 2010 to assess the existing condition of any ISTS and septic tanks. The analysis also evaluated future onsite wastewater and cluster soil-based wastewater treatment options for residents. Information regarding some specifics of different ISTS (i.e., drain field trench vs. mound) produced by the University of Minnesota Onsite Sewage Treatment Program[2] is found in Appendix A.

[2] University of Minnesota Onsite Sewage Treatment Program is the organization that provides the technical training and continuing education for individuals who design, inspect, install, and maintain ISTS in Minnesota. Additional homeowner information regarding ISTS can be found at their website: http://septic.umn.edu/

Building from the information gathered in the county file review and field investigation, three alternatives were evaluated for long-term wastewater infrastructure.

Alternative 1:	Existing homes install compliant ISTS
Alternative 2:	Combination of individual and cluster ISTS
Alternative 3:	All homes on common system

Service Areas (based on geographic location, topography, density, access, existing ISTS compliance status, and size of parcels) were identified to allow for calculation of average costs for the Alternatives; these boundaries may be modified or altered as future projects develop. The CAR boundaries include two Service Areas to provide flexibility in evaluating alternatives. In addition, costs for individual properties using only ISTS onsite wastewater systems are included in Appendix B.

2.0 Existing Conditions

2.1 INTRODUCTION

This section summarizes the findings of the existing ISTS conditions. All the properties to be evaluated were served by ISTS of varying age or holding tanks. Each property had a determination made of likely compliance status. In addition, a determination was made as to whether it was feasible to replace the failed system with a combination of standard ISTS and/or cluster systems.

Individual parcel information was provided by the Douglas County Land and Resource Management Department. The number of parcels identified for investigation by Carlos Township was 52. One of these parcels was a vacant parcel with no wastewater generation anticipated in the foreseeable future (Carlos Gun Club). The remaining 51 parcels were occupied by some type of residential wastewater generating structure.

2.2 METHODS

Determination of feasibility of ISTS and/or cluster system installation required evaluation of the soils. In addition to the soil survey data available (Figure 2), Wenck used available permit records and onsite borings to establish a profile of soils in the area. Wenck was able to access all included properties to complete a visual site inspection of any existing ISTS with the intent of documenting: Imminent Threats to Public Health or Safety (ITPHS)[3]; assessing likelihood of

[3] ITPHS is defined in 2008 MN Rules Chapter 7080.1500 Subp. 4A. "…a system that is an imminent threat to public health or safety is a system with a discharge of sewage to the ground surface, drainage systems, ditches, or storm water drains or directly to surface water; systems that cause a reoccurring sewage backup into a dwelling or other establishment; systems with electrical hazards; or sewage tanks with unsecured, damaged, or weak maintenance hole covers."

ISTS system compliance with respect to protection of groundwater[4]; and determine compliance with setbacks from surface waters, wells, buildings, and lot lines. In addition, at properties with adequate room for a replacement mound or drain field soil analysis was completed to determine future ISTS type.

Prior to commencement of field work, Douglas County provided available past permitting/design/inspection records for individual parcels as well as the GIS shape file of the parcels. Homeowner surveys were sent to parcel owners to gain further knowledge of the existing wastewater treatment infrastructure and to evaluate seasonal and parcel specific water usage. Homeowner surveys are the property of the township and available upon request. To gain further knowledge of the ISTS in the CAR area, Wenck interviewed Aaron Jensen of the Douglas County Land and Resource Management Department. Mr. Jensen provided historical information regarding the procedural efforts of the county and ISTS permitting information.

Wenck began the CAR by participating in a town hall meeting hosted by the Carlos Township on June 21, 2010 to inform the citizens of the project and answer questions. Field work began in July 2010 and included an initial data gathering phase where maps were created for each individual parcel, wells were located, and tanks with surface access were located and evaluated for water-tightness.

This initial phase was followed by a meeting with Aaron Jenson, Douglas County Land and Resource Management, Nick Haig, Dave Gustafson, and Dan Wheeler, all from the University of Minnesota; to visit the project area and discuss CAR methodology.

Using information gleaned from the initial data gathering and parcel base map preparation, a site visit was conducted to each parcel. The site visits included a compliance assessment to obtain the information found in Section 2.3. Holding tank only properties simply required evaluation of holding tank compliance status, since no additional ISTS components were in use. An evaluation

[4] Failure to protect groundwater is defined in 2008 MN Rules Chapter 7080.1500 Subp. 4B. "…a system that is failing to protect groundwater is a system that is a seepage pit, cesspool, drywell, leaching pit, or other pit; a system with less than the required vertical separation distance described in items D and E; and a system not abandoned in accordance with part 7080.2500."

was also made to determine if suitable area existed onsite for a future ISTS. At properties where an ISTS soil treatment area existed, the vertical separation between seasonally high groundwater (as determined using soil borings and nearby surface water features) and the bottom of the effluent dispersal area was determined. Seasonally high groundwater levels were estimated in areas that did not have soil borings completed by documenting elevations of field verified seasonally high groundwater levels and extrapolating contours across the entire project area. Properties with less than three feet of vertical separation were determined to be non-compliant for a failure to protect groundwater (FTPG). Setbacks to wells, property lines, surface waters, and buildings were also assessed. Finally, an evaluation was made to determine if a suitable area existed onsite for a future ISTS and what type of system would most likely be installed.

2.3 FINDINGS

The purpose of the site visit was to obtain: information on source of drinking water, the type of dwelling contained within the parcel, type of ISTS (if any) currently serving the residence, the likely compliance status of the ISTS, setback conformance of any compliant ISTS, and the next ISTS to serve the dwelling.

2.3.1 Drinking Water Source

The source of drinking water for the dwellings in the CAR area is individual wells. The individual onsite wells are either shallow (screen at less than 50 feet below ground surface) or deep (screened at greater than 50 feet below ground surface). Depth and location of wells must be taken into account when considering ISTS setback requirements. A deep well requires a 50-foot setback to a drainfield while a shallow well requires a 100-foot setback. Some wells were not able to be located during field survey, but their locations were reported either on homeowner surveys or in conversations with property owners (Appendix B). Table 1 and Figure 3 summarize the makeup of the wells in the CAR Area:

Table 1: Existing Well Types

Well Type	Number	Percentage
Shallow (<50')	8	15%
Deep (>50')	31	61%
Unknown*	12	24%

*Wells with unknown location were not mapped. Wells with unknown depth were mapped as deep in Figure 3.

2.3.2 Occupancy Status of Residences

Table 2 shows the estimated current occupancy status of the evaluated residences in the CAR area. The data in the table was collected via homeowner surveys, conversations with homeowners, and conversations with individuals knowledgeable about the occupancy status of the CAR area. An especially important factor when considering seasonal occupancy of a residence is the cost of maintaining ISTS, particularly a Type II Holding Tank. A seasonal resident will pay much less in annual pumping costs for a holding tank than a permanent resident. Two of the four full-time residents have a holding tank as their only available future option. Theses costs are discussed in detail in Section 3.2.1.

Table 2: Existing Status of Residences*

Usage Pattern	Number	Percentage
Seasonal	47	92%
Full-Time	4	8%

*Estimate - can change - highly variable. Designs and costs in this report are based on estimated current usage of residences.

2.3.3 ISTS Types

Table 3 provides a breakdown of the ISTS types (51 total) in the CAR area. One community system exists, serving nine dwellings on what is locally known as the "Hilltop System." In addition, two properties were discovered where multiple dwellings on the same parcel were served by different systems including both a holding tank and an ISTS with a soil treatment area. The descriptions listed in Table 3 are common names.

Table 3: Existing ISTS Types

ISTS Type	Number	Percentage
Individual Drain Field	29	56%
Community Drain Field	9	18%
Mound	1	2%
Holding Tank Only	10	20%
Individual Drain Field + Holding Tank	2	4%

2.3.4 ISTS Compliance Status

Upon visiting each individual parcel a determination was made regarding the potential that the ISTS for the dwelling(s) at the address would be compliant or non-compliant with Minnesota Rules Chapter 7080.

The ISTS that are likely non-compliant were identified as such for one of two reasons; 1) ITPHS as identified from site reconnaissance or 2) failure to protect groundwater (FTPG). The FTPG determination was made using localized seasonally high groundwater elevations. Groundwater elevations were determined throughout the CAR area by completing soil borings (Figure 2) and documenting elevations with a Trimble R8 GPS unit. In addition, lake water levels and adjacent wetland water levels were recorded with the GPS unit and seasonally high groundwater interpreted across the CAR area.

In general, at lots east of the Carlos Gun Club property, elevations of seasonally high groundwater ranged between 1367.7 feet near the lake (the ordinary high water level of Lake Miltona) to 1370.8 feet (the highest noted elevation of the wetland) near the south edge of the lots. These same lots had ground surface elevations ranging between 1370 feet near South Lake Miltona Drive to around 1375 feet on the beach ridge where most of the houses are built. Therefore, depending on the location on the lot, depth to seasonally high groundwater below ground surface ranged from less than 1 (south of the road) to about 7 feet (at the beach ridge). Lots west of the Carlos Gun Club property varied much more in both groundwater elevation and topography. Appendix B documents the depth to groundwater below ground surface at the soil treatment areas (or tanks if holding tank systems were used at the individual lot).

Table 4 summarizes the ISTS compliance status data for the properties. The compliance status is based on county permit information, soils data, known surface and groundwater elevations, anecdotal information provided by county staff, site visits, and our experience.

Table 4: ISTS Likely Compliance Status

Status	Number	Percentage
Compliant Holding Tank	9	18%
Compliant Non-Holding Tank	4	8%
Non-Compliant FTPG	38	74%

Of the compliant holding tanks, two of the nine did not meet the required setback to a shallow well. Appendix B contains a table that shows the likely compliance status of the evaluated parcels and Figure 4 depicts likely compliance status.

2.3.5 Existing Septic Tank Compliance

Even though a property's ISTS soil treatment area may be non-compliant, a septic tank may exist at a property that meets current compliance requirements and could be used in a future ISTS or community wastewater treatment system. During field reconnaissance, tanks with surface access were inspected for water tightness below the outlet of the tank. If a septic tank was not accessible, the age of the tank, the permit status, field reconnaissance, and/or homeowner information assisted in making the compliance status decision. Six tanks, shown in Appendix B that passed initial field compliance screening, were selected for pumping to determine likely compliance status. Wenck was onsite at the time of pumping to observe the pumping and the tanks that were pumped. After pumping it was concluded that all but one of these six tanks was water tight below the normal operating level. However, the majority of tanks were noted to have infiltration and inflow (I & I) occurring above the normal operating level through risers that were not water-tight. In addition, a number of tanks were noted without baffles. At the time of upgrade, tanks with I & I issues or missing baffles would need to be repaired. The costs for these upgrades are accounted for in this report.

2.3.6 Next ISTS Options

The final piece of information obtained during the investigation was determining the type of ISTS that the property could accommodate in the future. Appendix B shows the properties' most-likely future ISTS option. Trenches are generally not an option at lakeside properties in the CAR area due to the depth to seasonally saturated soil conditions and groundwater, which were confirmed by soil borings. Figure 2 shows locations of soil borings, with boring results documenting depths to seasonally saturated soil conditions located in Appendix D. Soil borings were conducted at a number of locations to determine depth to seasonal saturation and assess likely infiltration rates of soils for future SSTS options.

For a dwelling that does not have a suitable area, the next ISTS would likely need to be a holding tank. Minnesota Rules, part 7080.2200 – 7080.2400 (February 2008) define different ISTS system types; a brief summary of system types is given below:

- **Type 1:** Standard systems including subsurface drain fields or mound systems on undisturbed soils with or without a pump system.
- **Type 2:** Holding tanks (tank with a sealed outlet requiring regular pumping), floodplain properties.
- **Type 3:** Systems installed on problem soils, disturbed soils, or soils where high groundwater is within one foot of the ground surface.
- **Type 4 and 5:** Commonly referred to as "performance" systems. These systems offer a level of pre-treatment through a mechanical treatment unit or media filter prior to discharge to a drain field or mound. Also included in this category are systems installed with higher soil loading rates or reduced vertical separation distance to groundwater than what is allowed in rule.

Type 1 systems meet all technical rule requirements, have adequate onsite soils, and are able to meet setbacks. Type 2 systems are holding tanks that need visual and/or audible alarms to notify the owner when pumping is required. The lack of an alarm on a holding tank or the neglect of a homeowner not to pump the tank when full can cause an ITPHS and fail to protect groundwater. Type 3 systems require county approval, but can be installed on sites where disturbed soils would otherwise limit the landowner to a Type 2. Type 1 systems that do not meet compliance due to FTPG may be able to upgrade to a Type 4 or 5 system by adding pretreatment that allows wastewater to be discharged with a reduced vertical separation to seasonally saturated soils.

Table 5 and Figure 5 summarize the next ISTS likely to be installed when the non-compliant systems are upgraded, assuming the property owner would not install a holding tank if they have another option. See Appendix B for more detailed information.

Table 5: Next ISTS Replacing Non-Compliant by Property

ISTS Type	Number	Percentage
1 (Mound)	3	8%
2 (Holding Tank)	12	32%
3 (Mound)	14	37%
4/5 (Performance)	9	23%

Table 6 summarizes what the make-up of the ISTS in the community will be after upgrades if all parcels stay on ISTS rather than choosing a community SSTS or other option.

Table 6: Future ISTS Types by Property

ISTS Type	Number	Percentage
1	6	12%
2	21	41%
3	15	29%
4/5	9	18%

Data presented in Table 6 indicates that 12% of parcels have adequate room and suitable soil conditions on their property to install a Type 1 or "standard" ISTS for the next system. Nearly 2 out of 5 parcels have a Type 2 holding tank as their only option for the next system. This is due to seasonally saturated conditions in the underlying soils, lot sizes, and location of houses and/or other permanent structures that prevent homeowners from installing a Type 1 mound. The remaining property owners, just under half of the total, have a Type 3, 4, or 5 ISTS as their best option. Appendix B contains a table that documents the recommended next ISTS for the evaluated parcels.

2.4 SUMMARY

Of the existing 51 properties that were evaluated and generate wastewater, 74% (38) are estimated to be in non-compliance. The properties are considered non-compliant due to a FTPG. In this context, the portion of the FTPG definition that is causing the non-compliance is the lack of the required three-foot vertical separation distance from the bottom of the drain field to seasonally saturated soil or a septic tank that is not water tight below the normal operating depth. All but one of the evaluated septic or holding tanks is water tight below the outlet of the tank.

Of the 51 wastewater-generating properties evaluated, six have a suitable area onsite for installation of a Type 1 mound or drain field. Fifteen more have a suitable area onsite and would be best served by a Type 3 system. An additional nine properties would be best served by a Type 4-5 system. The remaining 21 properties have a Type 2 holding tank as their only option.

3.0 Alternatives Analysis

3.1 INTRODUCTION

When considering alternatives for long-term wastewater infrastructure all three components need to be evaluated. These components are:

1. Collection: The means in which wastewater leaves the individual structure and is conveyed to the primary treatment unit.
2. Treatment: Removal of pathogens and nutrients in primary and secondary processes.
3. Effluent Dispersal: Final distribution of treated effluent to surface waters, the ground surface, or subsurface soils.

With many ISTS, the treatment and effluent dispersal components occur with the same infrastructure – a drain field removes pathogens and viruses while dispersing the effluent. The two components are broken out separately, however, because a septic tank does provide a primary treatment mechanism. In addition, state rules require some cluster SSTS to employ additional "pre-treatment" methods prior to effluent dispersal. The following alternatives are available for long-term wastewater infrastructure:

1. ISTS
2. Combination of individual and cluster ISTS
3. All homes on common system

This section discusses the different alternatives and highlights advantages and disadvantages. Cost estimates for the alternatives are discussed in Section 4.0.

3.2 INDIVDUAL ISTS (ALTERNATIVE 1)

A Managed ISTS Program utilizing the best available onsite technologies and management can be effective in protecting public health and the environment. For the purpose of this report, the discussion of this alternative assumes that Carlos Township would provide financial management, ISTS maintenance, and component replacement. An economy of scale and assurance of long-term performance is achieved using this management structure.

The Township would be the financial and operational vehicle to assist property owners with ISTS upgrades. The Township would oversee management of the systems through either employees or sub-contracts for financial and operational services.

In this scenario, once property owners upgrade their ISTS to a compliant status, all property owners would pay annual sewer treatment fees for ongoing operation, maintenance, pumping, and a repair reserve fund for their ISTS. The amount each pays would be proportional to the required annual maintenance expense incurred and/or requirements of the lender. All system types, discussed in Section 2.3.4, would require some level of annual maintenance expense; however, fees will vary based on the system type.

3.2.1 ISTS Upgrades

As stated in Section 2.3.3, 38 of the ISTS are estimated to be in non-compliance. This accounts for some type of ISTS upgrade at 38 evaluated properties. ISTS type needed is significant as it directly influences the capital costs for the upgrade as well as long-term operation and maintenance costs.

Recent changes to the ISTS rules dictate that systems that are not considered Type 1, 2, or 3 will require some type of operating permit for the life of the system. State rules dictate that the permit requirements include regular operation and maintenance of the systems by a licensed Service Provider[5].

Table 5 illustrated the number of ISTS needed by type for the next system at the non-compliant addresses. Type 1 systems comprise only 8% (3 parcels) of the ISTS types needed at upgrade. These dwellings can achieve compliance with the installation of a Type 1 system utilizing a mound with three feet of vertical separation beneath the effluent dispersal area and the seasonally saturated condition. These Type 1 mound systems have nominal operation and maintenance expenses of septic tank pumping on average once every three years, electrical costs, and components such as pump replacement. The Type 3 systems that are recommended for 37% of the properties (14 parcels) also fall into this category. The difference in the Type 1 and Type 3 systems is that the Type 3 systems will require special design and installation procedures; increasing their overall capital cost. Average annual operating costs for a Type 1 mound are estimated at approximately $100. Average annual operating costs for a Type 3 mound are estimated at approximately $200.

Type 2 (holding tank) comprises an upgrade group of 12 properties. Holding tanks are required on small lots, lots with setback constraints, and/or lots with multiple structures with little usable land. These lot constraints make the installation of any system that discharges to the soil not permittable.

County governments typically will only permit a holding tank system in situations where no other system type is feasible and will not allow them on the construction of new homes. The hesitation for permitting holding tank systems comes from experiences where homeowners take it upon themselves to empty the tank in an unapproved manner or do not pump the tank when full. Not pumping when the tank is full allows it to overflow out the top or through the seam along the top of the tank. These examples cause an ITPHS and/or fail to protect ground water. A Managed ISTS Program would need to encompass the oversight and pumping frequency on holding tank systems to prevent these situations.

[5] Service Provider is a new license category under 2008 MN Rules Chapter 7083. A Service Provider can assess, adjust, and service ISTS for proper operation.

A disadvantage to a holding tank system for a homeowner is the ongoing operational expense of pumping the tank. A full-time residence with 2-3 residents on average uses approximately 4,000 gallons per month. With a holding tank capacity of 2,000 gallons, pumping frequency would be approximately every two weeks. Average tank pumping costs of $150/2,000 gallons will yield an estimated annual pumping cost of approximately $3,600. For a seasonal dwelling, the cost would likely be around $75/week occupied; again depending upon number of residents in occupancy and water use habits of the residents. An average of 6 weeks occupied per year yields annual pumping costs around $500.

The remaining properties could upgrade to a Type 4-5 ISTS. Similar to Type 2 systems, Type 4-5 systems would also require annual operation and maintenance oversight and expenses, estimated at about $400 per system per year for a Type 4-5 system. Service Providers are trained on ISTS technologies and have the knowledge to operate and maintain Type 4-5 systems that provide alternative treatment in addition to a conventional subsurface drain field or mound.

3.2.2 ISTS Alternatives Summary

- Managed ISTS Program Alternative
    - Advantages
        - Economy of scale for operation and maintenance expenses
        - Capital costs based on need, you pay for your problem and nobody else’s
        - Publicly finances
    - Disadvantages
        - High operation and maintenance expenses for full-time residents on holding tanks
        - Holding tanks pose practical limitations for future use and development of a property

3.3 COMBINATION OF INDIVIDUAL AND CLUSTER ISTS (ALTERNATIVE 2)

When a series of homes, generally less than 100, are connected to a decentralized wastewater treatment system, it is commonly referred to as a cluster system (a.k.a. a big septic system). Cluster system ownership, operation, and management occur through a municipality, the formation of a special purpose district (District), or through private ownership. For the purpose of this report the assumption is made that any cluster system would fall under the ownership of the Township. Private ownership is an option but presents legal challenges as it relates to land ownership/easements and fee collection.

For this alternative it was determined that there exists some properties that are not in need of anything other than an individual ISTS. Large properties that are relatively removed from denser development do not stand to gain significantly from the connection to a cluster system. This assumes a landowner is not interested in sub dividing land to obtain additional building sites.

In the analysis for this alternative, the CAR area has been divided into three Service Areas as shown on Figure 5. Service Areas have been selected based on geographic location and similar property conditions. Smaller Service Areas using shared systems across backyards or other small clusters spread throughout the community were also evaluated, but were ruled out for a majority of the properties due to small lot sizes and soils within the CAR area. A select few properties have the small cluster option; however, it was not a best-case scenario for keeping average wastewater treatment system costs down area-wide. The Service Areas as selected and shown on Figure 6 have the best potential for minimizing wastewater treatment system costs area-wide.

Table 7 highlights the number of wastewater generating parcels per Service Area and the estimated daily flow. Flow calculations can be found in Appendix F.

Table 7: Estimated Flow Rates

Service Area	System Type	Existing Dwellings	Average Daily Flow Gallons/Day*	Permit Type Required
1	**Individual**	6	2,700	County
2	**Individual**	16	6,300	County
3	**Individual**	30	12,900	County
Total	**Individual**	52	21,900	
1	**Individual**	6	2,700	County
2	**Cluster**	16	5,673	County
3	**Cluster**	30	8,903	County
Total	**Cluster & Individual**	52	17,276	

*The average daily flow for individual systems includes holding tanks (Type 2 Systems); therefore, the actual average daily flow dispersed to the subsurface would be less. The average daily flow for the cluster systems includes allowed reductions in daily flows for cluster systems as well as estimated I & I from the proposed collection systems for the clusters.

Using 2008 Minnesota Rules, Part 7081.0120, an average daily flow for each Service Area is estimated using a formula specified in the rule. This formula calculates a flow based on the number of bedrooms in each of the residences, the treatment system type (individual or cluster), and the total number of wastewater generating parcels in the Service Area.

To provide the analysis in this report, we have assumed an average of 3 bedrooms per residence for homes which did not fill out a homeowner survey, which have an average daily flow of 450 gpd (the average bedroom size in the CAR area based on returned surveys was 2.6).

In the future, if a design plan is created an actual flow for each Service Area would need to be determined based on the actual number of bedrooms in each home. Design flow considerations for properties not included in the CAR study area that desire to be included in the selected wastewater system would also be required. Design flows shown included additions for infiltration and inflow into a collection system as well as allowed reductions in estimation of daily flows due to the number of wastewater generating properties connected to a cluster treatment system. These numbers could also change slightly based on actual numbers of bedrooms in each home and any additional wastewater generating properties to be included in a final cluster treatment system design.

Design flows would impact permitting of any wastewater alternative. Average daily flow estimates dictate the level of treatment required and other permitting requirements. For average daily flows greater than 10,000 gallons per day within a ½ mile radius (dispersal sites within ½ mile of each other) of each subsurface sewage treatment system or (SSTS) owned by one entity, permitting is completed through a Minnesota Pollution Control Agency State Disposal System (SDS) Permit. Future SSTS with an average daily flow under 10,000 gallons per day would be permitted by Douglas County using Minnesota Rules Chapters 7080-7083. In addition, SSTS with an average daily flow greater than 5,000 gallons per day would be required to meet design guidance referenced in Minnesota Rules Chapter 7081. Greater permitting effort increases the overall cost of SSTS design, construction, and operation and maintenance as more research and investigation is required upfront and pretreatment of effluent may be required. Table 7 also highlights permitting requirements for individual and cluster treatment options based on average daily flows for the different Service Area scenarios.

3.3.1 Collection System

Four collection system methods to convey wastewater or effluent to the cluster system treatment and dispersal site are available: gravity collection via septic tank effluent gravity systems (STEG); gravity raw effluent collection to a large septic tank located near the cluster site; grinder pump basins at each home to a low pressure force main; and septic tank effluent pump (STEP) system at each residence to a small diameter force main.

Based on topography and depth to groundwater of the Service Areas and the cost of installing a lift station relative to the small population of the CAR area, pressure collection would likely be the least expensive collection method. The two pressure options employ similar technologies. A grinder basin sends solids to the treatment site. With a STEP system, solids are retained on site. STEP collection does not require the same level of hydraulic retention at the treatment site as solids remain at each parcel.

Onsite solids retention with a STEP system requires less capital cost at the treatment site. Other advantages of STEP systems over grinder basins include: greater reserve capacity during power outages or pump failures; less maintenance required on the force main; and longer pump life. For these reasons, the most cost effective collection of solids is within individual septic tanks at each residence. Existing septic tanks already in compliance at individual residences can still be used; a STEP system would just need to be installed in an adjacent tank. In cases where the property does not have an existing compliant septic tank, new tanks would need to be installed along with the STEP system. Appendix C illustrates a typical schematic of a STEP tank.

STEP systems connect to a small diameter pressurized force main installed in road right of ways and easements. The force main follows topography below frost line (6-9 feet) with air release manholes installed at high points in the line. Small diameter force main lines would only transfer effluent with solids management occurring at the individual septic tank. Force mains would discharge effluent into a stilling tank at the cluster treatment site.

3.3.2 Treatment and Dispersal System

Cost estimates generated for this alternative assume that the residents within an individual Service Area would agree to be connected to a cluster system at the same time. Project development within an individual Service Area would likely re-define properties interested in connecting, which could have an impact on the estimated costs.

A general location within or adjacent to the Service Area practical for this alternative has been identified for the potential of cluster treatment and dispersal system sites. These locations are being used for comparison purposes only to provide a preliminary cost estimate based on length of the collection system, type of dispersal system, etc. At the time of project development these locations, or different locations, would need to be further investigated. In addition, aquifer sensitivity to nitrogen impacts must also be considered. Appendix E contains the NRCS aquifer sensitivity map for sanitary facilities. At the time of design, nitrogen impacts to groundwater must be evaluated.

Property access allowed for a soil investigation on four potential cluster system sites, including three neighboring parcels used as farmland or forest and the local golf course. The field investigation on these properties, reviewing soil maps, and general viewing of the properties lead to the assumption that soils at all but one of these locations (the golf course driving range) would support Type 1 mound effluent dispersal systems. In addition, soils at the golf course north of County Road 5 would support a Type 1 subsurface effluent dispersal system.

With this alternative, the Township would own and operate the cluster system(s), collection system(s), and maintain the septic tanks with STEP on each property. The Township could phase this approach as Service Areas organize and property becomes available. Design of the cluster systems would need to follow applicable state rules based on the size (daily flow) of the cluster system.

The cluster treatment systems considered included a mound cluster system for Service Area 2 and a subsurface cluster systems for Service Area 3. Cluster systems were not considered for Service Area 1 because remaining on individual ISTS appears to be a better option financially based on the size of the lots and the distance away from the other Service Areas.

3.3.3 Cluster System Summary

- Advantages
  - Subsidized interest rate loans for cluster system construction and STEP installation
  - Lower operation and maintenance expenses for properties than holding tanks
  - Dispersal of treated effluent away from surface waters
  - Allows for more usable land on individual lots
  - Large parcel owners removed from dense development are allowed to stay on individual ISTS, while dense areas are allowed to connect to a cluster system
- Disadvantages
  - Obtaining land in close proximity to Service Areas could be difficult based on landowner preferences
  - More local involvement required for project development

3.4 COMMON WASTEWATER TREATMENT SYSTEM (ALTERNATIVE 3)

Alternative 3 evaluates the possibility of combining effluent from Service Areas 2 and 3 into one larger wastewater treatment system. Specifically, a combination approach of summer spray irrigation of treated effluent and winter subsurface dispersal was evaluated. Alternative 3 offers a centralized approach for Service Areas 2 and 3 by providing sewer service to all dwellings from one common facility. In this scenario, Service Area 1 will continue to remain on ISTS. A surface discharging system such as this is outside the scope of the Small Communities Program. Additional questions related to permitting would need to be addressed. This information is provided as a courtesy to help understand what potential options are available.

3.4.1 Regionalization to Summer Spray Irrigation/Winter Subsurface Site

Spray irrigation of effluent would require storage to be built to accommodate flows during winter months and wet periods. Because the CAR area is occupied by largely seasonal residents, the flow during winter months is significantly lower. Therefore, the spray irrigation option that will be considered involves operating an effluent treatment system that seasonally discharges treated wastewater to golf course irrigation ponds, saving the significant cost of building ponds. Residents that produce wastewater outside of the normal spray irrigation season would be connected to a cluster subsurface system sized to meet flows during the winter months.

3.4.2 Regionalization to Spray Irrigation/Winter Subsurface Summary

- Advantages
  - Subsidized financing for capital cost improvements
  - Ability to expand for future development
  - System oversight

- Disadvantages
  - Capital costs

- To keep costs low, additional storage ponds would not be built, making spray irrigation a seasonal alternative
- Potentially only a portion publicly financed

3.5 SUMMARY

Three alternatives are being analyzed to provide wastewater infrastructure. Each alternative has advantages and disadvantages and can be incorporated solely or in combination to best fit the needs of the residents. Section 4.0 incorporates the estimated costs from the three alternatives.

4.0 Cost Comparison of Alternatives

Three wastewater infrastructure alternatives have been identified within the scope of this report. Side by side comparisons of capital and operation and maintenance costs have been provided for each alternative. This section gives cost comparisons, starting with capital costs, and ending with a present worth analysis for 25 years and 50 years.

4.1 MANAGED ISTS PROGRAM (ALTERNATIVE 1)

Table 8 reflects the average cost estimates to replace/upgrade each property with an ISTS for the three Service Areas.

Table 8: 25 Year Capital Cost Estimates for Managed ISTS Program

Service Area	Treatment System	Contingency	Legal, Eng., Admin	Total Cost Estimate	Avg. Cost/ Property
1	$ 45,000	$ 5,000	$ 5,000	$ 55,000	$ 10,000
2	$ 146,000	$ 15,000	$ 17,000	$ 178,000	$ 12,000
3	$ 277,500	$ 28,000	$ 31,000	$ 336,500	$ 12,000
Total	$ 468,500	$ 48,000	$ 53,000	$ 569,500	$ 12,000

* Costs for ISTS upgrades do not assess costs to currently compliant ISTS systems.

This analysis of ISTS is an average over an entire Service Area. Individual parcel costs for ISTS upgrades would vary by parcel. The table has been created to allow for side by side comparisons with the other alternatives in the present worth analysis. Average capital costs by system type that were used to create the table are as follows for a residential system (cost estimates for Type 1-4 systems based on Wenck experience with similar projects, see Appendix B for more detail):

- Type 1: $9,000
- Type 2: $500-2,000
- Type 3: $12,000
- Type 4/5: $15,000

What can be noted from Table 8 is there are no collection system costs as this component is already in place at each residence. Costs related to re-drilling a well to meet the required well setback are included where applicable (estimated at $3,000 per relocated well). On average, this alternative has the least capital cost.

4.2 CLUSTER SYSTEMS (ALTERNATIVE 2)

Table 9 provides the cost estimates for a cluster system in Service Areas 2 and 3 with the installation of a STEP system at each residence, collection system, and a treatment/dispersal system. Service Area 2 costs are for a cluster mound while Service Area 3 costs are for a cluster pressurized bed drain field. It was determined that due to larger parcel sizes and location relative to other parcels that Service Area 1 would not benefit financially from a cluster alternative.

Table 9: 25-Year Capital Cost Estimates for Cluster Systems

Service Area	Type of Treatment System	Treatment System	Land Acquisition**	STEP Collection System	Contingency	Legal, Eng., Admin	Total Cost Estimate	Avg. Cost/ Dwelling
1	Onsite*	$ 45,000	-	-	$ 5,000	$ 5,000	$ 55,000	$ 10,000
2	Cluster	$ 155,650	$ 16,000	$ 117,420	$ 29,000	$ 34,000	$ 352,070	$ 24,000
3	Cluster	$ 114,750	$ 8,000	$ 235,600	$ 36,000	$ 28,000	$ 422,350	$ 15,000
Total	-	$ 315,400	$ 24,000	$ 353,020	$ 70,000	$ 67,000	$ 829,420	$ 16,333

* Properties would continue with upgraded ISTS systems. Costs from Table 8 are repeated.

** Assumed cost of $4,000/acre * # of acres

Treatment system costs were based on average daily flow estimates, which are based on included properties (i.e., do not include properties not selected for evaluation). Any changes in occupancy would change the size requirement for the clusters, as well as the overall cost and the cost per dwelling. Prices included in Table 9 also take the increased cost of design due to permitting into account.

Land acquisition costs were estimated at $4,000/acre. As stated in Section 3.3 additional project development is needed to address the acquisition of land within close proximity to the Service Areas. Collection system costs were based on cost estimates of force main installation on a liner foot basis for both the mainline and laterals to the cluster sites shown on Figure 5.

STEP system costs were calculated using the same individual unit prices across the entire Service Area. A STEP system cost of $5,000/included site with a qualified pump package, new 1000 gallon pump tank, and new water-tight risers for old septic tanks was used. The cost takes into account compliant tanks within the Service Area.

4.3 SPRAY IRRIGATION (ALTERNATIVE 3)

Alternative 3, spray irrigation, would have costs related to collection and treatment only, since the spray irrigation ponds and equipment are already in existence at the golf course. Essentially, this option includes collection and treatment of wastewater with surface discharge of treated effluent into the existing spray irrigation ponds. As discussed earlier, unless additional storage ponds are built, the spray irrigation alternative is not a viable year-round wastewater treatment alternative. Therefore, Alternative 3 would function as a summer spray irrigation/winter drain field system, with a smaller drain field built at the golf course sized to accommodate flows from year-round residents. Table 10 shows the cost estimate for the spray irrigation option. Costs are estimated using the flows as calculated and shown in Appendix F.

Table 10: Cost Estimates for Spray Irrigation at Golf Course

Service Area	Type of Treatment System	Treatment System	Land Acquisition**	STEP Collection System	Contingency	Legal, Eng., Admin	Total Cost Estimate	Avg. Cost/ Dwelling
2&3	**Cluster**	$ 271,665	$ 4,000	$ 309,160	$ 59,000	$ 60,000	$ 703,825	$ 16,000
1	**Onsite***	$ 45,000	$ -	$ -	$ 5,000	$ 5,000	$ 55,000	$ 10,000
Total	**-**	$ 316,665	$ 4,000	$ 309,160	$ 64,000	$ 65,000	$ 758,825	$ 13,000

* Properties would continue with upgraded ISTS systems. Costs from Table 8 are repeated.

** Assumed cost of $4,000/acre*1 acres

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4.4 SUMMARY OF CAPITAL COSTS

Sections 4.1 – 4.3 highlight the cost estimates for each of the three wastewater infrastructure alternatives. The cost estimates for each alternative assume the entire area would be served by the alternative chosen. Table 11 is a side by side comparison of the average per unit capital cost for each of the alternatives.

Table 11: Summary of Capital Costs

	Alternative 1 Managed ISTS Program	Alternative 2 Cluster & Individual SSTS*	Alternative 3 Spray Irrigation & ISTS
Total Assessed System Costs	$ 569,500	$ 829,420	$ 758,825
Average Cost/Dwelling	$ 12,000	$ 17,000	$ 15,000

*Does not include costs for pretreatment for nitrogen, if required. Pretreatment for nitrogen would add approximately $3,000/dwelling.

Section 3.0 identifies the necessary components, advantages, and disadvantages of the three alternatives. While a managed ISTS program is least expensive alternative on an average per unit basis, other considerations such as operational costs and limited flexibility of lots must be considered as well. Alternative 3, the spray irrigation system alternative, is the second most affordable alternative of average per unit. Alternative 2, the two cluster alternative with Service Area 1 remaining on ISTS, is the most expensive alternative on a per unit cost basis.

4.5 ANNUAL OPERATION AND MAINTENANCE COSTS

When comparing costs for a wastewater infrastructure alternative, all costs, capital and annual operation and maintenance (O&M) must be considered. Table 12 provides the average annual operation and maintenance cost estimates for each alternative.

Table 12: Annual Operation and Maintenance Costs

	Alternative 1 Managed ISTS Program*	Alternative 2 Cluster + Individual SSTS*	Alternative 3 Spray Irrigation + ISTS*
Total	$ 18,000	$ 14,622	$ 15,067
Service Area 1	$ 1,400	$ 1,400	$ 1,400
Service Area 2	$ 4,400	$ 4,722	$ 5,167
Service Area 3	$ 12,200	$ 8,500	$ 10,333
Average Cost/Property/Year	$ 360	$ 290	$ 300

*Assumes holding tank properties are seasonal in use.

Annual operation and maintenance costs for Alternative 1 over the complete estimated 25-year life span that was used to create the table are as follows for a residential system:

- Type 1: $100
- Type 2: $500 (seasonal use); $2,400 (year-round use)
- Type 3: $200
- Type 4/5: $400

Alternative 2 O & M service costs include the costs to operate the ISTS systems in Service Area 1 plus costs to operate the cluster collection and treatment systems in Service Areas 2 and 3.

Alternative 3 O & M service costs include these costs plus a disposal fee of $5 per 1000 gallons for treated effluent irrigated onto the golf course (estimated total of $3,000 per year for disposal cost). The largest expense in O & M of individual ISTS is the annual pumping costs for all of the holding tank systems. A typical Type 1 or 3 ISTS may have only a nominal $100-$200 annual fee for maintenance, where as a holding tank system can run into the thousands of dollars annually if used year-round.

4.6 PRESENT WORTH ANALYSIS

All alternatives discussed in this report require different capital costs and operation and maintenance costs. These options also realize the costs at different times during the life of the infrastructure. Certain options can require more infrastructure (capital) costs at the start of the project; while other options experience higher maintenance costs throughout the life of the project. Also, infrastructure components have different expected life spans requiring replacement costs at varying intervals. All of these variables can create misconceptions when trying to compare the costs of one alternative versus another.

A present worth analysis allows the direct comparison of alternatives by converting all future costs into present-day dollar amounts. Future expenditures including capital and operation and maintenance are converted into present-day dollar amounts by using standard financial calculations, an assumed time-frame for the expense to occur, and a discount rate. The timing for the expenses was based on typical recurrences for maintenance and average life spans for infrastructure. The discount rate is generally described as the difference between the available rate of return on an investment and the average inflation rate. A discount rate of 4% was utilized in this study in the conversion of future costs to a present worth. After converting future costs into a present worth, these costs were added to initial capital costs and used in comparing the alternatives.

Section 4.5 evaluated operation and maintenance costs of the alternatives, a present worth analysis also takes inflation and debt service into account. Table 13 summarizes a present worth analysis over a 25-year period.

Table 13: Present Worth Analysis (25-year)

	Alternative 1 Managed ISTS Program*	Alternative 2 Cluster + Individual SSTS*	Alternative 3 Spray Irrigation + ISTS*
Total System Costs	$ 569,500	$ 829,420	$ 758,825
Annual Operation & Maintenance Costs (25 year present worth value)	$ 282,000	$ 229,000	$ 236,000
Estimated Total Present Worth	$ 851,500	$ 1,058,420	$ 994,825
Estimated Total Equivalent Annual Cost (annualized over a 25-year period, 2% interest)	$ 43,614	$ 54,213	$ 50,955
Estimated Average Equivalent Annual Cost per Property	$ 860	$ 1,070	$ 1,000

* Assumes holding tank properties are seasonal

The estimated Total Present Worth amounts (of the alternatives cost over a 25-year period) are tallied in Table 13 in the middle row. The estimated Total Equivalent Annual Cost represents the annual cost to pay the Total Present Worth Cost over a 25-year period assuming a 2% subsidized loan rate. The estimated Equivalent Annual Cost per Unit is simply the total annual cost divided by the number of participating units.

The Estimated Average Equivalent Annual Cost per Unit shown in the last row of Table 13 is not the actual cost experienced by the property owner each year. The timing and magnitude of actual costs will vary including upfront capital costs (i.e., assessments, individual system repairs, etc.) and periodic operation and maintenance (fees, utility bills, pump replacements, etc.) The Present Worth Analysis serves as a method of comparison and does not reflect the timing of actual payment. In addition, as in other tables, actual cost per unit will vary-units with more wastewater volume will face larger costs while units with lower wastewater volume will likely have lower actual costs.

Table 14 repeats the analysis over a 50-year period. Certain infrastructure components can have an expected lifespan of up to 50 years. Repeating the Present Worth Analysis over a 50-year period provides a complete comparison over the life span of all improvements.

Table 14: Present Worth Analysis (50-year)

	Alternative 1 Managed ISTS Program*	Alternative 2 Cluster + Individual SSTS*	Alternative 3 Spray Irrigation + ISTS*
Total System Costs	$ 741,000	$ 1,092,000	$ 1,008,000
Annual Operation & Maintenance Costs (50 year present worth value)	$ 387,000	$ 315,000	$ 324,000
Estimated Total Present Worth	$ 1,128,000	$ 1,407,000	$ 1,332,000
Estimated Total Equivalent Annual Cost (annualized over a 50-year period, 2% interest)	$ 35,897	$ 44,775	$ 42,389
Estimated Equivalent Annual Cost per Property	$ 710	$ 880	$ 840

This table accounts for ISTS and Cluster system component replacement after 25 years.

* Assumes holding tank properties are seasonal

The Total System Costs of ISTS and cluster systems increase from the 25-year analysis as certain capital costs need to be repeated in a 50-year timeframe. Present Worth operation and maintenance costs increase for all options as would be expected. The increases result in a closing of the gap between alternatives; however, Alternative 1 ISTS is still the least expensive alternative over the 50-year life cycle.

5.0 Summary and Recommendations

5.1 SUMMARY

This report estimates the compliance status for existing ISTS and provides the side by side comparison of the alternatives for long-term wastewater infrastructure for properties adjacent to the southern tip of Lake Miltona in Carlos Township (the CAR area). A summary of the findings:

- 74% of the evaluated ISTS are in non-compliance and fail to protect groundwater
- At least 15% of the individual wells in the CAR area are shallow wells that are likely susceptible to contaminated groundwater
- 18% of the evaluated ISTS are compliant holding tank systems
- 45% of the wastewater generating properties needing ISTS upgrades can install a Type 1 or Type 3 mound system
- 32% of the ISTS upgrades would require a holding tank as the only feasible option
- Estimated capital costs on average per property for the three alternatives:
    - Managed ISTS = $12,000
    - Cluster Systems = $17,000 (One large cluster mound for Service Area 2, one large cluster drain field for Service Area 3, and ISTS in Service Area 1)
    - Spray Irrigation = $15,000 (irrigation of treated effluent for Service Areas 2&3 and ISTS for Service Area 1)
- The CAR area can be divided up into three Service Areas based on geography, average property size, land use, and current ISTS compliance status to further reduce costs per unit by providing the best wastewater treatment option for each area

- Based on 25- and 50-year present worth analysis, the community has a number of options for a combination of cluster and ISTS wastewater treatment that provide the best long term value in terms of cost per unit when both capital and annual operation and maintenance costs are taken into account.
- Another alternative was not evaluated per the scope of this report. That alternative would include pursuing the spray irrigation option with residents adjacent to the southeast corner of Lake Miltona in Miltona Township. This area is being evaluated in a similar CAR and is also seeking wastewater treatment alternatives. Combining the two areas into one may reduce the overall cost per resident for the spray irrigation alternative.

5.2 RECOMMENDATIONS

This report will aid in making an informed decision on what steps to take as the alternatives are considered. It is our recommendation that the CAR area be treated by Service Area, with the following recommendations:

- Service Area 1 to remain on ISTS. Non-compliant system owners upgrade their individual system.
- Service Areas 2 and 3 have many properties with a holding tank as their only viable long term solution unless they consider connecting to a cluster system or common system with other adjacent homeowners. Homeowners can consider these options and determine interest in a cluster system alternative. If holding tanks are installed, we recommend attempting to purchase cluster sites to plan for long term infrastructure.

5.3 NEXT STEPS

The following describes future actions that could be taken by Carlos Township based on the CAR recommendations.

- As stated in this report, 74% of the existing septic systems are in non-compliance. Douglas County will continue to enforce the ISTS regulations of Chapter 7080. Non-compliant systems will likely require upgrades in the near future and homeowners would be on their own to ensure their ISTS remains in compliance. The properties within Service Areas 2 and 3 have an opportunity to collectively construct a wastewater system to serve multiple residents. Homeowners with small lots and/or high groundwater that require a holding tank or large mound system may stand to benefit the greatest from this option. The township board has an opportunity to assist these landowners by managing a new wastewater cluster system.

Figures

CARLOS TOWNSHIP CAR

Site Location Map

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1800 Pioneer Creek Center
Maple Plain, MN 55359-0429

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Figure 1

CARLOS TOWNSHIP CAR

Douglas County Soil Survey and Boring Location Map

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Figure 2

CARLOS TOWNSHIP CAR

Well Location Map

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Figure 3

CARLOS TOWNSHIP CAR

Property Compliance Status Map

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Figure 4

CARLOS TOWNSHIP CAR

Future ISTS Recommendation Map

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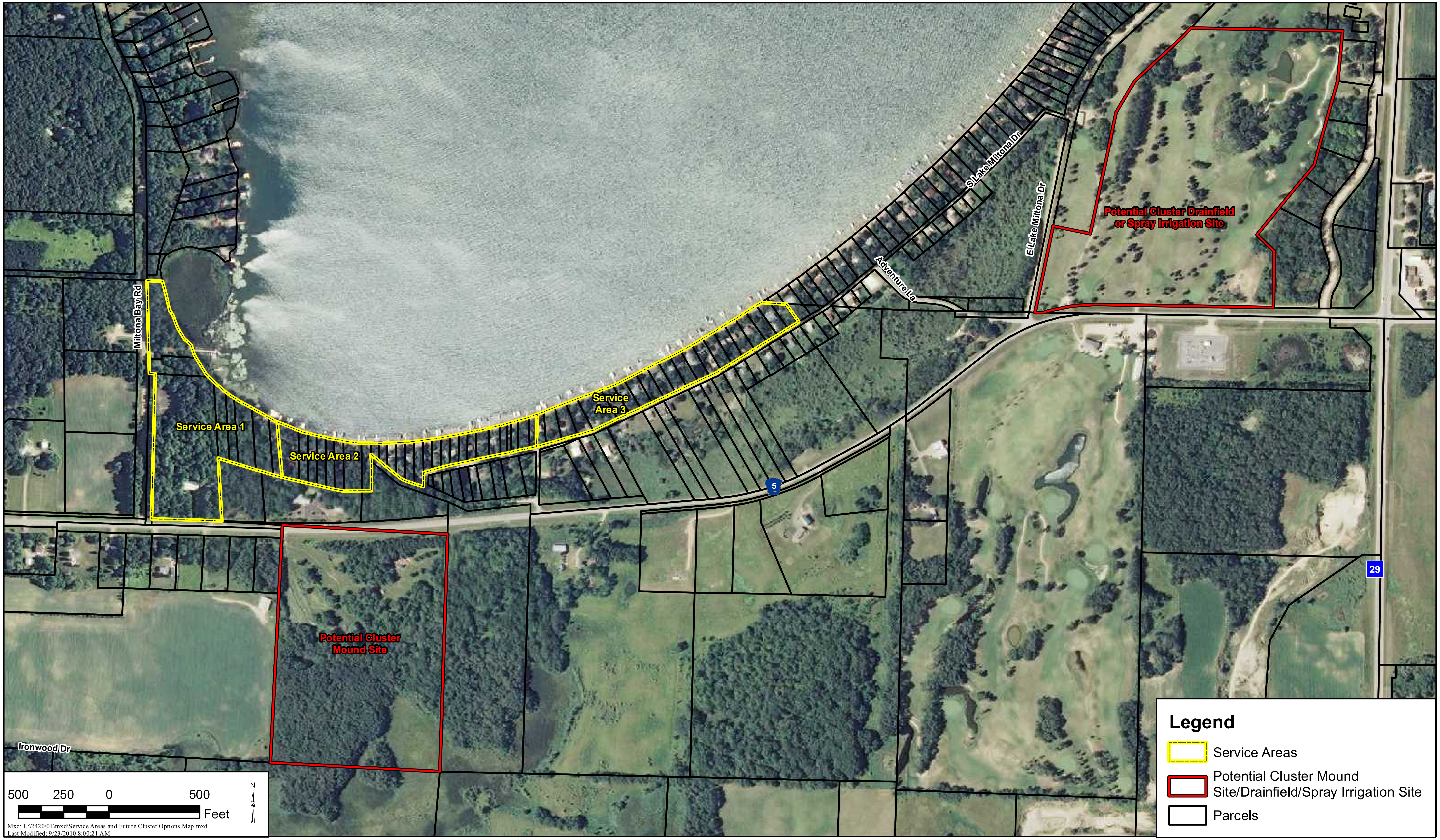
Figure 5



CARLOS TOWNSHIP CAR

Service Areas and Future Cluster Options Map

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Figure 6

Appendix A

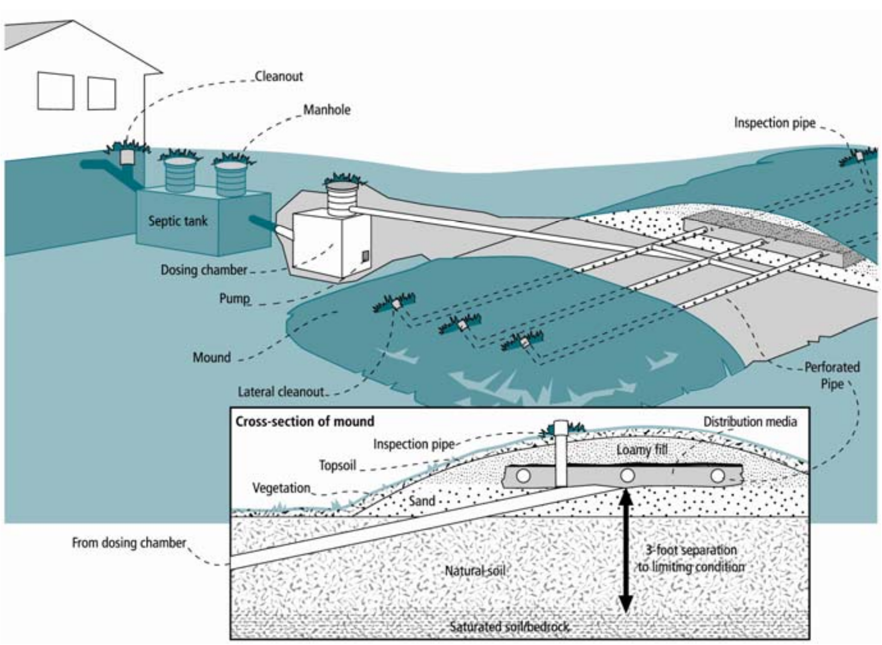
U of M ISTS Information

Mound Systems

Mound systems are defined in Chapter 7080.1100, Subp. 50, as "a soil treatment and dispersal system designed and installed such that all of the infiltrative surface is installed above grade, using clean sand between the bottom of the infiltrative surface and the original ground elevation, utilizing pressure distribution and capped with suitable soil material to stabilize the surface and encourage vegetative growth."

A sewage treatment mound is nothing more than a seepage bed elevated by clean sand fill to provide adequate separation between where sewage effluent is applied and a limiting soil layer as shown in the figure below. Mounds were developed in the early 1970s to overcome soil and site conditions, which limit the use of trenches and beds (Converse et al., 1977). Limiting conditions include high water tables, shallow soil depth to bedrock, slowly permeable soil, or soil too coarse for treatment.

Figure 1 - Mound System and Components



A mound system is a two-stage process involving both effluent treatment and dispersal. Treatment is accomplished predominately by physical and biochemical processes within the clean sand material and native soil. The physical characteristics of the influent wastewater, influent loading rate temperature, and the nature of the receiving fill material and in situ soil affect these processes.

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

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

- The mound effluent enters the more permeable natural topsoil over a larger area where it can move laterally until absorbed by the less permeable subsoil.
- The bio-mat that develops at the bottom of the media/sand infiltration area will not clog the filter media as readily as it would the less permeable natural soil.
- The infiltration area within the filter media is much smaller than it would be if placed in the more slowly permeable subsoil, yet the total mound area is probably larger than it would be for a conventional soil treatment system, if one could be used.

Mound systems are used primarily in shallow soils overlying a restrictive layer or elevated groundwater table. The shallower the soil, the more attention must be paid to transporting the treated effluent away from the point of application. Fifteen mound systems in Wisconsin were found to have a total nitrogen reduction of at least 55% from the pretreatment effluent to mound toe effluent (Blasing and Converse, 2004). Sufficient numbers of mounds have been installed in Minnesota and elsewhere to prove that the mound treatment system is a Type I technology. There are more than 50,000 single-family mounds successfully treating sewage in Minnesota.

Dispersal is primarily affected by the depth of the unsaturated receiving soils, their hydraulic conductivity, land slope, and the area available for dispersal. The mound consists of sand material, an absorption bed, and cover material. Effluent is dispersed into the absorption bed, where it flows through the fill material and undergoes biological, chemical, and physical treatment. It then passes into the underlying soil for further treatment and dispersal to the environment. Clean sand (defined by state rule) is required for mounds to effectively treat and disperse effluent.

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

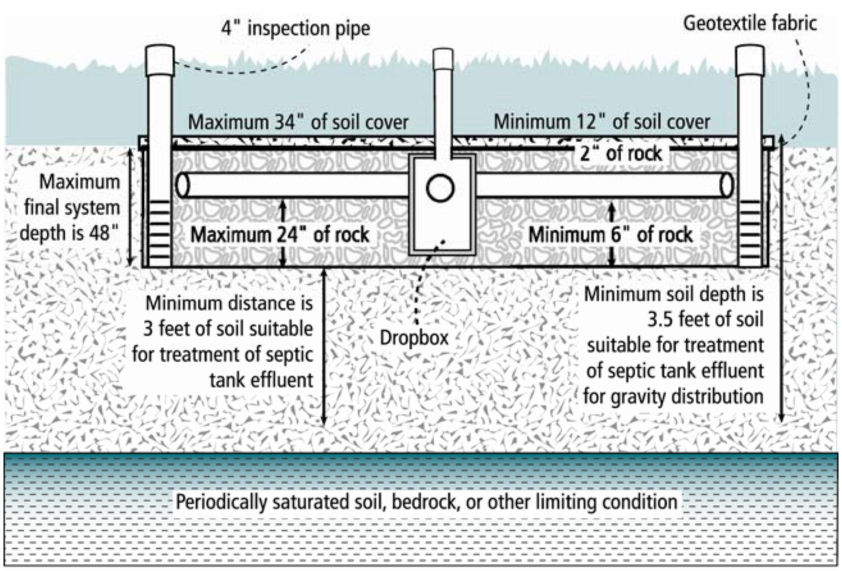
Below-Grade Systems

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

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

The figure below shows minimum depths and separation requirements for trenches or seepage beds. For systems without pretreatment, at least three feet of soil suitable for treatment should be located below the bottom of the distribution media. The minimum depth of distribution media is six inches, followed by a minimum soil cover of twelve inches, so that the total distance from the periodically saturated or other limiting condition to the final grade is approximately 4.5 feet. Note that this total could be made up of 3.5 feet of original soil and one foot of soil (7080.2150, Subp. 3) over the distribution media of the system.

Figure 1 - Trench and Bed Depth



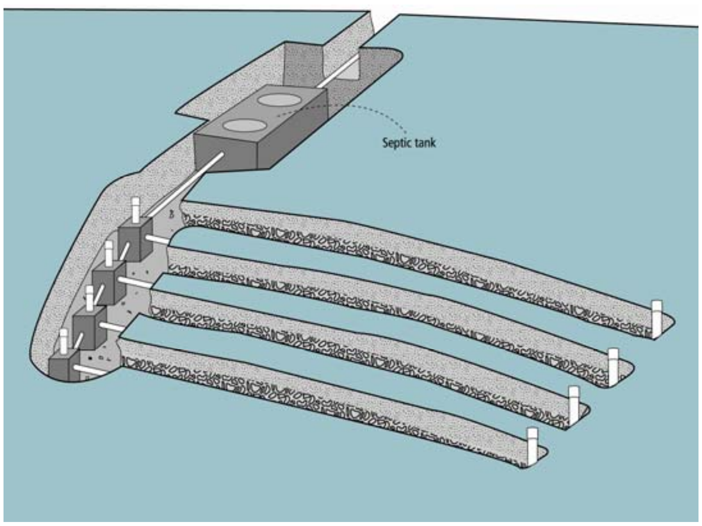
From MN Rules 7080.2260 Subp. 3. If the distribution media in a trench or a bed is in contact with soil texture group 2 through 4 (medium sand, fine sand, coarse and medium loamy sand) pressure distribution must be used.

Below-Grade Systems: Specifications

Trenches

The trench is the most common of the soil treatment systems. **According to MN Rules Chapter 7080.1100, Subp. 89 a trench is defined as a soil treatment and dispersal system, the absorption width of which is 36 inches or less.** Trenches are narrower than they are wide, no wider than three feet, and are laid out along the contours of the soil. A typical trench is constructed by making a level excavation 18 to 36 inches wide.The method of distributing the septic tank effluent can be either pressure or gravity. There are a number of different configurations by which the trenches can be connected with each other and with the septic tank: parallel, serial, and continual. A typical trench is constructed by making a level excavation 18 to 36 inches wide. A typical layout for a trench system is shown in Figure 2.

Figure 2 - Typical Trench Layout



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

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

Appendix B

Parcel Data Spreadsheet

PIN	Estimated Number of Bedrooms	Estimated Flow (Gallons per Day)	Permit on file? If Yes - year permitted	Well: depth of casing, cased (C), shallow (S), unknown (U)	House (H), Vacant (V), Seasonal Cabin (S)	Current Subsurface soil treatment type: SSTS:drainfield (D), mound (M), holding tank (H), cesspool (C), community straight pipe (S) none (N) or unknown (U)	Design Evaluation Status: Depth to seasonally high groundwater below ground surface at soil treatment area or holding tank	Design Evaluation Status: Suitable area onsite for future soil treatment area (X if Y)	Design Evaluation Status: Existing Compliant Septic Tank (X if Y)	Likely compliance evaluation status: SSTS Compliant (X if Y)	Likely compliance evaluation status: Non-compliant: FTPG Connected to Community System (X if Y)	Non-compliant: Fail to protect groundwater (X if Y)	Non-compliant: Reason: (lack of vertical separation (V), cesspool (C), privy (P), surfacing (S), no permit (N))	Tank Status ✓ if yes: Tank Field Located (X if Y)	Tank Status: Compliant Tank before pumping (X if Y)	Tank Status: Tank to be Pumped	Tank Status: Compliant Tank after pumping (X if Y)	Best Future ISTS Option: Type 1 (standard) mound	Best Future ISTS Option: Type 2 (holding tank)	Best Future ISTS Option: Type 3 (other, <12", problem soils) mound	Best Future ISTS Option: Type 4 or 5 (pretreatment)	Potential Service Area for cluster (see Figure 6)	ESTIMATED COST TO INSTALL FUTURE ISTS OPTION	Imminent Upgrade Cost of Future ISTS Option (for non-compliant systems)	Monthly O&M Cost of Future ISTS Option	Estimated Cluster SSTS Capital Cost	Estimated Spray Irrigation Capital Cost	Comments
12-0060-000	4.0	600	NO	C	S	D	5.7	X	X	X				X	X					X		3	$12,000	$0	$17	$15,000	$16,000	
12-0061-000	3.0	450	NO	C	S	D, HT	4.4	X	X			X	V	X	X						X	3	$18,000	$18,000	$33	$15,000	$16,000	Move neighbor's well for Type 4
12-0062-000	2.0	300	NO	S	S	D	3.4	X	X			X	V	X	X						X	3	$15,000	$15,000	$33	$15,000	$16,000	
12-0063-000	3.0	450	NO	C	F	D	4.4	X	X			X	V	X	X					X	X	3	$12,000	$12,000	$17	$15,000	$16,000	Could do Type 4 if neighbor's well is redrilled
12-0064-000	2.0	300	2002	C	S	D	5.5	X	X	X				X	X						X	3	$15,000	$0	$33	$15,000	$16,000	
12-0065-000	3.0	450	NO	C	S	D	2.5	X	X			X	V	X	X						X	3	$15,000	$15,000	$33	$15,000	$16,000	
12-0066-000	3.0	450	NO	C	S	D	5.0	X	X			X	V	X	X						X	3	$15,000	$15,000	$33	$15,000	$16,000	
12-0067-000	3.0	450	NO	C	S	D	5.3	X	X	X				X	X	X	X			X	X	3	$12,000	$0	$17	$15,000	$16,000	
12-0068-000	3.0	450	NO	105	S	D	4.2	X	X			X	V	X	X						X	3	$15,000	$15,000	$33	$15,000	$16,000	
12-0069-000	3.0	450	NO	C	S	D	3.3	X	X			X	V	X	X						X	3	$15,000	$15,000	$33	$15,000	$16,000	
12-0070-000	3.0	450	NO	C	S	D	4.6	X	X			X	V	X	X						X	3	$18,000	$18,000	$33	$15,000	$16,000	Move well for Type 4
12-0071-000	3.0	450	NO	U	S	D	4.7	X				X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0072-000	3.0	450	NO	S	S	D	2.6	X				X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0073-000	3.0	450	NO	U	S	D	2.5	X	X			X	V	X	X	X	X			X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0074-000	3.0	450	NO	C	S	D	3.3		X			X	V	X	X	X	X		X			3	$500	$500	$42	$15,000	$16,000	
12-0075-000	3.0	450	NO	S	S	D	2.2	X	X			X	V	X	X	X	X			X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0076-000	3.0	450	NO	C	S	D	2.5	X	x			X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0078-000	3.0	450	NO	C	S	HT	NA	X	x	X				X	X					X		3	$12,000	$0	$17	$15,000	$16,000	
12-0079-000	3.0	450	NO	120	S	D	3.6	X	X			X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0080-000	2.0	300	1996	114	S	D, HT	4.0	X	X			X	V	X	X					X	X	3	$12,000	$12,000	$17	$15,000	$16,000	Check setback to neighbors shallow well
12-0081-000	3.0	450	NO	U	S	HT	2.7	X	X	X				X	X	X	X			X		3	$15,000	$0	$17	$15,000	$16,000	Need to redrill well for Type 3
12-0082-000	3.0	450	1997	C	S	HT	4.1		X	X				X	X				X			3	$0	$0	$42	$15,000	$16,000	
12-0083-000	3.0	450	NO	C	S	D	2.5	X	X			X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0084-000	3.0	450	NO	S	S	D	4.1	X	X			X	V	X	X					X		3	$15,000	$15,000	$17	$15,000	$16,000	Need to redrill well for Type 3
12-0087-000	2.0	300	NO	C	S	D	2.9		X			X	V	X	X				X			3	$500	$500	$42	$15,000	$16,000	
12-0088-000	2.0	300	NO	105	S	D	0.7	X	X			X	V	X	X					X		3	$12,000	$12,000	$17	$15,000	$16,000	
12-0089-000	3.0	450	NO	C	F	D	2.8		X			X	V	X	X				X			3	$500	$500	$300	$15,000	$16,000	
12-0090-000	3.0	450	NO	C	S	HT	NA		X	X				X	X				X			3	$0	$0	$42	$15,000	$16,000	
12-0091-000	3.0	450	NO	U	S	*D	2.5				X	X	V						X			3	$15,000	$15,000	$17	$15,000	$16,000	ISTS cost to replace existing cluster
12-0092-000	3.0	450	NO	U	S	*D	2.5				X	X	V						X			3	$15,000	$15,000	$17	$15,000	$16,000	ISTS cost to replace existing cluster
12-0093-000	3.0	450	NO	96	S	*D	2.5	X	X		X	X	V	X	X			X				2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0094-000	3.0	450	NO	U	S	*D	2.5				X	X	V						X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0095-000	3.0	450	NO	U	F	*D	2.5		X		X	X	V	X	X				X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0096-000	3.0	450	NO	U	S	*D	2.5				X	X	V						X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0097-000	3.0	450	NO	U	S	*D	2.5		X		X	X	V	X	X				X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0098-000	5.0	750	NO	U	S	*D	2.5				X	X	V						X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
0	3.0	450	NO	U	S	*D	2.5				X	X	V						X			2	$15,000	$15,000	$17	$24,000	$16,000	ISTS cost to replace existing cluster
12-0135-000	3.0	450	NO	S	S	D	2.3	X	X		X	X	V	X	X					X		2	$12,000	$12,000	$17	$24,000	$16,000	
12-0137-000	3.0	450	1995	U	S	HT	2.3	X	X	X				X	X					X		2	$12,000	$0	$17	$24,000	$16,000	
12-0138-000	2.0	300	NO	C	S	M	5.0	X	X			X	V	X	X					X		2	$12,000	$12,000	$17	$24,000	$16,000	
12-0139-000	2.0	300	NO	C	S	HT	NA		X			X	V	X	X	X	N		X			2	$2,000	$2,000	$42	$24,000	$16,000	
12-0140-000	2.0	300	1996	45	S	HT	NA		X	X				X	X				X			2	$0	$0	$42	$24,000	$16,000	
12-0141-000	3.0	450	NO	C	S	HT	NA			X				X	X				X			2	$0	$0	$42	$24,000	$16,000	
12-0142-000	2.0	300	1999	S	S	HT	NA		X	X				X	X	X	X		X			2	$0	$0	$42	$24,000	$16,000	

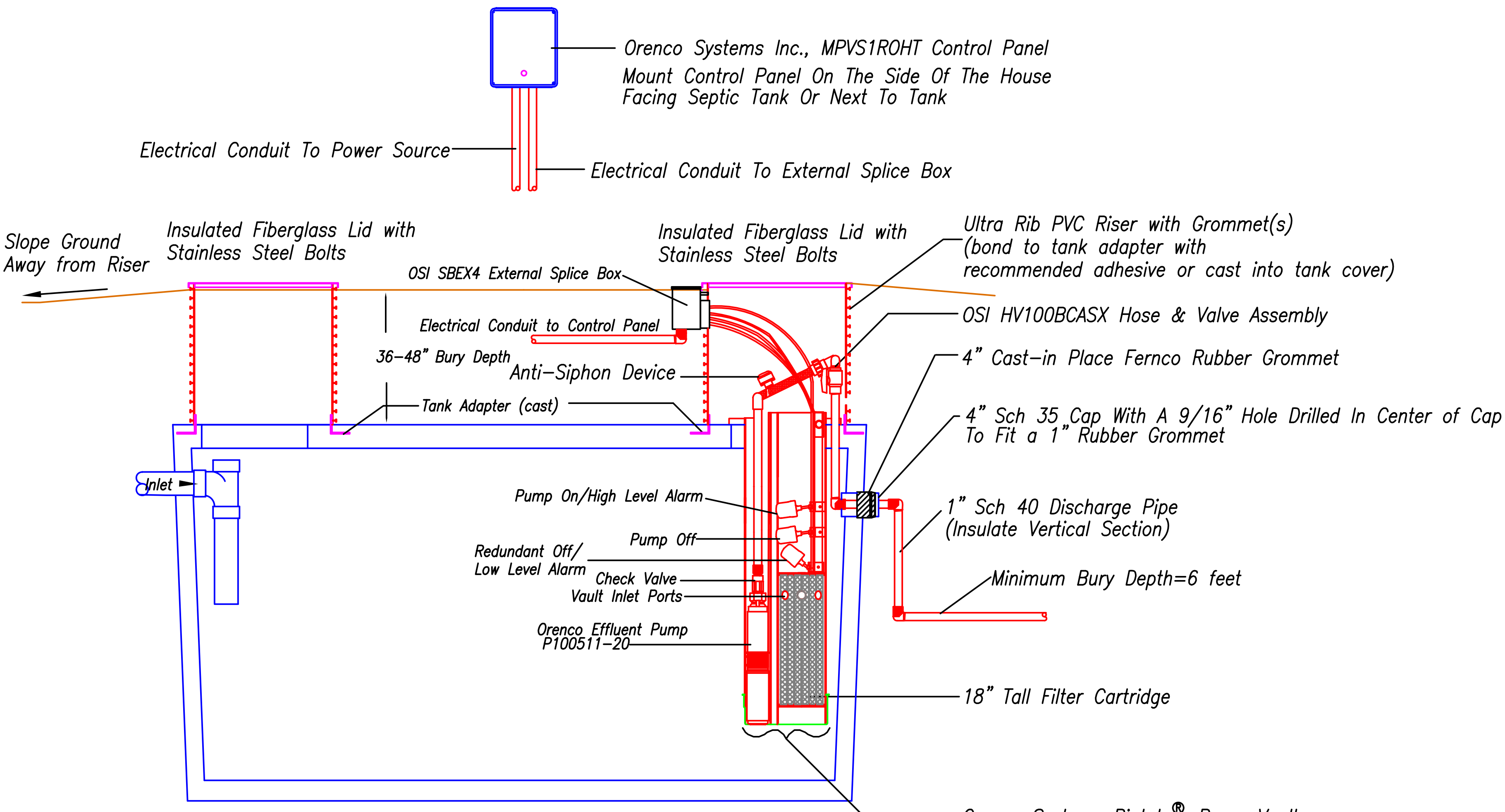
							Design Evaluation Status			Likely compliance evaluation status	Non-compliant			Tank Status ✓ if yes				Best Future ISTS Option										
PIN	Estimated Number of Bedrooms	Estimated Flow (Gallons per Day)	Permit on file? If Yes - year permitted	Well: depth of casing, cased (C), shallow (S), unknown (U)	House (H), Vacant (V), Seasonal Cabin (S)	Current Subsurface soil treatment type: SSTS:drainfield (D), mound (M), holding tank (H), cesspool (C), community straight pipe (S) none (N) or unknown (U)	Depth to seasonally high groundwater below ground surface at soil treatment area or holding tank	Suitable area onsite for future soil treatment area (X if Y)	Existing Compliant Septic Tank (X if Y)	SSTS Compliant (X if Y)	FTPG Connected to Community System (X if Y)	Fail to protect groundwater (X if Y)	Reason: (lack of vertical separation (V), cesspool (C), privy (P), surfacing (S), no permit (N))	Tank Field Located (X if Y)	Compliant Tank before pumping (X if Y)	Tank to be Pumped	Compliant Tank after pumping (X if Y)	Type 1 (standard) mound	Type 2 (holding tank)	Type 3 (other, <12", problem soils) mound	Type 4 or 5 (pretreatment)	Potential Service Area for cluster (see Figure 6)	ESTIMATED COST TO INSTALL FUTURE ISTS OPTION	Imminent Upgrade Cost of Future ISTS Option (for non-compliant systems)	Monthly O&M Cost of Future ISTS Option	Estimated Cluster SSTS Capital Cost	Estimated Spray Irrigation Capital Cost	Comments
12-0060-000	4.0	600	NO	C	S	D	5.7	X	X	X				X	X					X		3	$12,000	$0	$17	$15,000	$16,000	
12-0143-000	2.0	300	1998	S	S	D	4.8	X	X			X	V	X	X						X	2	$15,000	$15,000	$33	$24,000	$16,000	
12-0145-000	3.0	450	NO	C	S	D	5.7	X	X			X	V	X	X						X	1	$15,000	$15,000	$33	NA	NA	
12-0146-000	3.0	450	NO	C	S	D	3.8	X	X			X	V	X	X					X	X	1	$12,000	$12,000	$17	NA	NA	
12-0147-000	3.0	450	1995	85	S	D	3.7	X	X			X	V	X	X			X				1	$9,000	$9,000	$8	NA	NA	
0	0.0	0	NO	N	V	-	NA															2	NA	NA	$0	NA	NA	CARLOS GUN CLUB
0	3.0	450	NO	C	S	HT	NA		X	X				X	X				X			1	$0	$0	$42	NA	NA	VEIT
12-0114-020	3.0	450	NO	C	S	D	>5	X	X	X				X	X			X				1	$9,000	$0	$8	NA	NA	
12-0118-000	3.0	450	1952	C	F	D	1.7	X	X			X	V	X	X			X				1	$9,000	$9,000	$8	NA	NA	

Appendix C

Septic Tank Effluent Pump (STEP) Detail

STEP TANK - TYPICAL

Drawing provided by Orenco, Systems, Inc.



SCALE: NONE

Appendix D

Soil Borings

Soil Profile Description

Date Completed:	7/15/2010	Test Pit #	12-0062-000
Completed By:	Peter G. Miller, P.S.S. License No. 42636	Equipment:	4" Bucket Auger
Project:	Carlos Township	Highest Known Water:	36"
Landscape Position:		Vegetation:	Grass
Mapped Soil Type:		Parent Material:	

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
20	-	-	Sandy Fill		
28	10 YR 4/3	Sand			
39	10 YR 4/2	Sand	Moist		Wet at 36"

Soil Profile Description

Date Completed: 7/15/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0065-000
Equipment: 4" Bucket Auger
Highest Known Water: 30"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
12	10 YR 3/1	-	Topsoil		
21	10 YR 3/3	Sand			
48	10 YR 4/3	Sand	Moist		Water table at 48"

Soil Profile Description

Date Completed: 7/15/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0071-000
Equipment: 4" Bucket Auger
Highest Known Water: 45"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
20	10 YR 3/1	-	Topsoil		
45	10 YR 4/3	Sand			
60	10 YR 4/3	Sand	Moist		Water table at 60"

Soil Profile Description

Date Completed: 8/11/2010

Completed By: RML, P.E., MPCA Inspector #C8876

Project: Carlos Township

Landscape Position:

Mapped Soil Type:

Test Pit # 12-0072-000

Equipment: 4" Bucket Auger

Highest Known Water: 32"

Vegetation: Grass

Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
18	10 YR 3/1	Sandy Loam	Topsoil		
32	10 YR 5/3	Sand	Moist		
40	10 YR 5/3	Sand	Saturated		Water table at 32"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0074-000
Equipment: 4" Bucket Auger
Highest Known Water: 46"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
12	10YR2/1	Loamy Sand			
27	10YR3/1	Sand			
48	10YR5/4	Sand	Course		Saturated at 46"
					NHWL at 30"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0043-100
Equipment: 4" Bucket Auger
Highest Known Water: 26"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
10	10YR3/1	Loamy Sand			Fill
16	10YR4/3	Loamy Sand			Fill
20	10YR5/4	Sand			Fill
26	10YR2/1	Loamy Sand			NHWL at 20"
					Water at 26"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0080-000
Equipment: 4" Bucket Auger
Highest Known Water: 32"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
20	10YR3/1	Loamy Sand			
30	10YR3/2	Sand			
32	10YR4/3	Sand			
47	10YR5/3	Sand			Becoming wet
47+	10YR 5/2	Sand			Saturated

Soil Profile Description

Date Completed:	7/26/2010	Test Pit #	12-0088-000
Completed By:	Peter G. Miller, P.S.S. License No. 42636	Equipment:	4" Bucket Auger
Project:	Carlos Township	Highest Known Water:	22"
Landscape Position:		Vegetation:	Grass
Mapped Soil Type:		Parent Material:	

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
14	10YR3/1	Loamy Sand			
22	10YR4/3	Sand			
50	10YR6/2	Coarse Sand			Moist at 22"
					Water at 48"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0135-000
Equipment: 4" Bucket Auger
Highest Known Water: 28"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
14	10YR2/1	Loamy Sand			
20	10YR4/3	Sand			
48	10YR6/3	Sand			Moist at 28"
					Water at 42"
					NHWL at 28"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0145-000
Equipment: 4" Bucket Auger
Highest Known Water: 40"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR3/2	Fine Sandy Loam			
12	10YR3/3	Sandy Loam			
40	10YR4/4	Clay Loam			
42	2.5YR5/4	Loam		10 YR 6/2 depletion, 10 YR 5/6 concentration	Calcium Carbonates

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0146-000
Equipment: 4" Bucket Auger
Highest Known Water: 34"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
12	10YR3/1	Sandy Loam			
34	10YR5/3	Sandy Loam			
40	10YR4/4	Sandy Clay Loam		10YR 5/1 Depletions, 10 YR 5/6 Concentrations	NHWL at 2.83 ft below GS

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0151-000
Equipment: 4" Bucket Auger
Highest Known Water: 20"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
11	10 YR 2/2	Fine Sandy Loam	Topsoil		
20	10 YR 4/4	Clay Loam			
28	2.5 Y 4/4	Clay Loam		Many, Medium, Distinct 10 YR 6/2 and 7.5 YR 5/8	

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0119-400 #1
Equipment: 4" Bucket Auger
Highest Known Water: 24"
Vegetation: Soybeans
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
2	10YR 2/1	Loam			
18	10YR4/4	Clay Loam			
46	2.5YR5/3	Sandy Clay Loam		Few, Fine, Distinct 10YR 5/8 and Few Fine, Faint 2.5YR6/2 at ~24"	

Soil Profile Description

Date Completed:	8/11//2010	Test Pit #	12-0119-400 #2
Completed By:	Peter G. Miller, P.S.S. License No. 42636	Equipment:	4" Bucket Auger
Project:	Carlos Township	Highest Known Water:	20"
Landscape Position:		Vegetation:	Soybeans
Mapped Soil Type:		Parent Material:	

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
11	10YR 2/2	Fine Sandy Loam			
20	10YR 4/4	Clay Loam			
28	2.5Y 4/4	Clay Loam		Many Medium Distinct 10YR 6/2 and 7.5YR 5/8	

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 42-0814-175 #1
Equipment: 4" Bucket Auger
Highest Known Water: >34"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
10	10YR3/3	Loamy Sand			
14	10YR4/4	Gravelly Sand			
34	10YR4/4	Gravelly Sand			Refusal at 34"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 42-0814-175 #2
Equipment: 4" Bucket Auger
Highest Known Water: 54"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
32	10YR4/4	Loamy Fine Sand			
43	10YR4/4	Loamy Fine Sand			
52	10YR5/6	Sand			
54	10YR5/2	Sandy Clay Loam			
62	10YR4/3	Sandy Loam			
68	10YR6/3	Gravelly Coarse Sand			

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 42-0814-175 #3
Equipment: 4" Bucket Auger
Highest Known Water: >22"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
10	10YR4/3	Loamy Fine Sand			
22	10YR4/4	Coarse Sand / Gravel			Refusal at 22"

Soil Profile Description

Date Completed: 7/26/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0043-000
Equipment: 4" Bucket Auger
Highest Known Water: >40"
Vegetation: Trees
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR3/1	Sandy Clay Loam			
14	10YR5/3	Sandy Loam			
32	10YR5/3	Sandy Clay Loam			
40	10YR6/4	Sandy Clay Loam			Refusal at 40"

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0025-000 #1
Equipment: 4" Bucket Auger
Highest Known Water: 13"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
5	10YR3/1	Sandy Loam			Fill
13	10YR4/3	Sandy Loam			Fill
41	2.5Y6/3	Sandy Clay Loam		2.5Y 5/1 Depletions and 10YR 4/6 Concentrations.	Fill
45	2.5Y5/3	Loamy Sand			
52	2.5Y 5/3	Sandy Clay Loam		2.5Y 5/1 Depletions and 10YR 4/6 Concentrations.	Refusal from rock at 52"

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0025-000 #2
Equipment: 4" Bucket Auger
Highest Known Water: 17"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
12	10YR3/1	Loam			
17	2.5Y 4/3	Loam			
36	2.5Y 4/3	Clay	WET	2.5Y 5/2 Depletions and 10YR 4/6 Concentrations.	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0025-000 #3
Equipment: 4" Bucket Auger
Highest Known Water: 24"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR3/2	Sandy Loam			Fill
15	10YR4/3	Sandy Clay Loam			
24	10YR4/4	Fine Sandy Loam			
35	2.5Y 3/4	Clay Loam		7.5YR 5/6 Concentrations and 10YR6/1 Depletions.	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0025-000 #4
Equipment: 4" Bucket Auger
Highest Known Water: 17"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
7	10YR3/2 & 4/3 mixed	Sandy Loam			
17	2.5Y5/3	Fine Sandy Loam			
29	2.5Y 6/2	Fine Sand			
39	10YR 4/4	Sandy Clay Loam		2.5Y 6/2 Depletions and 7.5YR 5/8 Concentrations.	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0025-000 #5
Equipment: 4" Bucket Auger
Highest Known Water: 24"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
8	10YR3/2	Sandy Loam			Fill
24	10YR3/1 & 4/3 Mixed	Sandy Loam			Fill, saturation at 24"
41	2.5Y 4/3	Sandy Clay Loam		2.5Y 5/1 Depletion and 7.5YR4/6-5/8 Concentrations.	

Soil Profile Description

Date Completed: 8/11//2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0119-000 #1
Equipment: 4" Bucket Auger
Highest Known Water: >48"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR 3/2	Clay Loam			
12	10YR 5/3	Clay Loam			
40	10YR5/4	Clay Loam			
48	10YR 5/4	Clay Loam w/ Sand Lenses			Refusal at 48"

Soil Profile Description

Date Completed: 8/11//2010

Completed By: Peter G. Miller, P.S.S. License No. 42636

Project: Carlos Township

Landscape Position:

Mapped Soil Type:

Test Pit # 12-0119-000 #2

Equipment: 4" Bucket Auger

Highest Known Water: 32"

Vegetation: Grass

Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR 3/2	Clay Loam			
32	10YR 5/3	Clay Loam			
36	10YR 5/3	Clay Loam		Few, Fine, Distinct 10YR5/1 + 6/6	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0150-000 #1
Equipment: 4" Bucket Auger
Highest Known Water: 30"
Vegetation: Trees
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10 YR 3/1	Loam			
24	-	Clay Fill			
40	10YR 3/1	Loam		@ 30" Gray/Red Redox	
50	2.5Y 4/3	Loam		2.5Y 6/1 Depletions	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0150-000 #2
Equipment: 4" Bucket Auger
Highest Known Water: 28"
Vegetation: Trees
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
9	10YR 2/2	Loam			
15	10YR 3/3	Loam			
32	10YR 4/4	Clay Loam		@ 28-32" 7.5YR 5/8 and 10YR 5/8 Concentrations, and 7.5YR 5/2 Depletions	CaCO3 threads
50	2.5Y 4/3	Loam		2.5Y 6/1 Depletions	

Soil Profile Description

Date Completed: 7/16/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0150-000 #3
Equipment: 4" Bucket Auger
Highest Known Water: 48"
Vegetation: Trees
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
6	10YR 2/2	Loam			
10	10YR 3/3	Clay Loam			
22	10YR 4/4	Clay Loam			
36	10YR 4/6 and 5/6	Sandy Clay Loam			
50	2.5Y 5/4	Sandy Clay Loam		@ 48" Very Little Redox	
60	2.5Y 6/4	Sandy Loam			platy-like
74	2.5Y 6/4	Silt Loam			

Soil Profile Description

Date Completed: 7/15/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

Test Pit # 12-0083-000
Equipment: 4" Bucket Auger
Highest Known Water: 42"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
30	-	-			FILL
42	10YR 6/2	Sand			Moist
46	10YR 6/2	Sand			WET
46+	10YR 6/2	Coarse Sand			Saturated

Soil Profile Description

Date Completed: 7/15/2010
Completed By: Peter G. Miller, P.S.S. License No. 42636
Project: Carlos Township
Landscape Position:
Mapped Soil Type:

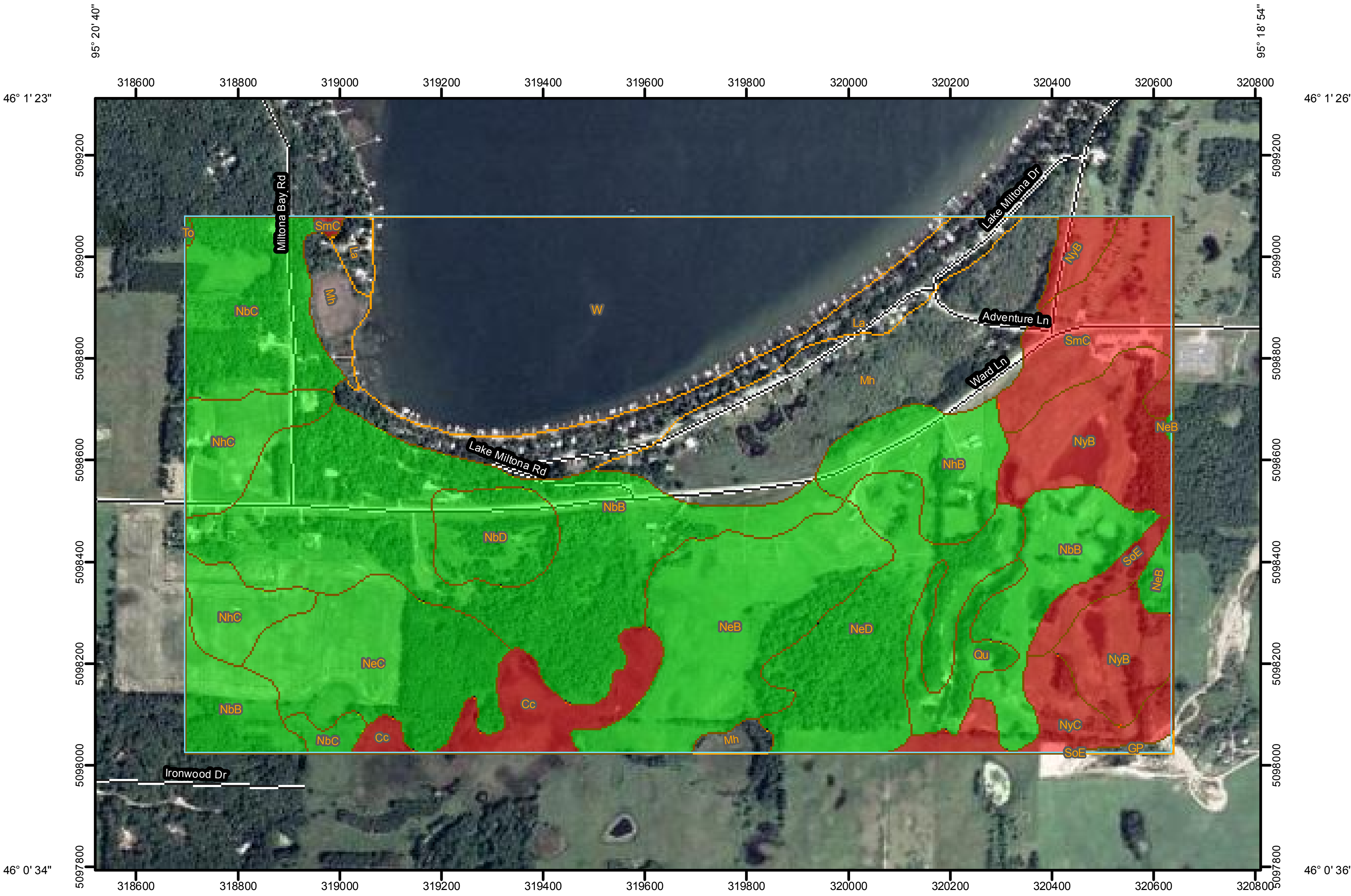
Test Pit # 12-0109-000
Equipment: 4" Bucket Auger
Highest Known Water: 16"
Vegetation: Grass
Parent Material:

HORIZON DEPTH END (INCHES)	MATRIX COLOR	TEXTURE	STRUCTURE-CONSISTENCE	REDOXIMORPHIC FEATURES	OTHER
8	-	-	Sandy Fill		
16	10YR 2/1	Loam			
16+	10YR 2/1	Sand	WET		

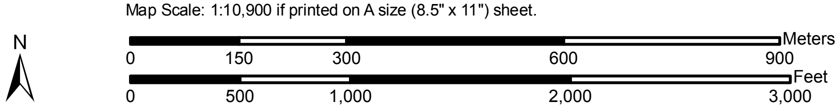
Appendix E

Aquifer Sensitivity Map for Sanitary Facilities

Aquifer Assessment (MN)—Douglas County, Minnesota
(Carlos Township CAR)



Map Scale: 1:10,900 if printed on A size (8.5" x 11") sheet.



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

Sensitive

Not sensitive

not rated or not available

Political Features

Cities

Water Features

Oceans

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:10,900 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 15N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Douglas County, Minnesota
Survey Area Data: Version 8, Feb 5, 2010

Date(s) aerial images were photographed: 7/1/2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Aquifer Assessment (MN)

Aquifer Assessment (MN)— Summary by Map Unit — Douglas County, Minnesota						
Map unit symbol	**Map unit name**	**Rating**	**Component name (percent)**	**Rating reasons (numeric values)**	**Acres in AOI**	**Percent of AOI**
Cc	Cathro muck	Sensitive	Cathro (90%)	Organic soil (1.00)	12.8	2.5%
GP	Pits, gravel-Udipsamments complex	Not rated	Pits, gravel (80%)		0.8	0.2%
			Udipsamments (20%)			
La	Lake beaches, sandy	Not rated	Beaches, lake, sandy (90%)		24.6	4.9%
Mh	Marsh	Not rated	Marsh (90%)		50.6	10.0%
NbB	Nebish sandy loam, 2 to 6 percent slopes	Not sensitive	Nebish (90%)		90.1	17.8%
NbC	Nebish sandy loam, 6 to 12 percent slopes	Not sensitive	Nebish (90%)		24.2	4.8%
NbD	Nebish sandy loam, 12 to 18 percent slopes	Not sensitive	Nebish (90%)		10.4	2.1%
NeB	Nebish loam, 2 to 6 percent slopes	Not sensitive	Nebish (90%)		37.7	7.5%
NeC	Nebish loam, 6 to 12 percent slopes	Not sensitive	Nebish (90%)		27.8	5.5%
NeD	Nebish loam, 12 to 18 percent slopes	Not sensitive	Nebish (90%)		31.7	6.3%
NhB	Nebish-Dorset complex, 2 to 6 percent slopes	Not sensitive	Nebish (60%)		15.3	3.0%
NhC	Nebish-Dorset complex, 6 to 12 percent slopes	Not sensitive	Nebish (60%)		17.3	3.4%
NyB	Nymore loamy sand, 2 to 6 percent slopes	Sensitive	Nymore (90%)	Sand and rock (1.00)	31.7	6.3%
NyC	Nymore loamy sand, 6 to 18 percent slopes	Sensitive	Nymore (90%)	Sand and rock (1.00)	10.8	2.1%
Qu	Quam mucky silty clay loam	Not sensitive	Quam (90%)		8.3	1.6%
SmC	Sioux loamy coarse sand, 6 to 12 percent slopes	Sensitive	Sioux (90%)	Sand and rock (1.00)	19.2	3.8%
SoE	Sioux gravelly loamy coarse sand, 12 to 35 percent slopes	Sensitive	Sioux (90%)	Sand and rock (1.00)	4.3	0.8%
To	Tonka loam	Not sensitive	Tonka (90%)		0.2	0.0%
W	Water	Not rated	Water (100%)		87.5	17.3%
Totals for Area of Interest					**505.5**	**100.0%**

Aquifer Assessment (MN)— Summary by Rating Value		
Rating	**Acres in AOI**	**Percent of AOI**
Not sensitive	263.1	52.0%
Sensitive	78.8	15.6%
Null or Not Rated	163.6	32.4%
Totals for Area of Interest	**505.5**	**100.0%**

Description

The Aquifer Assessment interpretation uses soil properties as a proxy to predict the presence of a sensitive surficial aquifer. Soil properties considered include the texture in the bottom horizon, the presence of bedrock, and the classification of organic soils (Histosols). The Aquifer Assessment interpretation is associated with the "desktop" evaluation of large individual sewage treatment systems to predict aquifer vulnerability and the potential risk of nitrogen impacting the aquifer. Regulatory requirements for large individual sewage treatment systems (flow greater than 2,500 gallons per day) are found in Minnesota Rule Chapter 7080.

The ratings are both verbal and numerical. Soils are assigned to rating classes based on their degree of risk. These classes are "not sensitive" (rating index of 0.00) and "sensitive" (rating index of 1.00).

The components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as the one shown for the map unit. The percent composition of each component in a particular map unit is given to help the user better understand the extent to which the rating applies to the map unit.

Other components with different ratings may occur in each map unit. The ratings for all components, regardless the aggregated rating of the map unit, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Rating Options

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Appendix F

Flow Calculations

Carlos Township CAR
Service Area 2 Cluster SSTS

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	3.00	I	450	1.00	450
2	3.00	I	450	1.00	450
3	3.00	I	450	1.00	450
4	3.00	I	450	1.00	450
5	3.00	I	450	1.00	450
6	5.00	I	750	1.00	750
7	3.00	I	450	1.00	450
8	3.00	I	450	1.00	450
9	3.00	I	450	1.00	450
10	2.00	I	300	0.45	135
11	2.00	I	300	0.45	135
12	2.00	I	300	0.45	135
13	3.00	I	450	1.00	450
14	2.00	I	300	0.45	135
15	2.00	I	300	0.45	135
				Total Dwelling Flow Estimate	5475

* Use 1.0 for the flow from the ten highest flow dwellings and 0.45 for remaining dwellings

Carlos Township CAR
Service Area 2 Cluster SSTS

Minnesota Pollution Control Agency

OSTP Final Permitting Flow Worksheet

University of Minnesota

1. Flow from Dwellings	Flow from Dwellings	**5475**	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:	**2620**	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):	**2.00**	inches	
	c) Flow from I& I in Collection System:	**198**	gpd	

4. Final Permitting Flow	**5673**	gpd	Sum of 1, 2 and 3c.

Carlos Township CAR
Service Area 3 Cluster SSTS

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	4.00	I	600	1.00	600
2	3.00	I	450	1.00	450
3	2.00	I	300	0.45	135
4	3.00	I	450	1.00	450
5	2.00	I	300	0.45	135
6	3.00	I	450	1.00	450
7	3.00	I	450	0.45	203
8	3.00	I	450	1.00	450
9	3.00	I	450	0.45	203
10	3.00	I	450	0.45	203
11	3.00	I	450	0.45	203
12	3.00	I	450	0.45	203
13	3.00	I	450	0.45	203
14	3.00	I	450	0.45	203
15	3.00	I	450	0.45	203
16	3.00	I	450	0.45	203
17	3.00	I	450	0.45	203
18	3.00	I	450	0.45	203
19	3.00	I	450	0.45	203
20	2.00	I	300	0.45	135
21	3.00	I	450	0.45	203
22	3.00	I	450	0.45	203
23	3.00	I	450	1.00	450
24	3.00	I	450	0.45	203
25	3.00	I	450	0.45	203
26	3.00	I	450	0.45	203
27	3.00	I	450	1.00	450
28	3.00	I	450	1.00	450
29	3.00	I	450	1.00	450
30	3.00	I	450	1.00	450
				Total Dwelling Flow Estimate	8498

* Use 1.0 for the flow from the ten highest flow dwellings and 0.45 for remaining dwellings

Carlos Township CAR
Service Area 3 Cluster SSTS

Minnesota Pollution Control Agency

OSTP Final Permitting Flow Worksheet

University of Minnesota

1. Flow from Dwellings	Flow from Dwellings	**8498**	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:	**5350**	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):	**2.00**	inches	
	c) Flow from I& I in Collection System:	**405**	gpd	

4. Final Permitting Flow	**8903**	gpd	Sum of 1, 2 and 3c.

Carlos Township CAR
Spray Irrigation Option

OSTP Flow Estimation: Existing Dwellings

Minnesota Pollution Control Agency

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	4.00	I	600	1.00	600
2	3.00	I	450	1.00	450
3	2.00	I	300	0.45	135
4	3.00	I	450	1.00	450
5	2.00	I	300	0.45	135
6	3.00	I	450	1.00	450
7	3.00	I	450	0.45	203
8	3.00	I	450	1.00	450
9	3.00	I	450	0.45	203
10	3.00	I	450	0.45	203
11	3.00	I	450	0.45	203
12	3.00	I	450	0.45	203
13	3.00	I	450	0.45	203
14	3.00	I	450	0.45	203
15	3.00	I	450	0.45	203
16	3.00	I	450	0.45	203
17	3.00	I	450	0.45	203
18	3.00	I	450	0.45	203
19	3.00	I	450	0.45	203
20	2.00	I	300	0.45	135
21	3.00	I	450	0.45	203
22	3.00	I	450	0.45	203
23	3.00	I	450	1.00	450
24	3.00	I	450	0.45	203
25	2.00	I	300	0.45	135
26	2.00	I	300	0.45	135
27	3.00	I	450	1.00	450
28	3.00	I	450	0.45	203
29	3.00	I	450	0.45	203
30	3.00	I	450	0.45	203

Carlos Township CAR
Spray Irrigation Option

OSTP Flow Estimation: Existing Dwellings

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)
31	3.00	I	**450**	1.00	450
32	3.00	I	**450**	0.45	203
33	3.00	I	**450**	0.45	203
34	3.00	I	**450**	0.45	203
35	3.00	I	**450**	0.45	203
36	5.00	I	750	1.00	750
37	3.00	I	**450**	0.45	203
38	3.00	I	**450**	1.00	450
39	3.00	I	**450**	0.45	203
40	2.00	I	300	0.45	135
41	2.00	I	300	0.45	135
42	2.00	I	300	0.45	135
43	3.00	I	**450**	0.45	203
44	2.00	I	300	0.45	135
45	2.00	I	300	0.45	135
				Total Dwelling Flow Estimate	11363

* Use 1.0 for the flow from the ten highest flow dwellings and 0.45 for remaining dwellings

Carlos Township CAR
Spray Irrigation Option

Minnesota Pollution Control Agency

OSTP Final Permitting Flow Worksheet

University of Minnesota

1. Flow from Dwellings	Flow from Dwellings	11363	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:	5280	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):	2.00	inches	
	c) Flow from I& I in Collection System:	400	gpd	
4. Final Permitting Flow		11763	gpd	Sum of 1, 2 and 3c.